WCRC - 7

Book of Abstracts

WORLD COTTON
RESEARCH CONFERENCE-7

INTERNATIONAL COTTON ADVISORY COMMITTEE

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4-7 October 2022, Cairo, Egypt

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PREFACE

The World Cotton Research Conference is held once every four years in different cotton-growing countries. Cairo is hosting the seventh edition. Previous conferences were held in Australia (1994), Greece (1998), South Africa (2003), the USA (2007), India (2011), and Brazil (2016). With my presence at this conference, I can proudly declare that I am fortunate to have attended all seven WCRCs. Each of the previous conferences exuded its own charm. I enjoyed all of them. They not only provided a platform for the global cotton fraternity to meet but enabled cotton researchers across the world to develop friendships and professional linkages. I am personally aware of several international collaborative research projects that were conceptualized at the conferences and eventually reached fruition to benefit the cotton world.

Einstein once said 'most people say that it is the intellect which makes a great scientist. They are wrong. It is character.' Conferences such as these help us to meet these characters with character. We publish our research as scientific papers. We read papers. We may know the names but not the characters behind the names. It is research conferences which allow us to meet fellow scientists, interact and learn their insights, their passion, their curiosity, and their wisdom. This conference, the WCRC brings us together so that we can present our work, meet our fellow cotton scientists in person and discuss with them to develop professional bonds.

WCRC was the brainchild of Dr. Rafiq Chaudhry, former Head technical information section of the ICAC. He initiated the WCRC and spearheaded six conferences successfully over 22 years. Dr. Rafiq also created the International Cotton Researchers Association (ICRA) as a body of scientists who could conduct the WCRC. The first six WCRCs were conducted by the ICAC. This seventh edition is a joint effort of the ICAC and ICRA. Four leaders, Dr. Michel Fok, former Chair of ICRA, Dr. Mohamed Negm, the current Chair of ICRA, Dr. Eric Hequet, Vice-Chair and Dr. Khalid Abdullah, President of ICRA Secretariat, Pakistan, deserve accolades for coordinating all the conference activities on the ground. The International organizing committee, chaired by Mr. Kai Hughes, Executive Director, ICAC supported the conference well. My colleagues Mr. Mike McCue, Ms. Caroline Taco, Ms. Lorena Ruiz, and members of the ICRA Executive committee chipped in many times to ensure the success of the conference.

We are grateful to Dr. Kater Hake, Vice President, Cotton Incorporated for the tremendous technical support and for helping with platinum sponsorship from Cotton Incorporated and Cotton leads. The ICAC and ICRA are grateful to the Ministry of Trade and Industry, H.E. Ahmed Samir, and Mr. Mohamed Khedyr, Chairman of CATGO, for hosting the conference. We thank Dr. Khalid Schuman, Executive Director, Egypt Cotton Association, and Wael Olma, Chairman Egypt Cotton Association for sponsoring World Cotton Day. We thank all the sponsors for their generosity.

Publishing this 'Book of Papers' wasn't an easy task. Dr. Michel Fok, Dr. Khalid Abdullah, Dr. Mohamed Negm and Dr. MV Venugopalan did a stupendous job as Chief Editors. The subject matter Editors worked hard to maintain quality and conformity to the WCRC standards. Editors of Plant breeding and genetics, Agronomy, Crop Protection, and Molecular Biology had to work more than other Editors, because of the large volume of papers in these disciplines. I am personally gratified to acknowledge Dr. Sabesh, Editor, Information Technology and Socio-economics, for rendering extraordinary help in not only editing articles but also personally type-set and creating this volume.

As organizers, we braved through COVID-19 and through several anxious times to reach where we are today with the conference. Dr, Mohamed Negm and his team deserve a standing ovation for retaining their cheer irrespective of all the turbulences. I congratulate them and would like to thank all the participants of the WCRC-7 for making it a grand success.

-Keshav Kranthi
Chief Scientist, ICAC
Secretary General, ICRA

WCRC-7 – BOOK OF Abstracts

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List of Full Papers

Genetic basis of blending breeding methods/steps spanning across mating system barriers to bring quick genetic gains in Cotton

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Mating system determines choice of breeding methods in a crop and these approaches are contrastingly different because the target genotype to be developed is different. The principles of population improvement involve random mating among selected productive plants of a population and this gives a genetic gain in every cycle. There is an immense scope for deploying this essential step for creating an improved equilibrium population during early segregating generations of cotton because of the ease of crossing. In routine efforts of varietal development the three phases cover the process of **creation of variability** which is unfortunately restricted to use of mere two parents followed by phases of **selection** and **stabilization of transgressive segregants** in to new varietal lines. This paper highlights need for plant breeding system research presents the genetic basis of innovative modifications at all these three levels of varietal development wherever possible supported by results of our own research.

Choice of parents for creating base population with large desirable variability itself is the foundation for successful varietal development. While traditionally two parents are chosen for hybridization but often they do not represent sufficient diversity and complementation for entire range of productivity, fibre quality and stress tolerance traits. Our studies have compared desirable variability released from carefully chosen multiple parent based base population with two parent based crosses and results indicate release of high proportion of desirable variability when a team of parents is constituted to build the base population. Even though the breeeders precious 7-8 years are involved in next two phases, often these efforts go in vain without the breeder coming to know reasons for his failure.

The Case of Missing most potential transgressive segregants: Population size raised during F_2 is a miniscule of what is required to be raised and too small as compared to the minimum population (4^n) which runs to trillions in realistic situations ('n' in hundreds) to be raised in F_2 Because of the sampling effect, most potential transgressive segregants are mostly absent in it. However the superior selections available in the population carry bits and pieces of the superior genetic background of these missing most potential transgressive segregants. A step of random mating among them will act as stitching together these desirable bits and pieces of their genetic constitution which can help in recreating the missing most superior genotypes. Our study in cotton provides clear evidence of this effect based on the performance of the restructured population parse as well as the best segregants selected there of.

Implication of reducing minimum population size: With every generation of selfing the mask heterozygosity becomes more transparent and the genotypic values become automatically reliable and this decrease is highly significant in first generation resulting from selfing. i.e. F_3 and further more in F_4. As a result of this, reliability of genotypic values increases and the chance of observing superior segregants increases. Parallelly the requirement of minimum population size reduces considerably on moving to F_3, and to F_4. This situation gives number of options of innovative modifications in handling segregating generations through a blend of step of SSD and pedigree methods. Effective use of off seasons enables breeder to dump large population of F2 through close spacing so that the selection can be initiated in F_3 during regular crop season. Handling early segregating generations can be characterized by a generation under selection followed by the next through using single seed/hill, a wise blend of steps of pedigree and SSD. Many situation based mix and match combinations of steps of SSD and pedigree methods are suggested here (supported by our studies) to increase genetic gain per unit time. This also gives scope for effective testing of consistency of performance of a line over two successive generations in the same season by raising them perhaps in two replications or in adjoining rows.

The Myth about proportion of homozygous individuals: Generally F_6 assumes a special significance as, in pedigree method by this generally with in line variability is ignored for selection while in SSD method, artificial selection initiated by this generation. However considering a realistic situation of segregation involving loci running to hundreds proportion of true sense homozygous plants is abysmally low (less than 0.1%) but by reconciling with the concept of accepting them as nearly homozygous plants the proportion increases to >90%. It must be hence remembered that residual heterozygosity needs to be addressed and attach importance to purifying it over generations by continuing to maintain individual plant selections of these proven potential lines. Further the advantages of storing remnant seeds of the selected plants of early generations are suggested in enhancing chance of obtaining still better segregants.

Concept of target genotype: It is very essential to understand the relative distribution of desirable alleles /traits between parents used for creation of variability. If the distribution is equal between two parents handling F_2 and subsequent segregating generations becomes relevant because here majority of the segregants are having close to 50:50 distribution of alleles from the two parents, and if the distribution is unequal it calls for case dependent modification such as handling BC_1 derived segregating generations etc. Comparison of performance of different segregating and back cross derived generations is given in support determination of target genotype. Some defects related to maintenance of minimum population size in back cross breeding are also explained and suggestions on modifications in handling back cross generations are made.

Concept of allelic frequency differences, heterosis and exploiting heterotic groups: Creation of allelic frequency differences leads to developing a unique disequilibrium population where frequency of heterozygote is higher than expected in equilibrium F_2 population. This increase is directly proportional to allelic frequency difference between the pool of male and female gametes and this itself termed as genetic distance which figure seen the formula of heterosis ($HF_1=dy^2$). This calls for forming heterotic groups and exploiting them to enhance genetic distance and in turn heterosis. The population improvement schemes defined for random mating crops such as Reciprocal recurrent selection has been modified to suit the mating system of cotton and the encouraging results are explained. Good knowledge of Population Genetics helps the breeder to execute innovative modifications and the genetic gain per unit time can be enhanced.

2

Validation of qFL-CHr25, a QTL for fiber length introgressed from *G. barbadense*

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Background:

The narrow genetic base for elite upland cotton (*Gossypium hirsutum L.*) germplasm has hindered the long-term improvement of yield and fiber quality.

Results:

Quantitative trait loci (QTL) introgression from sister taxa such as from *Gossypium barbadense* has been shown to confer positive effects on fiber quality. Previously, our group has identified a fiber length QTL *qFL-Chr.25* introgressed from *G. barbadense* and further validated its genetic effects in four different *G. hirsutum* backgrounds. Recent comparative transcriptome analysis via RNA sequencing has identified two candidate genes originating from *G. barbadense* that are significantly down-regulated during fiber development when compared to the native *G. hirsutum* genes.

Conclusion:

Work is now in progress on functional validation via CRISPR-Cas9 gene silencing.

Keywords:

CRISPR-Cas9, gene silencing, Quantitative trait loci, fiber quality

Evaluation of new cotton (Gossypium hirsutum L.) genotypes for yield and fiber traits

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Background:

Cotton (*G. hirsutum* L.) is cultivated in tropical and subtropical regions of the world for fibre and oil. As a result, the current study was carried out to evaluate the genetic variations of yield and fibre quality features in cotton, as well as to investigate the heritability and correlations that exist between the characters. In this context, a set of 08 advance cotton lines were evaluated at Cotton Research Institute, Tandojam during Kharif season 2020.

Results:

The mean squares of genotypes were significantly differences (P<0.01) for all studied traits. Regarding the agronomic performance, the genotype A-2 was noted as promising one in average values for maximum number of characters including plant height (147.53 cm), sympodial branches plant^{-1} (27.86), bolls plant^{-1} (31.80), seed cotton yield plant^{-1} (96.32 g) and staple length (28.53 mm), hence provides a great worth to be used as commercial cultivar. Three traits namely plant height (0.51*), sympodial branches plant^{-1} (0.92**) and bolls plant^{-1} (0.90**) were noted in useful associations, hence these characters would be set as selection criteria for evolving high yielding cotton genotypes. All studied characters revealed high heritability with range from 93.80% (boll weight) to 98.67% (plant height), indicating that agronomical characters were under the control of genes.

Conclusion:

It was concluded that newly evolved cotton cultivars retain substantial genetic variations for agronomical characters.

Keywords:

Upland cotton, correlation, heritability, yield traits, fiber traits

QTLs mapping linked with cotton leaf curl disease resistance in cotton (*Gossypium hirsutum L.*) using microsatellite markers

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Cotton leaf curl disease (CLCuD) always a danger to production of cotton (*Gossypium hirsutum* L.) in Pakistan, India, China and some parts of Africa. A molecular mapping F2:F3 population was derived from two diverse (*G. hirsutum* L.) cultivars AGC-555 X S-12 in order to perform quantitative trait loci (QTL) mapping to estimate the genetic inheritance and genomic position of genes linked with CLCuD. QTL mapping for CLCuD recognized simple sequence repeat (SSR) markers linked to resistance of this disease found in the similar region where my previous study identified many QTLs linked to this disease. A linkage map of 107 loci was established in segregating mapping population with 18 linkage groups covering 219.4 cm of genetic map.

Molecular mapping analysis for QTLs identification using 1350 markers on segregating mapping population identified (NAU5418 and JESPR158) in F2 and (JESPR158, NAU3377 and NAU5418) in F3 significantly associated with CLCuD resistance based on different reading data at chromosome number 11. In F3 population QTL identification at 60 days disease severity reading had maximum LOD score of 8.55 with JESPR158 and NAU3377 which supply about 22.18 % phenotypic variance (PV). Both the QTLs in F2 and F3 population distinguished at 60 days reading (qCLCuD-11-60d2,qCLCuD-11-60d3) along with flanking markers NAU5418, JESPR158 and NAU337 with LOD value of 7.63 and 8.55 respectively, which together give 42.77 phenotypic variance percent (PV%). Similarly in populations F2 and F3 mean reading values recognized 2 QTLs qCLCuD-11-m2, qCLCuD-11-m3 with NAU5418, JEPR158 and NAU3377 SSR markers with LOD score of 6.28 and 5.28 respectively, which together supply 28.73 PV%. QTLs distinguished during this study could be helpful to find out resistance sources of CLCuD with screening of these identified SSR markers.

Key Words: QTL mapping, CLCuD, molecular markers, SSRs, *Gossypium hirsutum* L.

Quantitative genetic analysis of yield, fibre and physiological traits for drought tolerance of elite cotton cultivars

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Classification of stress tolerant cotton genotypes is a big challenge for breeders and physiologists. In quantitative genetics, diallel analysis is one of the most important mating designs which are being used to identify superior genotypes for hybridization and selections programmes for various objectives. Six cotton genotypes viz. CRIS-134, Sadori, CIM-496, Sindh-1, and CIM-506 were crossed through 6 x 6 half diallel mating fashion during 2010 and 15 F1 hybrids were evaluated for genetic analysis in 2011. The experiment was carried-out in a factorial design with two irrigation regimes (non-stress vs. water stress at reproductive stage) in four replications at experimental field, Department of Plant Breeding and Genetics, Sindh Agriculture University, Tandojam during, Pakistan. The significance of treatments x genotypes interactions revealed that cotton cultivars performed variably over irrigation regimes. The mean squares for general combining ability (GCA) and specific combining ability (SCA) for most of the characters under water stress and normal irrigation were significant which indicated that both additive and non-additive genes were advocating the characters studied. However the SCA variances were higher than GCA for boll weight, leaf area, relative water content, and stomatal conductance indicating the predominance of dominant genes for these traits. Nonetheless, GCA variances were greater for other traits such as sympodia plant-1, bolls plant-1; seed cotton yield kg ha-1, lint%, staple length and fibre strength suggesting predominance of additive genes controlling the above characters. The parents CRIS-134, Sadori, and CIM-534 with higher GCA estimates proved as good general combiners while hybrids like Sadori x Sindh-1, CRIS-134 x Sadori, CIM-496 x CIM-534, Sadori x CIM-534 and CIM-496 x CIM-534 by expressing higher SCA effects for majority of traits were considered as good specific combiners, thus they are suitable for hybrid cotton development for both stress and non-stress environments. The combined correlation coefficients (r) determined from pooled data of parents and their F1 hybrids revealed that by and large, the correlations were higher in moisture stress than in non-stress environment. In stress conditions, the high positive associations between yield, fibre and physiological traits were recorded.

Keywords:

General and specific combining ability, drought tolerance, upland cotton

Screening of elite upland cotton genotypes for drought tolerance at seedling stage

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Considering the severity of drought on early stage of cotton The present research was conducted to screen out cotton cultivars for drought tolerance at seedling stage. The experiment was laid-out in a Randomized Complete Block Design with factorial arrangement in three replications at experimental area of the Department of Pant Breeding and Genetics, Sindh agriculture University Tandojam. Six popular cotton cultivars like CRIS-134, CRIS-342, CRIS-121, Sadori, Chandi and Sindh-1 with diverse pedigree and characters were evaluated. The experiment was conducted with two treatments (optimum irrigation and water stress till 44 days of sowing). The control treatment received two irrigations, first after 25 days of sowing and second after 44 days of planting while drought stress treatment received no irrigation till 44 days of sowing. The eight developmental traits studied were; root length (cm), shoot length (cm), number of lateral roots, root fresh weight (g): root dry weight (g): shoot fresh weight (g): shoot dry weight (g) and root-shoot ratio. Results suggested that genotypes and the traits differed significantly at $P \leq 0.01$ level. Due to genetic variability there were two reactions of cultivars under waters stress. The first group of cultivars like, CRIS-134 , CRIS-342 and CRIS-121 which were identified as drought tolerant increased their root lengths, no of lateral roots, root-shoot ratio, root dry weight in drought stress and gave less decline in above mentioned traits. Conversely the second group of cultivars like Sadori, Chandi Sindh-1 being sensitive to drought stress recorded significant decline in root length, number of lateral roots, root dry weight and root-shoot ratio under water stress conditions.

Keywords:

Screening , drought tolerance, upland cotton.

Overview: Smart breeding and genetic approaches in determining the role of gossypol as a friend or a foe

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Background:

Cotton seed has significant contribution in fiber, oil and feed in various industries around the globe, so it is declared as a multipurpose crop in tropical and sub-tropical regions. Despite of the fact that Pakistan is 4th largest producer of cotton, it is placed on 106th position amongst the 119 countries listed on Global Hunger Index (GHI). Fiber and fiber products have a major share in exports; however, cottonseed products are mostly utilized locally, due to having oil (23%) for human consumption and protein rich (21%) cottonseed cake as cattle meal. Unfortunately, the potential to utilize this high nutrient feed is limited due to the presence of gossypol. Gossypol is a toxic terpenoid and binds with the proteins during heating process of oil extraction that lead to less availability of proteins to the consumer. Approximately 14,000 mg/kg of total gossypol and 7,000 mg/kg of free gossypol are packed in small sacs in cottonseed, resulting in gossypol toxicosis which compromises the standards of international food safety. Due to this fact several developing countries which are good producers of cotton cannot take benefit from this protein resource. Besides this, cotton has higher adaptability to grow in warm and humid climate where insect-pest threshold is a major challenge. Gossypol, being a phenolic aldehyde is secreted by pigmented glands is considered as a natural defense barrier to combat the occurrence of insect-pest. To take the advantage of gossypol effectively from foliage as a friend and eliminate its toxic effects from seed products as a foe, allow the development of glandless cotton seed varieties without disturbing gossypol and linked terpenoids in other parts of the plants. Gene editing through CRISPR-CaS combined with other research practices *i.e.,* RNAi has been carried out to develop ways for low gossypol varieties. *G. sturtianum*, a wild species of cotton has leaves with dense gossypol but glandless seeds are reported in the literature. This feature provides the opportunity to plant breeder to exploit for the development of new germplasm for cited title.

Keywords:

Cotton; gossypol; terpenoid; food safety.

Evolution of Introgressed and Highly Cotton Leaf Curl Virus Tolerant Cultivar“Cyto-124”

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Central Cotton Research Institute (CCRI), Multan, Pakistan has evolved upland cotton cultivar “Cyto-124” through introgression for Cotton Leaf Curl Virus (CLCuV) resistance. It was developed through crossing [{2(G. hir. x G. ano.) X 3 G. hir.} x {2(G. arbo. x G. ano.) x 2 G. hir. It was tested for seedcotton yield in varietal trials, zonal varietal trials at Govt. and farmer fields. In varietal trails, Cyto-124 gave 37.1, 19.9 and 22.4% higher yield as compared to three standards MNH-786, CIM-554 and CRSM-38 respectively. In zonal trials, Cyto-124 had seedcotton yield 3075 in-contrast to 2919 kg ha -1 of CIM-573. Cyto-124 produced more SCY than the standards for two consecutive years (2013 & 2014) in National Coordinated Varietal Trial (NCVT). In NCVT during 2013-14; this strain had maximum yield of 2244 kg/ha -1 compared with 1326 kg ha -1 of standard variety CIM-573 in the Punjab. The virus data taken in NCVT indicated that minimum disease incidence was recorded in Cyto-124 making it the highly tolerant variety against CLCuV. The approval of this CLCuV highly tolerant cultivar will considerably contribute a lot in revival of cotton.

Key Words:

Cotton, Interspecific, CLCuV, Tolerant, Fibre Quality

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Biochemical assays are reliable tool for identification of salt tolerance in *Gossypium hirsutum L.*

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Background:

Salinity is a global issue which is increasing due to uncontrolled measures and improper land management. The effects of salinity (abiotic stress) are increasing significantly throughout the cotton regions due to climate change. Salinity not only effects the yield potential but also deteriorate the quality of lint. Such conditions provide an opportunity to cotton breeders to identify and develop salt tolerance germplasm by using physiological and biochemical parameters as reported for other crops.

Results:

Various populations were developed by crossing of salt tolerant and susceptible genotypes of cotton following the line × tester fashion in field conditions to understand the genetic basis of salt tolerance. The use of biochemical assays is increasing in current scenario for identification of potential genotypes against certain stress, particularly abiotic stresses. So, the data of various biochemical parameters namely CAT, POD, proline and H_2O_2 in addition yield and fiber traits were collected from cotton grown in control and saline conditions *i.e.,* 10 dSm^{-1} and 15 dSm^{-1}. The plant material showed significant difference for the recorded parameters, indicated the presence of diverse genetic background of the cotton accessions. So, the same data set was analyzed for other biometrical approached. It was found that the effects of salinity were significant for yield contributing traits namely, plant height, number of bolls per plant, boll weight and ginning turn out. The performance of MNH-1016, CIM-616 and IUB-212 was good due to preponderance of additive gene effects and found to be good general combiner for cited yield and biochemical traits, besides fibre traits namely, fiber length, fiber strength and fineness, also for ionic traits (Na^+, K^+ and K^+/Na^+). Similarly, accessions NIAB-1048, FH-144, DNH-40 and CIM-602 were found to be good general combiner for specific and cited traits. The cross of IUB-212 with NIAB-1048 also showed good specific combining ability for number of bolls per plant, boll weight, seed cotton yield, fiber length, fiber fineness, and fiber strength.

Conclusion:

The laboratory-based assays mentioned are found to be dependable tools for characterization of large germplasm of cotton against salinity. Besides, this study provides an opportunity to cotton researchers for identification of specific combinations from filial generations for breeding for salt tolerant genotypes.

Keywords:

Biochemical; cotton, salinity stress, yield traits

Potential of biochemical assays for identification of salt tolerance in *Gossypium hirsutum L.*

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Keywords:

Biochemical; cotton, salinity stress, yield traits

Cotton germplasm characterization for drought tolerance based on morpho-physiological and quality parameters.

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Abstract

Drought tolerance is a quantitative trait which is very hard to manipulate in allotetraploid cotton (*Gossypium hirsutum* L.) using breeding approaches. The future scenario of limited water resources, demands efficient screening approaches for developing drought tolerant cotton varieties, which can save major share of irrigated water during the summer.

Correlation Studies Among Morphological Traits Providing Natural Resistance Against Insect, Pest And Yield In Upland Cotton (*Gossypium hirsutum L.*)

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Background:

Worldwide cotton production is handicapped by more than 1326 insect species and in Pakistan 93 insect pest species were discovered which significantly reduce its yield. Insect pest attack drops crop production from 30 to 45 percent and yield losses are greater than 70 percent in the absence of preventive measures. Mostly farmers prefer to use insecticides and pesticides because of their quick action but extensive use is becoming the source of human & animal health problems, environmental pollution, and resistance in insects, disturbance of natural equilibrium. Therefore, it is essential to adopt alternative method which is compatible with environment and inexpensive for farmers.

Results:

13 different traits associated with genetic defense umbrella of cotton plant revealed significance difference among of 50 different elite cotton genotypes. Correlation matrix exhibited a single character association can be helpful for better yield results. Traits such as leaf hairiness, stems tip hairiness, gossypol content, okra leaf type etc. can be desirable for high yield production and resistance against insect pest population. Cluster analysis depicted specific genotypes responsible for the better performance of a typical character. Principal component analysis showed that elite traits with positive or negative correlation with other traits can be selected for breeding purpose. During the first year, elite association was found among traits such as bract width, boll weight and stem tip hairiness while in the second year elite relationship was found among leaf hairiness, stem tip hairiness, gossypol content and bract length. For both the years (2020-21) there were total three clusters and second cluster had greater number of genotypes. First year, genotypes in cluster-1 elucidated maximum genetic divergence against cluster-2 and 3 whereas cluster-3 depicted minimum genetic divergence while second year genotypes in cluster-1 elucidated maximum genetic divergence against cluster-3 whereas cluster-3 depicted minimum genetic divergence. The cumulatively variability was 63.95% and 61.77% of total variation for the both years.

Conclusion:

The alternative method of insect control to reduce yield losses is to breed for natural resistance against insect pest. Promising traits such as leaf hairiness, stem tip hairiness, gossypol content, okra leaf type are desirable for high yield and provide tolerance against insect pest. These traits having significant positive correlation with insect control and high yield can be used to breed elite cotton genotypes for future breeding programs.

Key Words:

Cotton pest, Correlation study, Principle component analysis, Natural resistance.

Correlation and path coefficient analysis of polygenic traits of upland cotton genotypes grown in Zimbabwe

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Background:

Cotton consists of traits with different associationship due to genetic and environmental factors. In order to determine the degree of association between seed cotton yield and important traits, a study was done using a RCBD experiment with ten genotypes. Seed cotton yield, GOT, lint yield, boll weight, bolls per plant, seed weight, plant height, fibre length, elongation, fineness and strength data was collected and analysed. Genotypic and phenotypic correlation analysis was done in Meta R and estimation of the direct and indirect effects using path analysis.

Results:

Analysis of variance revealed significant differences for boll weight, seed weight, GOT and plant height. Seed cotton yield was correlated with lint yield (r = 0.71***), fibre elongation (r = 0.54***), bolls per plant (0.27***), seed weight (r = 0.22***), strength (r = 0.21***) and fineness (r = 0.13*) at genotypic level. Gin outturn was correlated with lint yield (r = 0.70***), elongation (r = 0.60***) and strength (r = 0.50***). Boll weight was correlated with seed weight (r = 0.56***) whilst plant height was highly associated with fibre strength (r = 0.58***). The adjusted R Square (0.98), low standard error (0.12) and low residual effect (R=0.01) in regression analysis indicated that variability of seed cotton yield was explained by the causal variables. Lint yield had the highest direct effect on seed cotton yield (r = 1.055). Traits that could be used for indirect selection were bolls per plant (r = 0.006), seed weight (0.022) and or plant height (0.012). Gin outturn (0.737) had the highest indirect contribution to seed cotton yield through lint yield, followed by strength (0.012) through plant height, seed weight (0.011) through boll weight, fibre fineness (0.010) through boll weight.

Conclusion:

It was therefore concluded that selection of high yielding cotton genotypes could emphasise more on lint yield, boll weights, plant height and bolls per plant for better performing lines. Gin outturn and fibre strength could be used indirectly to improve seed cotton yield through other traits.

Key words:

Phenotypic, genotypic, correlation, path analysis

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Assessment of physiological and biochemical assays in Gossypium hirsutum under heat stress

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Background:

Cotton plant is sensitive to heat stress at all the stages of its lifecycle, but square, bud formation, flower development, and boll formation are more vulnerable to high temperature fluctuations. Heat stress increases the production of reactive oxygen species, *i.e.,* hydrogen peroxide (H_2O_2) in cotton. Increased concentration of H_2O_2 causes oxidative stress that leads to lipid peroxidation in plasma membrane. Proteins of cellular membranes also denatured when crop plant is exposed to high temperature. Thus, increased electrolyte leakages from membrane that reduce the cell membrane thermostability under stress conditions.

Results:

The research work was planned to assess the potential of 154 accessions of cotton for heat tolerance by using various physiological and biochemical traits. Increased concentration of peroxidase (≥ 24 U mg^{-1} protein) and proline (≥ 1.05 µmol g^{-1} FW) were recorded in some accessions under heat stress conditions. The genotypes high value of peroxidase activity showing, and proline content were found to be optimal for hydrogen peroxide concentration (0.15 to 0.55 µmol g^{-1} FW). Pollen viability varied significantly among the genotypes from 45 to 70 % under heat stress conditions. Genotypes with better agronomic and fibre quality performance were also higher in cell membrane thermostability (≥ 55 %) and pollen viability (≥ 65 %). K-means cluster and principal component analysis further confirmed positive relationship among these traits and grouped the genotypes based on the performance. The genotypes, IUB-13, GH-Mubarak and FH-Lalazar were grouped as heat tolerant, while NIAB-Kiran, FH-115 were grouped as heat susceptible accessions. Later on, heat tolerant and susceptible genotypes were hybridized to develop filial and backcross generations to understand the genetic basis of cited traits and developing germplasm for the said purpose.

Conclusion:

Current study has enabled us to understand the variables for selecting heat tolerant germplasm. The baseline data generated through this experiment is helping us in identification of heat tolerant genotypes in filial and backcross populations developed through crosses of heat tolerant and susceptible germplasm.

Keywords:
Abiotic stress; Climate Change; High temperature; Seed cotton yield

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Comparative study of 67 cotton cultivars tested in 2021-National Coordinated Varietal Trial (NCVT) conducted at 12 different agro-ecological zones of Pakistan

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Background:
National Coordinated Varietal Trial (NCVT) is conducted annually by Pakistan Central Cotton Committee (PCCC) with the objective to test promising cotton strains/cultivars developed by breeders of various federal and provincial public institutes and private sector organizations as well. These cotton varieties are tested for 2 consecutive years for their yield potential, fiber and bio-chemical characteristics in different agro-ecological zones prior to their approval for general cultivation. The data generated through NCVT are used as a basis for variety approval process by the provincial seed councils.

Results:
In 2021-22-NCVT, sixty seven (67) cotton varieties with two standard varieties (CIM-600 and CIM-610) were tested in 12 different agro-ecological zones at 19 different locations in four provinces (Punjab, Sindh, Balochistan, KPK) across Pakistan. The 39 candidate varieties were from public sector institutes and 27 candidate varieties from the private sector organizations. Among 67 varieties 43, 22 and 2 varieties were tested for their 1st, 2nd and 3rd year, respectively. The technologies claimed in these candidate varieties were non-Bt (2), single gene (47), Double gene (3) and Triple gene (15) varieties. The 67 candidate varieties were divided into 4 sets named as set-A, set-B, set-C and set-D. The varieties IR-NIBGE-17 (2182 kg/ha^{-1}), FH-189 (2981 kg/ha^{-1}), BH-226 (3668 kg/ha^{-1}), Cyto-230 (2789 kg/ha^{-1}), ICS-386 (2767 kg/ha^{-1}) showed highest yield in Punjab, Sindh, Balochistan, KP and on Pakistan basis, respectively. The varieties Cyto-227, FH-494 and IR-NIBGE-16 showed highest staple length (29 mm). The average quantification of genes in single, double and triple gene varieties was 2.75 µg g^{-1} (Cry1Ac), 2.42 µg g^{-1} (Cry1Ac+Cry2Ab) and 1.01 µg g^{-1} (Cry1Ac+Cry2Ab+GTG) was studied.

Conclusion:
The highest average yield among four provinces was obtained in Balochistan (3343 kg/ha^{-1}) and average yield of Pakistan remained at 2521 kg/ha^{-1}.Among 67 varieties, in four sets, only 15 varieties were found above standard in terms of yield in Punjab & KP provinces and 11 in Sindh and Balochistan provinces. The data obtained from these trials revealed the adaptability and production potential of

these genotypes in different agro-climatic ecological zones and this data would provide a guideline to the provincial seed councils while granting official approval for general cultivation.

Keywords:
Varietal trial, Staple length, non-Bt, climatic zones, Bt gene, Yield

Inheritance studies of fiber colour in natural Colour-cotton (Gossypium spp.)

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Background:

Chemical dyeing is still used to colour the cotton cloth. Textile effluents are highly toxic to human beings and pose a serious threat to ground and surface water resources. To mitigate these, natural colour-cotton is an attractive proposition for the textile industry. An understanding of inheritance of fiber colour trait helps to accelerate colour cotton breeding. Genotypes contrasting in fiber colour trait were crossed to develop hybrids during the 2016 rainy season. F_1, F_2 and backcrosses in six crosses were developed during summer 2016. These generations were then evaluated and the pattern of segregation for fiber colour was recorded during the 2017 and 2018 rainy seasons at Agricultural Research Station, Dharwad farm, University of Agricultural Sciences, Dharwad.

Results:

Results indicated that the brown and almond fiber colour is partially dominant over white fiber colour. Dark brown was controlled by two genes with duplicate dominant interaction whereas almond colour was under the control of biallelic single gene. Green fiber colour was inherited as monogenic biallelic with white as dominant over green. Brown and almond were partially dominant over white and green.

Conclusions:

Fiber colour trait is simply inherited and easily assayable using visual assessment. Transfer of fiber colour in the background of agronomically superior genotypes can be easily achieved.

Key words:

Inheritance, colour-cotton, Fiber colour

Introgression of Cotton Leaf Curl Virus (CLCuV) resistance from Wild Species to Upland Cotton

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Background:
Cotton leaf curl virus disease is a major hurdle for successful cotton production in Pakistan. Economic loss due to this disease is estimated about 10.5 billion US $. Introgression of desirable traits in upland cotton has been going on in this institute since 1985. This disease spread in epidemic from 1992 to 1995. The first CLCuV resistant variety was evolved in 1996 at Central Cotton Research Institute (CCRI), Multan/Pakistan. Resurgence of this disease occurred in 2001 (Burewala) breaking resistance of all exiting available germplasm of cotton. Interspecific hybridization for leaf curl virus resistance is the only economical and long term approach to tackle this hazardous problem. A total of 3338 genotypes were screened during 2003 to 2004 but none of these genotypes showed resistance to this disease. Two cultivated diploid species viz *Gossypium herbaceum* A1, *G.arboreum* A2, and eight wild species viz *G. anomalum* B1, *G. capitisviridis* B4, *G. gossypoides* D6, *G.laxum* D8, *G. stocksii* E1, *G. somalense* E2, *G. areysianum* E3 and . *longicaly* F1. *G. arboreum* is immune to CLCuV, two synthetic allotetraploids of 2(*G. hirsutum* L x *G. anomalum*) x 3*G. hirs*. and 2 (*G. arboreum* L x *G. anomalum*). x 2*G. hirs*. were manually hybridized under field conditions. These two hybrids were also crossed for gene pyramiding [{.2 (*hirs*. x *G. anom*.) x 3*G. hirs*.} x {2*G. hirs*. x 2 (*G. arbo*. x *G. anom*) x 2*G. hirs*}] x 2*G. hirs*.

Results:
Exogenous hormones containing 50 mg/l gibberellic acid and 100 mg/l naphthalene acetic acid was applied to control boll shedding. 3:1 ratio was not observed in above said combinations. Some plants were found resistant against CLCuV by using petiole grafting technique. But no resistance was observed. Maximum tolerance was found in this combination, that is, [{.2 (*hirs*. x *G. anom*.) x 3*G. hirs*.} x {2*G. hirs*. x 2 (*G. arbo*. x *G. anom*) x 2*G. hirs* }] x 2*G. hirs*.

Conclusions:
By using this material; upland cultivars have been evolved having high tolerance to CLCuV; this will increase cotton production.

Keywords:
Cotton, interspecific, CLCuV, Fiber quality

Genetics and Pattern of Inheritance of Cotton Leaf Curl Disease Resistance Genes in Upland Cotton (Gossypium hirsutum L.)

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Cotton Leaf Curl Disease (CLCuD) has been causing huge yield losses to the cotton crop in South Asia since its first epidemic during early 1990s. Researchers face many serious problems while screening and breeding for CLCuD resistant varieties. The absence of a reliable screening system, controversial inheritance data about the disease resistance, lack of genetic information about the resistance sources used as breeding material and reliability on small segregating populations are the major reasons in the failure of several cotton varieties that were initially released as resistant to CLCuV. In the present studies we used a highly CLCuV susceptible breeding line Stoneville-47 tagged with a herbicide resistance marker gene (Round-Up-ready cotton) to cross with newly discovered resistant accessions i.e. Mac-07 and USG13_1087 to understand the genetics of resistance and pattern of inheritance of resistance genes against CLCuD. The screening of breeding material against CLCuD, was carried out in the pots followed by grafting with susceptible scions and quantification of begomovirus and associated betasatellite by qPCR in the parental genotypes. The Chi-square test reflected a single dominant gene/cluster of tightly linked resistance genes controlling disease resistance by analyzing F_1, F_2 of direct and reciprocal crosses. However, the data from backcrosses of F_1s with the resistant parents suggested involvement of certain modifying factors/suppressors, which affect the expression of resistance gene(s). The circumvention of the suppressors of resistance from the selected progenies can only be achieved by raising larger plant populations with a clear picture of segregation of the resistant gene cluster.

Keywords:

Grafting, qPCR, CLCuD, disease resistance, genetics

Evaluation Of Different Embrapa Cotton Cultivars In Paraguay

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Cotton (*Gossypium hirsutum*) is a characteristic and traditional crop for Paraguayan farmers. Is one of the few income items that small producers can produce with their resources and have an assured market. The lack of cotton quality seeds is one of the main problems that producers face, affecting their yield, fiber quality and income generation. In this context is that the Trilateral South-South Cooperation Project, +Cotton, jointly with Embrapa and IPTA ran field test to validate different cotton varieties in Paraguay. The objective of this study was to evaluate the agronomic and technological behavior of four Embrapa white cotton fiber varieties (BRS 335, BRS 336, BRS 286 and BRS 293), with the commercial samples IAN 425 and Delta Opal under the agroecological conditions of the eastern region of Paraguay. The research was carried out in three IPTA fields (Caacupé, San Juan Bautista and Tomás Romero Pereira), during the 2016/17, 2017/18 and 2018/19 campaigns. The field's experimental design consisted of randomized blocks with six treatments, with four repetitions each, four rows per 10-meter plot. A distance of one meter between rows and six to eight plants per meter, with the two central rows of each plot being used. Sowing with a technical manual system, with a population of 70 thousand plants per hectare. The variables evaluated were plants height, cocoon weight, fiber yield, 100 seeds weight, cotton in-branch yield and fiber's technological quality. The variance analysis of the average of three years was made with the "GENES" program of the Federal University of Viçosa (Brazil), didn't detect significant differences for yield, only to highlight, the best yield was given by the variety BRS 286 with an average yield of 2.724 kg/ha of cotton in-branch followed by the BRS 293 with 2.535 kg/ha, against the country's commercial witnesses. The mentioned varieties also stood out with significant differences for the average capsules weight and the ginning fiber yield. The fiber samples were analyzed in the laboratory of Embrapa Cotton in Brazil with excellent results for all varieties understudy, not detecting significant differences between treatments. The information about these new materials is presented with very good options for the cotton growers in the country, contributing to the national cotton genetic improvement, strengthening the technical capabilities of technicians and researchers, and facilitate access to quality cotton materials for cultivation.

Keywords:

Gossypium hirsutum, variety, yield

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Genetics and breeding in upland cotton based on an 8-way MAGIC population

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Background:

Upland cotton (*Gossypium hirsutum* L.) provides the most natural fibre for the manufacture of textiles worldwide. And it is one of the most important economic crops in China. The growth period, plant type, yield, and fiber quality are important agronomic traits that decide the economic value and planting pattern of upland cotton. They are quantitative traits with a complex genetic basis that are controlled by multi-genes with small effects. Therefore, it is difficult to improve them based on traditional breeding methods. Revealing the genetic basis of these agronomic traits will promote the development of high-efficiency molecular breeding in upland cotton.

Results:

The multi-parent advanced generation inter-cross (MAGIC) population was reported with high power and advantage in QTL mapping compared with bi-parental segregation population and natural population. In this study, a MAGIC population containing 960 lines (MLs) was developed based on 8 diverse parents (PMs), which come from the Yangtze River (YtRR) and the Yellow River (YRR) regions with phenotypic characteristics of high yield and fiber quality, pest resistance and disease resistance. A multi-environment field experiment in three locations covering YtRR and YRR from 2013 to 2015 was designed for phenotyping. Fourteen agronomic traits, including FT, FFSBN, PH, EBN, BW, LW, LP, SI, FUHML, FS, FU, FE, MV and SF, were investigated in five environments. The heritabilities of all trait ranged from 0.11 to 0.87 and 0.17 to 0.85 in PMs and MLs, respectively. Phenotypic analysis showed that the PMs have wider variation than the MLs in single year-locaton environment and BLUP value.

A total of 284 SSR markers showed high quality and good polymorphism were screened by 8 PMs from a high-density interspecific (*G. hirsutum* × *G. barbadense*) genetic map. The 284 SSR markers were used to genotype the MLs. The means of PIC value for all SSR in PMs and MLs were 0.346 and 0.390, respectively, as well as the gene diversity index were 0.415 and 0.463. Statistical analysis of PIC and gene diversity confirmed the more genetic variations in MLs than PMs. The MLs also were revealed without population structure by PCA analysis. In addition, the MLs population showed fast LD decay that the distance were 0.76cM when r^2 dropped to 0.1. Marker-trait association for 14 traits based on SSR markers were performed using MLM(K) which ignored the characteristic vector of population structure. There were 139 loci significantly associated with 14 traits under the $p<0.01$. The percentage of phenotypic variation explained by the identified loci ranged from 0.71%-7.23% with an average value 1.60%. The 139 loci were covered by 96 SSR markers on genetic map. Forty SSR markers were reported in recent studies, while 6 of them were consistent with our results. In addition, 26 SSR markers that were associated with more than one trait demonstrated the pleiotropism. Further more, some loci clustered on some chromosomes for target traits and 9 hot pleiotropic loci were explored.

To deeply discover the genetic basis of important upland cotton agronomic traits, a subset MAGIC population contains 372 lines selected from the 8-way Upland cotton MAGIC population. The 372 lines and 8 parents were phenotyped in six environments and genotyped by SLAF-seq. Referencing the third physical map of *G. hirsutum* (TM-1) genome, a total of 60495 polymorphic SNPs were obtained. In parents and MAGIC lines, the average PIC values of all SNP were 0.252 and 0.288, respectively, and the genetic diversity index of all SNP were 0.324 and 0.362. The LD decay distance of SMLs was 600 kb (r^2=0.1). The GWAS were performed using 60495 SNPs and phenotyping data of SMLs. Base on the phenotype of 6 environments and BLUP, 975 SNPs were identified significantly associated with 14 agronomic traits. And the identified SNPs were divided in 400 QTLs by LD decay distance. The QTLs could explain 5.08% to 53.80% of phenotypic variation. Among the 400 QTLs, 30 QTLs could be identified stably in multiple environments. In addition, 88 QTL regions were proved with pleiotropism that associated with multiple traits.

According to the phenotype data and QTL information, some elite lines were selected from the MAGIC population, which have good performance of comprehensive traits and harbor favorite QTL alleles. These lines will are being applied in cotton production.

Conclusions:

The MAGIC population has wide range of phenotypic variations and rich genetic diversity, which is powerful for genetic analysis. The MAGIC population can combine different favorite QTL alleles and produce elite breeding lines, which could be applied in cotton production. This study revealed the genetic basis of important agronomic traits of Upland cotton and will facilitate molecule breeding in cotton.

Keywords:

Cotton, MAGIC population, SSR, SNP, Association mapping

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Genome-wide association mapping for traits related to tolerance to water stress in cotton

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Background:

In most countries, cotton production is rainfed and relies on increasingly unpredictable rainfall patterns. The availability of water during plant development impacts productivityand fiber quality, andthe development of plant ideotypes capable of maintaining their yield potential and adequate fiber quality under limited water supply isdesirable. Tolerance to water stress depends on the complex interaction between mechanisms whose genetic bases are not well understood. This study aimed at characterizing plant growth parameters (biomass accumulation) in response to water stress of apanel of Upland cotton genotypes. Association studies allowed identifying markers associated with such a drought-tolerance related trait.

Results:

Two hundred and sixty ninecotton genotypes were grown undercontrasting water regimes on PhenoArch, a High-Throughput Phenotyping Platform, and genotyped using 21.930 high-quality SNP markers. Water deficit affected biomass accumulation by 34% on average. High levels of genetic variability were observed ($p<0.05$) for biomass accumulation under both regimes, and heritability was moderate (46%). GxE interactions were of low magnitude. GWAS identified three (individually displaying anR^2=10%) and five (individual R^2=13%) markers for biomass accumulation, under water stress and control conditions, respectively, defined three and two genomic regions. None of the loci were common to both scenarios.

Conclusions:

While the analysis of the phenotypic data pointed out a lack of GxE interactions for biomass accumulation, GWAS uncovered distinct genomic regions. The genetic control of biomass accumulation appears to depend on environmental conditions. Once validated, these markers could prove useful for the marker-assisted selection of traits associated with tolerance to water deficit.

Keywords:
Upland Cotton, *Gossypiumhirsutum*, Water deficit, Plant biomass, GWAS

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GERMPLASM CHARACTERIZATION: AN IMPORTANT STEP TOWARDS COTTON IMPROVEMENT PROGRAMS

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King of fiber crops " Cotton" is being grown in subtropical and seasonally dry tropical areas ofmore than 70 countries on an area of 31.1 million hectares that produce 22.4 million tons of cotton seed. Over the lasttenyears, world`s cotton production is stagnant due to continuously decreasingcultivation area and irregular climate changes that include change in climatic *i.e.*increase and prolong summer season and irregular rainfalls.These conditions warn to cotton researchers for the development of new germplasm. This objective is possible through exchange of germplasm, characterization in hot spots and use of identified lines in breeding methods. Studies on genetic diversity in *Gossypium* species have been found to be useful for cotton improvement programs but still there is more to be found. Cotton breedersneed to know the extent of genetic diversity to take the advantage fromexisted diversity. Due to decline in area of cultivation globally, cotton breeders are taking interest in development of compact plant structure and high cultivation value particularly in developing countries.Keeping in view the importance in economy Cotton AnalyticalLaboratory of University of Agriculture Faisalabad and Zhejiang state key laboratory of Zhejiang University China are playing their role in crop improvement program through germplasm exchange and characterization programs.

Role of ICI Pakistan in Developing Glyphosate, Heat and Drought Resistant Cotton Cultivars Through Segregating Generations

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Weeds compete for nutrients and moisture and may cause yield losses to the extent of 50 to 80 percent. High temperatures above 40°C, can affect quantitative parameters of cotton resulting in reduced yield. Water resources are limited and may become in short supply during the 21st century due to the increase in population, non-agricultural uses of water, and increase in cropped area for food and fiber needs of population.

In present climate change scenario, the studies were under taken at ICI Cotton Research Station, Multan in a strip trialmaintainingfour irrigation regimes during the year 2019 to screen out high yielding glyphosate, heat and drought resistant cultivars from F3 segregating generation against two commercial Bt cotton varieties.

The results revealed that out of 24 hybrid combinations, 8 progenies which were high yielding glyphosate, heat and drought resistant with progeny numbers 18087, 18094, 18095, 18120, 18155,18187, 18188, and 18198 were selected for further similar trials/studies in F4 generation during 2020 year for development of cultivars with targeted objectives. When glyphosate at the rate of 1800 ml/acre was sprayed after 35 days of planting, all 24 combinations survived with less than 2% mortality in plants due to segregation. Commercial varieties (CIM-602 and IUB-2013) which had Cry1Ac Mon53 gene were not sprayed with glyphosate.

Results of drought tolerance studies revealed that progeny 18198 performed best by producing highest number of bolls per plant (31) under severe irrigation stress followed by 18155 with 30 number of bolls per plant against two commercial varieties which produced 19 and 22 number of bolls per plant under same irrigation treatment.

It could be concluded from present studies that almost all progenies have produced greater number of bolls per plant as compared to two check varieties under severe irrigation stress conditions thus will be requiring less irrigation water and low inputs with acceptable yield.

Keywords:
Cotton (*Gossypium hirsutum* L.), drought, irrigation scheduling, glyphosate resistant, climate change

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Genome-wide characterization of AGC gene family for abiotic stress tolerance in cotton (G. *hirsutum)*

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Background:

The AGC kinase, named after cAMP-dependent protein kinase A (PKA), cGMP-dependent protein kinase G (PKG) and phospholipid-dependent protein kinase C (PKC) family. The AGC is a member of serine/threonine (Ser/Thr) protein kinases group and is highly conserved among eukaryotic organisms. AGC kinases are essential regulators of cell development, metabolism, and cell death in mammalian systems. Plant AGC kinase catalytic domains share showed sequence similarities with mammalian AGC kinases, but little is known about their role in plant growth and development.

Results:

In the present work, we characterized thirty members of AGC gene family in cotton. Phylogenetic analysis classified members of AGC gene family into six clades. Sequence logo depicted high degree of conservation in the aminoacid sequence of AGC protein between *G. hirsutum*, *G. arboreum* and *A. thaliana.* Presence of growth and stress related cis-acting elements in the upstream regions of *GhAGC* highlights their plausible role in plant development and abiotic stress. Ka/Ks levels showed that *GhAGC*s experienced purifying selection pressure with limited functional divergence arising from segmental or whole genome duplication events. The expression profiling of candidate genes through qPCR exhibited the role of AGC gene family in abiotic stress tolerance and fiber development.

Conclusions:

Taken together, these results provide vital information to further decipher biological functions of AGC genes in cotton breeding.

Keywords:

AGC, Genome-wide Characterization, evolution, synteny, gene expression.

Evaluation of molecular markers linked to drought tolerance in Cotton

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Background:

Abiotic stresses like drought are major limiting factors that influence plant growth and crop production. Drought stress due to water deficit reduces the cotton lint production. Thus, it is important to develop drought tolerant cotton cultivars.

Results:

In this study Recombinant Inbred Line (RIL) population (129 lines) derived from the interspecific cross of *G hirsutum* (28 I) X *G barbadense* (Suvin) were evaluated for SSR markers linked to osmotic potential (OP). The SSR markers BNL3259 on chromosome 14, BNL1153 on chromosome 25 and BNL2884 on chromosome 6 which were linked to osmotic potential (OP) was selected and they were validated among the parents and RIL (129) population. Physiological parameters like canopy temperature (CT), chlorophyll content (SPAD value), Relative water content (RWC), Proline content were measured in the parents and RIL (129) population. Canopy temperature ranged between 27 to 31 ◦C and the Chlorophyll content ranged from 31 to 40 SPAD value. Relative Water Content (RWC) was calculated it ranged between 85 to 90% in the RIL population. The proline content in the RIL population was observed in leaf samples (1 gm fresh weight) ranged from 150 to 270 µmole/mg of tissue.

Conclusion:

The data generated from this study provides a valuable insight for further utilization in development of drought tolerant varieties. The molecular markers evaluated will be used for marker assisted selection to transfer drought tolerant traits to high-yielding cultivars.

Keywords:

Drought tolerance; *G hirsutum; G barbadense;* interspecific cross; RILs; SSR markers.

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Engineering CLCuD Resistance Using Genome Editing Tools

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Background:

Cotton leaf curl disease (CLCuD) is one of the major factors for low yield of cotton in Pakistan. Engineering resistance in cotton cultivars against CLCuD through RNA-directed Cas9 is a powerful tool to tackle the viral disease in cotton. Previously, we used TALEs, TALENs and dCas9 to target cotton leaf curl virus and got promising results. We have targeted coding and non-coding regions of viral DNA individually with Cas9/TALENs and dCas9/TALEs and found promising potential target sites for viral interference. On basis of screening results of gRNAs tested in transient assay in *N. benthamiana*, we designed multiplex gRNA for targeting three most promising sites simultaneously with multiplexed Cas9.

Results:

We found that targeting non-coding regions of virus is more effective for virus suppression than targeting coding regions. In transient assay, we found 70-90% decrease in accumulation of virus. Cotton transformation with multiplex gRNAs has been done successfully.

Conclusions:

Genome-edited cotton may be regulated as non-GMO. This strategy can also be translated for developing resistance against other viral diseases in various plant species.

Keywords:

CLCuD, Cotton, CRISPR/Cas9, Virus resistance, Multiplexing, Transformation

Comparative Chloroplast Genome Analyses of Three wild Cotton Species through Bioinformatics Methods

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Background:

Chloroplast research have significant advantage of genomics and genome sequencing, and a new picture is emerging of how the chloroplast functions and communicates with other cellular compartments. As a world's leading textile crop and a model system for studies of many biological processes, genomics research in cotton has advanced rapidly in the past few years. *Gossypium* contains 5 tetraploid (AD_1 to AD_5, 2n = 4×) and 47 diploid species (designated A through G, plus K, 2n = 2×), but the origin and evolution of allotetraploid *Gossypium* has remained controversial.

Results:

The complete chloroplast genome sequences belong to three diploid species were determined and annotated. Bioinformatic analyses showed that, the chloroplast genomes of *Gossypium* were highly conserved. The three chloroplast genomes were typical circular chromosomes like those of most other higher plants, including the large single copy (LSC), the small single copy (SSC) and 2 IR regions. The whole genome size ranged between 159,945 bp (*G. laxum;* D_9), 159,973 bp (*G. turneri*; D_{10}) and 160,122 bp (*G. shwendimanii;* D_{11}). Differences in the chloroplast genome size of *Gossypium* were mainly attributed to the length variations of IGS. The assignment of the potential genes identified 140 genes for each genome, including 113 functional gene (79 of protein coding genes, 30 tRNA and 4 rRNA), 2 ORFs, four pseudogenes and 21 repeated genes. SSRs totally varied from 62 to 64, and the average rate was 0.36 SSRs/kb between the 3 genomes. The predominant mononucleotide repeats were A or T, which accounted for 94.85% to 97.28% of the mononucleotide repeats among the 3 genomes with a definition mononucleotide ≥8 bp. This study revealed that wide ranges of expansions and contractions of IR, andare very common evolutionary events among 14 *Gossypium* species which were compared in our research. The phylogenetic analyses based on 50 protein coding genes for 41 angiosperms and four gymnosperm out groups (Cycas, Ginkgo, Pinus and Gnetum) were performed.

Conclusion:

Four genes viz. *infA, ycf68, ORF42* and *ORF56*, in addition to earlier mentioned genes, were confirmed to be existed in the studied genomes. The gene order was consistent with that of *Nicotiana*, which showed rearrangement did not exist. The data obtained from this study indicated that SSR polymorphism is very rich in the chloroplast DNA of *Gossypium* and that the number of polymorphic SSRs would decrease along with SSR length decreasing or SSR motif elongation. The expansions/contractions of IR as observed in the IR/SSC/LSC borders are probably mediated by intra-molecular recombination between two short direct repeat sequences that frequently occur within the genes located at the borders. Our phylogeny tree continued to strongly support that *Theobroma cacao* as the closest species to *Gossypium* inside eudicots.

Key words:

Gossypium, Chloroplast genome, Sequencing, Inverted repeats, Phylogeny

Revival of cotton crop in Pakistan by using four brothers (FB) next generation (NG) cotton technologies

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Background:

Agriculture sector plays an important role in the economic development of the country. The private sector of Pakistan is playing pivotal role in developing innovative technologies to increase productivity of the field crops. For the silver lining nothing would have been more suitable than white gold, the cotton. Cotton is crucial for economy and effects more than 70 million farmers directly. The FB Genetics is the first Agri biotech Private Sector Plant Biotechnology lab which is ISO 17025-2017 accredited by Pakistan National Accreditation Council (PNAC), continuously thriving to provide excellent quality solutions to combat biotic and abiotic stresses to the field crops. Genetic engineering enables molecular biologists to reshuffle genes in combinations otherwise not possible conventionally, opening a vast new source of genetic diversity for crop improvement. FB Genetics research focuses on the crop improvement through advanced molecular biology tools especially in cotton crop. FB Genetics developed plant transformation systems for gene transfer in cotton and other important field crops using a current state of the art and unified methodologies. FB Genetics research work centres around the positive improvement of crop plants that can resist to both biotic and abiotic stresses. In doing that FB Genetics pursued several lines of work that span multiple aspects including yield improvement, tolerance against chewing and sucking insect/pests, heat stress and improving plant immune system.

Results:

An outstanding achievement is the development of Next Generation (NG) Cotton Technology which include insect resistant especially whitefly, Pink Bollworm, Glyphosate and heat resistant multiple genes cotton technology. A tetra, triple and separate two double gene constructs were designed and developed to combat devastating effects of whitefly, Pink bollworm, heat and drought on cotton crop. It is the modern, cost-effective, prosperous and advanced herbicide tolerant cotton field crop solution for millions of farmers worldwide including Pakistan. The best performing events of NG technology are being evaluated at lab and contained field trials. This has been approved by the National Biosafety Committee (NBC) and patented by Intellectual Property Organization (IPO) of Pakistan. Patenting of the NG Technologies of the FB group is also in process in the USA, India, China, East African.

FB Genetics has established genome-wide SNP markers of local cotton varieties and also developed DNA barcodes for variety identification. The CRISPR-Cas9 system open new avenues to exploit the disease susceptible genes and negative regulators of immune system for crop protection. FB Genetics has engineered cotton plant with enhanced immune system by knocking out negative regulators with cutting edge CRISPR-Cas9 system. The CRISPR -Cas9 edited cotton plants with strong immune system are being tested under contained field trials.

Conclusions:

Four Brothers Group Pakistan is the only private sector company in Pakistan which have its own nine commercialized GM cotton varieties including first ever triple gene cotton variety i.e., Hataf-3 along with six more in the approval process.

Gene Stacking in Plants for biotic and abiotic stress tolerance

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Background:

Losses due to biotic and abiotic stresses are posing a serious threat to crop production. Particularly, tolerance to viruses like Cotton Leaf Curl Virus (CLCuV) requires effective approaches to engineer genomes. Gene stacking has recently emerged as a potential approach for integrating multiple genes in crop plants.

Results:

In the present study, recombinase technology was used for site-specific gene integration and stacking. A target vector (pG-Rec) was designed to introduce a recombinase target site in cotton genome whereby genes can be stacked repeatedly. Using *Agrobacterium*-mediated transformation, the pG-Rec was transformed into cotton cv. Coker-312 along with *Nicotiana tabacum* L. cv. Xanthi and *Nicotiana benthamiana*. The transgene analysis of target lines was conducted through junction PCR. Confirmed target lines were used for further transformations to site- specifically stack two genes of interest using *Bxb1* and *PhiC31* recombinases. The first construct contained Cas9 driven multiplex gRNAs against the Replicase gene of CLCuV. Site specific integration of this CRISPR/Cas based construct was determined by junction PCR and real-time PCR. The resulting plants were subsequently used to stack the AVP3 gene from *Arabidopsis thaliana* to improve abiotic stress tolerance. Stacking of genes was simultaneously achieved with the removal of marker genes for recycling in the next round of gene stacking. Consequently, transgenic marker-free plants were produced with two genes stacked at the specific site. The recombination events were confirmed with junction PCR and real time PCR analyses. The results of the research successfully demonstrated the gene stacking strategy to introduce multiple genes sequentially at predefined genomic sites. These transgenic plants can be potential germplasm to introduce resistance against various strains of cotton leaf curl virus and abiotic stresses.

Conclusion:

After evaluating virus and drought tolerance in the resulting plants, the lines act as a primer to initiate stacking of further genes as well as introgression into elite cotton lines through back crossing. The current climate change scenario highlights the use of such technologies so that gigantic environmental issues can be tackled by several traits in a single step.

Keywords:

Cotton, Gene stacking, recombinases, CRISPR/Cas9, CLCuV, drought

Transformation and Overexpression of Primary Cell Wall SynthesisRelated Zinc Finger Gene *Gh_A07G1537* to Improve Fiber Length in Cotton

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Background:

Molecular interventions have helped to explore the genes involved in fiber length, fiber strength, and other quality parameters with improved characteristics, particularly in cotton. The current study is an extension and functional validation of previous findings that *Gh_A07G1537* influences fiber length in cotton using a chromosomal segment substitution line MBI7747 through RNA-seq data.

Results:

The recombinant *Gh_A07G1537* derived from the MBI7747 line was over-expressed in CCRI24, a genotype with a low profile of fiber quality parameters. Putative transformants were selected on MS medium containing hygromycin (25mg/ml), acclimatized, and shifted to a greenhouse for further growth and proliferation. Transgene integration was validated through PCR and Southern Blot analysis. Stable integration of the transgene (*ΔGh_A07G1537*) was validated by tracking its expression in different generations (T0, T1, and T2) of transformed cotton plants. It was found to be 2.97-, 2.86-, and 2.92-folds higher expression in T0, T1, and T2 plants, respectively, of transgenic compared with non-transgenic cotton plants. Fiber quality parameters were also observed to be improved in the engineered cotton line.

Conclusion:

Genetic modifications of *Gh_A07G1537* support the improvement in fiber quality parameters and should be appreciated for the textile industry.

Keywords:

CSSLs, fiber length, zinc finger, genetic transformation, cotton biology

In silico analysis and expression profiling of *sucrose synthase*-like (Sus1) gene in interspecific lines and *Gossypium species*

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Background:

In plant kingdom, Sucrose synthase (SuSy) is a renowned enzyme which is involved in splitting of sucrose into monosaccharide components, fructose and glucose. Various homologues of SuSy have been identified and categorized in higher plants, but complete information of SuSy genes in cotton genome is not available hitherto. Here, we account transcriptomic analysis of Sus1 gene in three interspecific lines and three Gossypium species through RT-PCR. Transcript level of Sus1 gene was evident in all fibre stages examined.

Results:

Variable expression was noted in all phases of fiber growth with maximum value at 20 DPA fibre depicting its role in fiber secondary cell wall formation. In silico analysis designated the Sus1 as a cytoplasmic protein without signal peptide. Protein analysis predict various helices and trans membrane helices in its secondary structure. Swiss model for tertiary structure analysis showed that oligo state of protein is homodimer. Post translation modification analysis showed, N-glycosylation, N-acetylation and phosphorylation potential sites in protein sequences. Promoter analysis revealed several motifs related to vital functions in plants involved in stress, light and hormone specific response.

Conclusions:

The study ~~will provide basis to assess~~provided insights on Sus1 gene role in cotton species and interspecific lines. The Sus1 gene and promoter may be used in cotton for improving fiber strength.

Keywords:

Sus1, Expression Profiling, Gossypium species, Interspecific lines

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Genome and transcriptome wide analysis of OFPs in cotton and their possible roles in fiber development

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Background:

Ovate family proteins (OFPs) are crucial transcriptional repressors and involved in DNA repair, ovule development, fruit ripening and formation of secondary cell wall. We have performed a genome wide analysis of OFPs on genomes of wild and cultivated cottons and identified 52, 49, 29, and 30 OFP genes in tetraploid *G. hirsutm* (AD) and *G. barbadense* (AD) and diploid *G. arboreum* (A), and *G. raimondii* (D). Phylogenetics divided OFPs of A and D genomes into two broad groups A and B.

Results:

Most of the *OFP* gene were predicted to be localized in nucleus which indicated their role in gene regulation. Moreover, presence of stress, hormonal, and light responsive *cis*-regulatory elements highlighted their role in abiotic stress tolerance. *OFP* genes of *G. barbadense* showed intron gains during evolution process, whereas most of the genes remained intron less. Dominance of purifying selection suggested that evolution had exerted its impact on evolution of OFPs. Most of the gene pairs were duplicated through segmental type of duplication during polyploidization, and their time of divergence was ranged from 0.04 MYA to 3.26 MYA. RNA-seq data analysis further revealed that OFP's expression in epidermal cells, ovule, and fiber development related tissues.

Conclusions:

Furthermore, genes up-regulation under salt, drought, and heat also observed highlighting their stress responsiveness. Findings of this study will provide basis for studies to characterize the identified stress responsive genes.

Key Words:

Cotton; Genome wide analysis; OFPs; Transcriptome; Stresses

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Biotechnology for sustainable cotton production in Pakistan

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Cotton production in Pakistan has declined due to various factors such as reduction in area under cotton cultivation, pests and diseases and increase in cost of production. New events of transgenic cotton with double (Cry1Ac+Cry2Ab) and triple gene (Cry1Ac+Cry2Ab+EPSPS) where two or three genes are placed in tandem have been characterized and introgressed into elite cotton lines. A new source of resistance to cotton leaf curl disease has been identified and characterized through genomic approaches. New sources of sucking pest resistance have been explored and the mechanism of insect resistance is being studied. The presentation will discuss expression levels of Bt and herbicide tolerance genes in new transgenic events at different plant growth stages as well as bioassays against pink bollworm, cotton bollworm and armyworm.

Novel synthetic RNAi duplex of PHYB gene causes early flowering and fiber quality in cotton (*G. hirsutum* L)

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Different light-sensing systems involve responding the light signal. The majority of important plant responses are regulated by the phytochrome photoreceptor system. Previously, RNAi technology was used to characterize *PHYA1* gene function in cotton, and several high-quality novel cotton cultivars were developed. Here, we generated synthetic oligonucleotide-based RNAi duplexes in order to specifically silence of phytochrome B gene (*PHYB*) in cotton. The overall objectives of this research were to: 1) create synthetic oligonucleotide-based duplex for cotton *PHYB* gene(s); 2) develop and characterize new biotechnological cotton cultivars based on *SynB* RNAi lines; 3) obtain high generations of *SynB* RNAi lines by self-pollination and crossing with Uzbek commercial cultivars; 4) study morphological traits within greenhouse and field condition over in multiple years/seasons; and 5) statistically analyze greenhouse and field agronomic performance data.

As results, a number of somatically regenerated *SynB* RNAi lines of Cocker-312 were obtained with increased fiber strength, low micronaire (finer fiber) and decreased flowering time. Novel *SynB* RNAi lines were further crossed with several elite Uzbek commercial Upland cultivars. Result from independent plants of three generations of *SynB* RNAi and their hybrids (BC_3F_3) showed significant changes in fiber micronaire and an improvement of other major traits, such as vigorous vegetative growth and early-flowering. Our results should be useful for the development of early-maturing and superior fiber quality Upland cultivars.

Key words:

PHYB, Upland, *G. hirsutum,* RNAi technology, self-pollination

Acknowledgment:

I thank Academy of Sciences of Uzbekistan for basic science and several applied research grants. Also, my appreciation to our lab members for their help and supports to complete and summarize research experiments.

Bringing global best cotton production practices to Africa- the ICAC approach

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Background:

Cotton productivity in Zambia, Chad, and Burkina Faso is low ranging from 190 kg/Ha to 380 Kg/Ha while in Ivory Coast and Cameroon it ranges between 500-600 Kg/Ha. More than 95% of African cotton is rainfed, rendering smallholder farmers extremely vulnerable to the expected effects of climate change. Production costs per kilogram of lint range from 0.13 USD to 1.04 USD and per kilogram of seed cotton range from 0.09-0.45 USD. Inputs like fertilizers are very expensive and unavailable. Increasing seed cotton yields in some of these rainfed regions requires the adoption of sustainable global best practices that also contribute to climate resilience. ICAC attempts to increase its value for membership by implementing model-funded projects of global best practices and empowering trainers, in these regions so that cotton production in Africa remains sustainable in the face of climate change.

Results:

Five projects are being implemented with Africa in focus and these projects are funded by Cotton Incorporated, GIZ, International Trade Centre, and the European Union. Two projects involved the development of digital tools- Virtual Reality modules and the ICAC Soil and Plant Health APP. The Virtual Reality modules that have been produced incorporate principles of seed health, soil health, agronomy, and sustainable integrated pest management. The use of virtual reality enables training programs to be gender inclusive and is the first initiative taken globally for any commodity crop. The interactive AI-based ICAC Soil and Plant Health APP can speak to farmers in 25 languages. It also incorporates AI-based features of pesticide recognition; GPS based community alerts apart from advisories. Three projects involve the development of a training curriculum and providing technical backstopping for demonstration plots to showcase that good seed, soil health, agronomy, and select pest management strategies can increase seed cotton yields without increasing costs. Cameroon and Burkina Faso have laid out model demonstration plots, while Zambia has completed its second year with 382 farmer field trials. The virtual reality digital training tool has been launched in 8 African countries this year.

Conclusion:

Global best cotton production, climate-resilient practices, their demonstrations, practical training, and working in conjunction with local stakeholders and researchers have the potential to sustainably increase cotton yields in Africa.

Keywords:

Africa, production practices, ICAC, App, climate-resilient

The effect of different water quantities and irrigation regime on cotton yield and yield components in direct and planting methods

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Background:

Considering the importance of cotton in crop rotation and the high reduction of cotton cultivation in recent years, it is necessary to use new approaches to increase the cultivated area and production of cotton and reduce the production cost of this strategically important crop. One of these novel methods is delayed cotton cultivation in the form of the transplanting method by using early maturing cultivars. This method can be used to plant cotton after wheat in a double cropping system. Due to the shortening of the growth period, the crop escapes cold and an acceptable amount of crop yield can be obtained. Optimizing the time and amount of irrigation plays an important role in delayed plantings. In this regard, it is necessary to determine the optimal amount of water used by cotton in transplanting and conventional methods.

Results:

This experiment was carried out in a split-split plot design with three repetitions with transplanting and direct treatments as main plots, irrigation frequency including irrigation after 70, 105, and 140 mm cumulative evaporation from the evaporation pan as a subplot, and various water quantities including 50, 75, 100 and 125% of evaporation from the pan were considered as sub-sub plots. This experiment was carried out in the north of Iran (Gorgan), which has a moderate Mediterranean climate and sandy clay loam soil texture, in 2019 and 2020 years. The results showed a 38% increase in the yield for the transplanting method in comparison to direct cultivation, but this increase was not significant. Water use efficiency, earliness percentage, and lint percentage in transplanting were 14%, 45%, and 3.3% higher than direct planting, respectively. The highest yield, water use efficiency, earliness, and lint percentage were related to irrigation frequency after 105 mm evaporation of the pan. The treatment of 50% of used water had higher yield, water use efficiency, and lint percentage than other treatments. Therefore, the best treatment was the transplanting method with 105 mm pan evaporation and 50% used water.

Conclusion:

For maximizing yield and inducing earliness to facilitate cotton-wheat rotation, the cotton crop can profitably be established using the transplanting method and irrigated at 105 mm of cumulative pan irrigation and using only 50% of the quantity of the pan evaporation per irrigation.

Keywords:

Cotton, Transplanting method, irrigation, yield.

Cotton yields are increased and carbon footprint decreased with the use of nitrate based fertilizers

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Background:

Nitrogen (N) fertilizer use efficiency in tropical agroecosystems is commonly low, and efforts to find the right N source are important to optimize crop yields and decrease its negative impact on the environment, such as those related to the emissions of nitrous oxide and ammonia to the atmosphere. This study aimed at evaluating the continuous usage of urea and calcium ammonium nitrate (CAN – YaraBela) in cotton production.

Results:

A field trial with cotton following soybean was established during the 2015/2016 cropping season under clayey soil in Diamantino, Mato Grosso, Brazil. The trial was set up as a randomized block design with four replicates, arranged in a factorial [(2 x 4) + 1], with two N sources (urea and calcium ammonium nitrate - CAN) and four N rates (48, 96, 144 and 192 kg ha-1), plus the control, without N application. Treatments were applied to the same plots in consecutive cropping seasons of 2016, 2017, 2018, 2019, and 2020. The data presented here is related to the 144 kg N ha-1 (commonly recommended rate for the region) and the yield was summed up to show the accumulated seed cotton production for the five last cropping years. The carbon footprint (CFP) for cotton was calculated using the Cool Farm Tool (CFT) and considered the accumulated seed cotton production from both urea and CAN, the fertilizer production at the plant (CAN is produced in Europe and urea in Russia), and its transportation to Brazil, soil properties and residue management. Yields were submitted to variance analysis and the means were compared by Scott-Knott ($p \leq 0.10$). Seed cotton accumulated yield was 936 kg ha-1 higher for CAN compared to urea and the control (Figure 1). CFP was decreased by 7% (t CO2eq ha-1) and 10% (kg CO2eq t-1) when CAN was used (Figure 2).

Conclusions:

Such results show the importance of using more stabilized N-sources for cotton production, that will increase both crop and dry matter yields and will positively decrease the CFP.

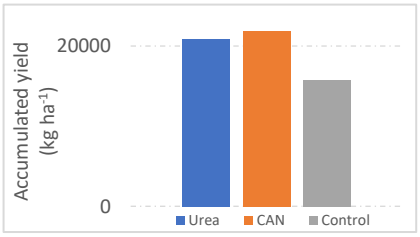
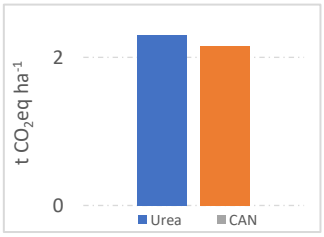


Figure 1



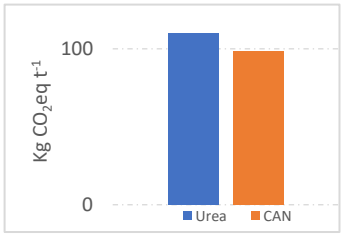


Figure 2

Keywords:

urea, calcium ammonium nitrate, tropical, nitrogen, eqCO2

Regenerative Agriculture: tools to increase cotton's profitability

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The principles of Regenerative Agricultural have been listed by a consortium of supply chain participants from production to consumption as minimizing soil disturbance; maintaining living roots in soil; continuously covering bare soil; maximizing diversity with an emphasis on crops, soil microbes, and pollinators; and integrating livestock where it is feasible. Although the "branding" is new, the farming practices are indigenous in origin. Employing them at scale and in cotton has required adaptation to local physical conditions and cultures.

These practices have been adopted by farmers on millions of row crop hectares to reduce input costs, stabilize yields, and preserve for subsequent generations the land and quality of life that farm families cherish. Public sector research, government/market encouragement, and shared farmer innovation and knowledge have made the adoption of Regenerative Agriculture possible. Examples will be pulled from all three to illustrate the ingredients for successful adoption in U.S. cotton: seed quality and planters; weed, insect, and disease control; soil and climatic condition; water availability; residue and cropping systems management; and off-farm incentives. Farming practices that were optimized over decades of more stable weather are now being challenged by climate change.

Local adaptations of Regenerative Agriculture principles may alleviate some of the climate change damage but will require locally intensive investments in research, support, and communication.

Influence of harvest splitting on the technological characteristics of cotton fiber and seed

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Background:

The major stakes of the cotton culture in Côte d'Ivoire are the improvement of the outputs to the field and the production of cotton of good quality. One of the methods suggested to guarantee the quality of the cotton fiber is the split harvesting of cotton. In order to study the influence of this practice on the physical characteristics of cotton fiber and seed, a study was undertaken in the main production areas of cotton in Côte d'Ivoire. In the present study, cotton was harvested when the capsules were opened at 50 %, 75 % and 100%. After ginning, the fibers and seeds were analyzed and their main fiber technological characteristics were evaluated.

Results:

The results obtained show that irrespective of the location, the partitioning of harvest influences the studied parameters such as the length, the micronaire index, the brightness and the yellow index of the fiber, the seed index, the germination rates and rotten or aborted seeds. Further, split harvesting at 50 % opening of the capsules, improved the fiber length by 1 mm, the tenacity by 1.7 g/tex, the micronaire index by 0.4 and the yellow index by 0.96, is the ideal split.

Conclusion:

These quality parameters are better when moving from early to late harvests. Splitting cotton harvest is therefore a good practice that should be recommended to producers in order to preserve the quality of cotton fiber and seed.

Key words :

harvest, splitting, cotton, fibre, seed, characteristic, quality

Remotely detecting cotton nitrogen status in the Mid-South region of the USA

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Background:

In the Mid-South region of the U.S., nitrogen (N) is spatially variable across cotton (Gossypium hirsutum L.) fields but the nutrient is rarely applied at variable rates within a given field. Due to the yield penalties and additional input costs associated with over and under applications of N, there is a considerable amount of interest in the potential of remote sensing to capture cotton N status and ultimately drive a variable rate application.

Results:

Research in Starkville, Mississippi State and multiple locations in Tennessee has shown that active and passive narrow wavelength sensors are capable of detecting N deficiencies. Furthermore, research in Marianna, Arkansas and multiple locations in Tennessee has show that even passive, inexpensive cameras mounted on ground-based applicators or unmanned aerial vehicles are also capable of detecting cotton N status. Regardless of the sensor, however, the time at which the sensor can detect N status is occasionally too late to make an ameliorating application.

Conclusions:

Future research will focus on the ability of inexpensive cameras to capture N status and drive variable rate N applications in the following season.

Keywords:

Nitrogen, Remote sensing, Site specific management, camera, sensor

Acknowledgement:

Authors would like to thank Cotton Incorporated for their continued support of this research.

Effect of different planting time on yield and other contributing traits in upland cotton

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Background:

Cotton is the most beneficial and cash Crop of Pakistan and earns a good fortune for the country in the form of foreign exchange. Crop was grown on an area of 2.2million hectares with a production of 8.6 million bales with average seed cotton yield 713 kg/ha. Pakistan ranks four in cotton production and cotton contributes 1.6 percent in GDP and 8.9 to the value added.

Result:

The experiment was carried out at experimental field of cotton research station, Sibi, Balochistan during kharif season 2021-22 in Randomized complete design RCBD with 03replication having 3m x 4m (12m2) plot size. The two cotton varieties 'CM-602' and CRIS-342' were sown on different sowing dates viz., 15th April, 1st May, 15th and 1st June using hand drilling method to assess the growth performance. Results revealed that the maximum cotton yield (3229.0 kg - 1) was obtained in the crop sown on 15th April and the yields declined at later sowings viz. 15th May and 1st June. Temperature has a major impact on cotton yield and high temperature negativity impacted cotton yield when the sowing was delayed from 15th April to last sowing date. Among the varieties CIM 602 produced maximum seed cotton yield (2976 kg/ha) with maximum boll plants, boll weight, and plant height as compared with CRIS-342.

Conclusion:

It was concluded that 15th April sowing is more appropriate for the environmental condition of Sibi, Balochistan..

Keywords:

Genotypes, sowing dates, yield performance

Early planting: A way to improve yield and minimize risk of Cotton Leaf Curl Virus attack

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Background:

The cotton responds very well to the prevailing environmental conditions. The decision about planting time is very important in this regard. The planting time not only affect the yield but influence the disease and pest infestation levels. There are multiple factors which influence choice of planting time. These may be local weather, cropping system (to make land available), legislation, risks of diseases and pest infestation and yield goals. The planting time is strictly monitored and legally implemented in certain regions of the world to prevent disease and pests. The planting time is adjusted in order to coincide the growth stage with optimum weather conditions. The experiments were conducted to evaluate the response of various genotypes over a wide planting window, commenced from April 01st to June 15th. In this experiment, two genotypes (CIM-610 and CIM-735) from non-transgenic group and four genotypes (CIM-775, CIM-875, Cyto-535 and Cyto-536) from transgenic group was used. Besides plant height, yield and yield formation traits, the incidence of cotton leaf curl virus (CLCV) disease was also monitored.

Results:

The results showed that early planting avails maximum growth season which was reflected in form of higher values of plant height, number of bolls and seed cotton yield. It was also observed that CLCV attack was relatively less in early sown cotton. The low CLCV attack also contributed to higher yield in early sowing. The late sown crop has less growth season on one side and heavily infested with CLCV on other side, hence, the low yield in late sowing is result of cumulative impact of both of these factors.

Conclusions:

The effect was stable for all genotypes irrespective of transgenic and non-transgenic groups. Therefore, early sowing is best option to secure the high yield and to minimize the losses from CLCV attack.

Key Words:

Planting window, Genotypes, Seed cotton, Virus

Spectral characterization and mitigation of leaf reddening in Bt cotton genotypes though proximal sensor based nitrogen management

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Background:

Study was undertaken for spectral characterization of red leaf and to mitigate leaf reddening in Bt cotton genotypes with different nitrogen management practices through proximal sensors. Further correlation of spectral values, leaf nitrogen content and seed cotton yield with red leaf index was studied.Field experimentation was carried during Kharif (Monsoon) 2019 and 2020 with two Bt Cotton genotypes (First Class and Ajeet 155) in main plot and eight proximal sensor based N management practices in sub plot.

Results:

Spectral characterization of red leaves was recorded through GreenSeeker (NDVI) and SPAD meter (SPAD value) and quantitative estimation of degree of leaf reddening was visualized by intensity of red leaf colour at 130 DAS. Genotypes showed non-significant (P>.005) difference for NDVI and SPAD value and significant (P<.005) difference for red leaf index (1.03 and 1.59 with First Clasas and Ajeet 155, respectively). Proximal sensor based N management practices significantly (P<.0001) influenced spectral values and red leaf index. N supplementation at 1.1 – 1.5 RI, 81 – 90 % SI and RDF recorded comparable and significantly higher NDVI (0.78, 0.77 and 0.74, respectively) and SPAD value (31.70, 31.23 and 28.72, respectively) as compared to rest of treatments. Proximal sensor based N management practices (1.1 – 1.5 RI and 81 – 90 % SI) significantly reduced red leaf index (0.18 & 0.23) as compared to RDF (1.12)and N omission(2.23). Interactions were found non-significant. NDVI and SPAD value of red leaf, N content in leaf (%) and seed cotton yields were strongly and negatively correlated with red leaf index.

Conclusion:

The results showed that the Nitrogen supplementation at 1.1 – 1.5 RI and 81 – 90 % SI reduced the incidence of leaf reddening and also resulted in recording higher spectral values like NDVI and SPAD meter readings.

Keywords:

Proximal sensors, Red leaf index, NDVI of red leaf, SPAD value of red leaf

Improving Resource Use Efficiency and Soil Health by Integrating Rice Crop in Cotton

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Background:

Cotton is an industrial as well as cash crop for the farmers in Pakistan. The area and production of cotton in the country are lower to fulfill annual industrial demand. Cotton cultivated area has shifted to other crops like rice, maize and sugarcane due to economic factors. One of the options to meet the country's lint demand is the vertical expansion of cotton plant to gain better yields per unit area. The other viable options adopted by farmers in different countries to increase the farm income to intercrop other crops along with cotton. Intercropping is the proven option of vertical expansion of cotton that can help to ensure both subsistence and disposable income to the farmers. The present study, conducted in 2021, describes the results of rice intercropped in cotton with the objectives to increase the farm income per unit land area and to make efficient utilization of available resources.

Results:

Cotton was sown with line-to-line distance of 2.5 ft on beds and rice seedlings were transplanted in three lines 6 inches apart between cotton rows with plant-to-plant distance of 4 inches. The experiment comprised of five treatments i.e. T1-Sole cotton, T2-Cotton (PxP 1ft) + Rice, T3-Cotton one row skip (PxP 1ft) + Rice, T4-Cotton (PxP 1.25 ft) + Rice, and T5-Cotton (PxP 1.5ft) + Rice. Results revealed that in treatment T3, main stem height, bolls per plant and boll weight remained maximum while in T1 main stem height and number of bolls per plant remained minimum. Although, maximum seed cotton yield was obtained in T1 treatment and minimum seed cotton yield in T3 but paddy rice yield remained maximum in this treatment. In the treatment T2, the soil parameters such as moisture content, bulk density and soil temperature remained more promising as compared to other treatments. Similarly, in T2 Treatment, the parameters of economic analysis such as land equivalent ratio, area time equivalent ratio and cotton yield equivalent ratio also remained higher as compared to other treatments. Furthermore, in the treatments T3, T4 and T5, the seed cotton yield and other studied parameters remained inferior to those in T1, which indicated to be less profitable for intercropping.

Conclusion:

From the study, it is concluded that the configuration of planting of cotton in rows 75 cm apart with 30 cm between plants in a row and intercropped with transplanted rice (in 3 lines spaced 15 cm apart with plant-to-plant distance of 10 cm) was more resource efficient and economical for farmers over other inter cropping configurations.

Key words:

Intercropping, seed cotton, rice, profitability, bulk density, soil temperature

Does phosphorus application time affect growth, development and productivity in cotton?

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Background:

Crop growth requires soil nutrients' availability and constant supply throughout the growing season. Cotton yield responds positively to the application time of each nutrient, especially P. The time of fertilizer application in the soil affects the nutrients uptake by plant and dry matter accumulation in the cotton plant parts. The time of application of P is crucial as it influences earliness, root development, accumulation of other nutrient and plant biomass with greater tendency towards the vegetative and reproductive organs.. Due to present hike in phosphatic fertilizers, the P fertilizer use strategy needs a careful revision, considering its low recovery in the cotton belt. Conclusive experimental data regarding critical P application time are lacking. Keeping in view the significance, experiments were conducted, during two cropping seasons 2020 and 2021, on two cotton cultivars e.g. Cyto-537 and Cyto-535 to evaluate the response of applied P2O5@50 kg ha-1 at sowing, 25 days after planting (DAP), and in two equal splits at 25& 50 DAP (Control).

Results:

P applied @ 50 kg P2O5/ha at 25 DAP improved the main stem height, number nodes on main stem and intermodal length in both the cotton genotypes as compared to full P at sowing and control treatments. Similarly in the treatment where full P was applied at 25 DAP, the fresh biomass of leaf, stalk and root portions increased by 59% & 45%, 53% &37%, 44% & 38% in Cyto-511 and 17% & 22%, 12% & 8%, and 37% & 27% in Cyto-535 during 2020 and 2021, respectively, as compared to full P at sowing. Furthermore, in the treatment where full P was applied at 25 DAP, the nutrients uptake such as N, P and K was also higher in both genotypes as compared to full P at sowing and control treatments. Moreover, in treatment where full P was applied at 25 DAP, the seed cotton yield, number of bolls and boll weight increased by 17% &13%, 20% & 14% and 7% & 5% in Cyto-511 and 12% & 30%, 19% & 31% and 3% & 3% in Cyto-535 during 2020 and 2021, respectively as compared to treatment with P applied in full at sowing. In the treatment where P applied in two equal splits such as 25 & 50 DAP the seed cotton yield and other parameters remained higher as compared to full P at sowing and control while remained at par with P at 25 DAP.

Conclusion:

Delaying the application of P in cotton until 25 days after planting is more beneficial as indicated by improved plant structure, increased biomass, seed cotton yield and yield attributing factors in both cotton genotypes- Cyto-537 and Cyto-535.

Key words:

Phosphorous, plant structure, Seed cotton yield, nutrient uptake

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Evaluating the effect of organic manure and foliar application of boron on agro-morphological characteristics of Sindh-1 and CKC-3 cultivars under semi-arid climate

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Background:

Cotton (Gossypium hirsutum L.) has a central position in expansion and consistency of agriculture. Similarly it adds to Pakistan's economy as trade profit. Most of the cotton growing soils of Pakistan are deficient in organic matter because of the continuous mono-cropping without using organic sources. Concerning these issues, current study was conducted to evaluate the effects of organic manure along with micronutrient (boron) on agro-morphological parameters of selected cotton cultivars.

Results:

A one-year field research was conducted during Kharif season in 2021 to evaluate the effect of organic manure and foliar application of boron on agro-morphological characteristics of CKC-3 and Sindh-1 cultivars of cotton under semi-arid climate. Treatments included soil applied Farm yard manure (FYM) and the foliar application of boron (B): T1 = Control (0 FYM + 0 B), T2 = FYM @10 tons/ha, T3 = 1% B, T4 = 2% B, T5 = FYM @10 tons/ha + 1% B, T6 = FYM@10 tons/ha + 2% B. Our results suggested that the treatment of soil applied FYM and foliar applied B @ FYM 10 tons/ha1 + 2% B significantly ($P \leq 0.05$) and positively changed the agro-morphological characters including, sympodial branches plant-1, opened bolls plant-1, seed cotton weight plant-1 (g), seed cotton yield (kg ha-1), lint yield plant-1 (g), and G.O.T (%) of both Sindh-1 and CKC-3 cultivars of cotton. However, CKC-3 cultivar having drought and heat stress tolerance characteristics performed better than Sindh-1 cultivar in most of the growth and yield related parameters under different treatment regimes. Hence, the optimum FYM and B foliar application levels for economical cotton production were considered to be FYM @10 tons/ha1 and foliar spray of 2% boron along with recommended dose of NPK fertilizers under semi-arid climate.

Conclusion:

The results showed that the treatment of soil applied FYM along with foliar application of boron at the rate of FYM @10 tons/ha-1 + 2% B significantly increase the overall growth, hence increase the cotton yield.

Keyword:

Cotton cultivars, Sindh-1, CKC-3, Organic manure, Boron, Growth, Yield

High Yield of Non-Irrigated Cotton Crops From Brazilian Cerrado: A Study of Case

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Background:

Brazil is the 2nd exporter and the 4th cotton producer in the world. Most of the areas are rainfed (92%) and located in the Cerrado Biome, mainly in Mato Grosso and Bahia States. The objective of this report was to characterize high yield rainfed fields in Sapezal (12°59'22" S; 58°45'52"W Oeste Mato Grosso - 2021) and Riachão das Neves (11°31'49"S; 45°43'57" W- Bahia - 2022). Plant height, node number, boll number, boll weight, gin turnout and fiber yield were evaluated in 20 replications inside each field.

Results:

Yields achieved 3111 and 3239 kg ha-1 of fiber in Sapezal (SPZ) and Riachão das Neves (RN), respectively, almost the double of the national average. Plant density (m), plant height (cm) and node number were 8.0 and 7.4; 107 and 97.4; 21.7 and 19.5 for SPZ and RN, respectively. Yield components such as boll number (m-2), boll weight and gin turnout (%) were 165 and 167; 4.27 and 4.36; 43.3 and 44.00 for SPZ and RN, respectively. Boll retention was 61 and 66% in SPZ and RN, respectively.

The achievement of high yields of rainfed cotton crops (>3000 kg ha-1 of fiber) occurs by a combination of adequate climate (rain, radiation and temperature) field history of cultivation, soil quality (fertility, physics and biology), management expertise and the use of modern and adapted cultivars.

Keywords:

boll number, boll weight, boll retention

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Effect of the timing of weed removal on the growth and yield of cotton

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Background:

Cotton is an important cash crop throughout the world. It is the primary raw material of textile products. In recent years, textile industries in Bangladesh have been playing the key role in boosting our economy. Export of readymade garments is the single most important source of foreign earning and economic growth. But, The area and production of cotton in our country are much lower compared to its annual demand. One of the major limiting factor of cotton production is that its slow growth and varieties of weeds available between the rows. A number of weed types specially broad leaves, grasses, sedges grows well in a cotton field. Generally, yield losses in cotton may be up to 30–40% due to weed infestation. Again, Yield reduction depends on weed species, population density and time of emergence and distribution as well as on the soil type, soil moisture, pH and fertility. Herbicides are widely used in cotton field worldwide. But, in Bangladesh, hand hoeing technique is mostly used for weeding in a cotton field which is very costly and there is scarcity of workers. So, it is necessary to practice weed management efficiently. So the experiment was conducted to find the out the critical period of weed control that will be efficient in terms of labor and yield.

Result:

The experiment was conducted at the Cotton Research Farm, Sreepur, Gazipur during 2020-21 and 2021-22 growing season. The site was high land and located in the centre of Madhupur Tract of agro-ecological zone (AEZ)-28 in Bandladesh. Experiment was laid out in randomized complete block design (RCBD) with three replications. The unit plot size was 5.4 m x 4.5 m. 5 treatments included weeding the plot upto 20 DAE (Days After Emergence), weeding the plot upto 40 DAE, weeding the plot upto 60 DAE, weeding the plot upto 80 DAE and without weeding the plot. CB-14 variety was used as the planting material. Recommended dose of fertilizer was applied. Liming was done 25 days before sowing. There were significant influences of weeding on plant height, monopodial branches, sympodial branches, number og boll/plant , yield and GOT . In 2020-21, maximum yield (2.93t/ha) was found for weeding the plot upto 80DAE. However that was statistically similar with that of weeding the plot up to 60 DAE (2.87t/ha). Similar results were found in 2021-22. Maximum yield(3.80t/ha) was found for weeding the plot up to 80DAE. However that was also statistically similar with that of weeding the plot up to 60DAE(3.72t/ha) which is more cost and labor efficient without significant yield loss.

Conclusion:

Weeding the plot upto 60 DAE and 80 DAE significantly increase yield.So, weeding the plot upto 60 DAE could be recommended for efficient weed management without significant yield loss

Keywords:

Cotton, monopodial branches, Days After Emergence(DAE), sympodial branches, yield, weeding,

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Effect of Timing of Last Irrigation on Growth, Yield and Water Productivity In Cotton Under Gezira Conditions

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Background:

A field experiment was conducted for two seasons (2015/2016 and 2016/2017) at Gezira Research Station Farm (GRSF) to determine the optimum timing of the last irrigation for the newly released Bt. cotton (Seeni1) along with non Bt. cotton (Hamid) on the basis of scheduling irrigation approach. The experiment was executed in a split plot design with the two cotton cultivars comprising the main-plots and eight timings of last irrigation as sub-plots. All treatments were replicated three times.

Results:

Delay of final irrigation significantly increased number of sympodia per plant and plant height. Irrespective of cotton cultivar, 27 WAS recorded the highest number of bolls/plant in both seasons. Cotton yield, water productivity and fiber quality were highly affected by irrigation treatments. Delay of final irrigation up to 21 WAS resulted in higher crop and water productivities. Moreover, delaying the last irrigation after 21 weeks showed no improvement in cotton fiber quality.

Conclusion:

These results indicate that excessive irrigation might not produce more yield or improve cotton quality.

Keywords:

Irrigation, Sudan, productivity, cotton quality

Evaluation of Non-GM Cultivars at Boll-setting Stage for Seed Multiplication for Organic Cotton in Pakistan

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Background:

Introduction of GM-cotton nearly replaced the non-GM. Further, the likely contamination of non-GM-cotton with GM cotton created a hurdle for non-GM cotton seed in Pakistan. Hence the availability of non-GM cotton seeds is a big challenge to organic cotton.

Material and Methods: We evaluated five different non-GM cotton cultivars (NIAB-2008, Cyto-230, Cyto-226, CIM-554, CIM-610) at two different locations (Barkhan and Lasbella) of Balochistan-Pakistan using randomized complete block design. Morphological and indices (plant height, number of node on main stem, number of vegetative branches, number of fruiting branches, number of sympodial branches, number of flowers and white flower per plant, number of bolls per plant, fresh mature boll weight, height above the functional leaf, area of functional leaf, area of subtended leaf to cotton boll on seventh fruiting branch), insect and pest incidence (white fly, pink boll worm, American bollworm, army bollworm, Thrips, Jassid) and diseases (root rot and cotton leaf curl virus) were studied at boll setting stage.

Results:

Data of morphological indices and boll related traits showed that CIM-554, Cyto-230, and NIAB-2008 were observed comparatively better for the climatic conditions of Balochistan. However, cultivars grown under Barkhan conditions showed better results as compared to Lasbella. Study further showed that the cultivars with better boll weight, boll number and fruiting branches and less vulnerable to insect pest and disease can be a good non-GM seeds multiplication source for organic cotton.

Conclusion:

Based on morphological features, economic traits and reaction to pests and diseases, cultivars CIM-554, Cyto-230, and NIAB-2008 were more suitable for agro-climatic conditions of Balochistan, Pakistan.

Keywords:

Organic seed; genotypes; field performance; trait comparison; boll weight

Effect of cotton residue incorporation with conservation tillage and integrated nutrient management on yield attributes and yield of Bt cotton (Gossypium hirsutum L.)

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Background:

Conservation agriculture aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive cultivation and burning or removal of crop residues. Conservation tillage along with residue management though INM is indeed the need of the hour.

Results:

The treatments of the study included three tillage treatments (conventional tillage, reduced tillage and zero tillage) and five integrated nutrient management practices (100% RDF (Recommended Dose of Fertilizers), 100% RDF + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1, 75% RDF + FYM 6 t ha-1 + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1, 50% RDF + FYM 12 t ha-1 + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1 and control). The experiment conducted at AICRP for Dryland Agriculture, VNMKV, Parbhani, during the year 2019-20 and 2020-21 in a split plot design with three replications. The result show that conventional tillage with 100% RDF + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1 recorded significantly higher number of picked bolls plant-1, seed cotton yield plant-1 and seed cotton-1yield per ha. Fibre quality was also improved in the same treatment. Soil microbial populations were high under zero tillage as well as 50% RDF + FYM 12 t ha-1 + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1. Bulk density and infiltration rate were improved under conventional tillage and 50% RDF + FYM 12 t ha-1 + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1. Soil organic carbon, available N, P2O5 and K2O were significantly high under zero tillage and 100% RDF + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1.

Conclusion:

The results showed that conventional tillage along with 100% RDF + cotton residue @ 3 t ha-1 + DM @ 12 kg ha-1 recorded higher yield attributes, yield and quality of Bt cotton.

Key Words:

Bulk density, cotton residue, conservation tillage, infiltration rate, fibre quality, organic carbon

Thermal plasticity and cotton production enhancing attributes of phosphate solubilizing bacteria from cotton rhizosphere

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Background:

Phosphate solubilizing bacteria (PSB) have been known to improve the availability of soil fixed phosphorus (P) to the crop. However, the performance of PSB under thermal stress is poorly understood. The purpose of this study was to isolate thermo-tolerant PSB from the cotton (Gossypium hirsutum L.) rhizosphere, cultivated in the alkaline soil of a semi-arid region. Seventeen isolates were identified as efficient PSB on the National Botanical Research Institute's Phosphate (NBRIP) agar plate. The P solubilizing activity was observed on NBRIP liquid media and in soil incubated at 30, 40, 45, and 50°C. Cotton growth-promoting traits of the strains were tested in the laboratory and field conditions.

Results:

The phosphorus solubilization index (PSI) for isolate TPB11 (2.62) was the highest, followed by TPB19 (2.26), TPB30 (2.26), and TPB8 (2.35). The isolates TPB4, TPB19, and TPB30 significantly improved P solubilizing activity on NBRIP broth and in soil at 30, 40, 45, and 50°C. The seed inoculation of PSB significantly increased cotton seedling growth in the laboratory. Isolate TPB30 showed the maximum increase in shoot length (+45%), root length (+167%), shoot fresh weight (+143%), shoot dry weight (+54%) and vigor index (+116%) over control. While isolate TPB4 showed the maximum increase in root fresh weight (+180%) and root dry weight (+76%) as compared to control. The isolate TPB19 showed the maximum increase in cotton seed germination (+89%) over control. Readings by the The values of Soil Plant Analysis Development (SPAD) meter, leaf area index, photosynthetic rate, seed cotton, and biomass yield of field-grown cotton were significantly improved in comparison to control by the PSB inoculation. Inoculation with TPB30 demonstrated maximum increase in seed cotton yield (+26%) and biomass yield (+30%) over control. The efficient isolates (TPB4, TPB19, and TPB30) were identified as Bacillus subtilis subsp. subtilis, Bacillus halotolerans, and Bacillus pumilus, respectively, and showed thermal stability.

Conclusion:

The study results suggested that the efficient PSB in the cotton rhizosphere could improve cotton production under high-temperature growing conditions. The isolates (TPB4, TPB19, and TPB30) isolates can be can be inoculated to improve cotton production under natural conditions in P deficient soils of the semi-arid region.

Keywords:

Inoculation, high-temperature stress, global warming, phosphorus fixation, PGPR

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Effects of preceding cover crops on cotton root length and yield

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Background:

The use of cover crops with vigorous root system enhances soil physical properties, resulting in better root growth of the successor crop, and improves tolerance to abiotic stresses. The objective of this study was to evaluate the relationship between root growth of cover crops and cotton, soil density, and cotton yield in different crop rotations in the off-season. The treatments were : single ruzigrass (Urochloa ruziziensis), ruzigrass+pearlmillet (Pennissetum americanum velvet bean (Mucuna pruriens) (mix); millet+velvet bean; ruzigrass+millet, and fallow.

Results:

In the first year. the use of a forage and mix of cover crops improved the yield of succeeding cotton crop compared with the other treatments. In the second year the use of any cover crop resulted in higher cotton yield. In the first year, cotton grown after mix had 18% more bolls than the other treatments, except for forage. In the second season, the use of a single forage increased boll number by 19% compared with fallow, and the mixture of cover crops improved boll weight in 9% compared with ruzigrass+millet. A negative correlation was found between soil density (0-5cm) and cover crop roots (0-20cm) in the first season, whereas in the second season this correlation was observed for cotton (0-20cm). In the first year, cotton root length in the layers of 0-20 and 40-60cm was positively correlated with the cover crop root lengths in the layer of 60-80cm. Furthermore, in the same year, it was also be observed that cotton root length (20-40cm) and cover crops' root lengths (40-60cm) were positively related.In the second year, cover crops´root and cotton root systems were positively correlated in the 20-40 cm layer.

Conclusion:

The use of cover crops resulted in increased yield of succeeding cotton crop, a decrease in soil density and increased root growth in the 20-40 cm layer.

Keywords:

root length, boll number, soil density.

Effects of calcium sources and rates on cotton yield

Fábio Rafael Echer[a], Carlos Felipe dos Santos Cordeiro[a], Leonardo Vesco Galdi[a], Thais Coser[b] & Leonardo Soares[b], [a]Unoeste [b]Yara

Background:

Calcium (Ca) uptake is about 71-155 kg ha-1 in high yielding cotton crops. In Brazil, limestone is the main source of Ca and Mg for both crop uptake and acidity neutralization of typical soils from the Cerrado region. For those lime amended soils (ph 5.5-6.0) with low Ca saturation (below 50%) in the CEC (Cation Exchange Capacity) there is still a demand for Ca fertilization. Ca availability in soil solution and uptake by cotton plants depend on the type of sources and their solubility. The objective of this study was to evaluate the effects of different sources and rates of Ca on cotton yield. Dolomitic limestone was applied in all treatments to raise base saturation to 50% and Ca to 30% of CEC. The other macro and micronutrients were applied as needed and balanced within treatments. The experimental design was a randomized block with five replications: control (C0), calcitic limestone (30 kg ha-1 of Ca) [CL30]; calcitic limestone (60 kg ha-1 of Ca) [CL60]; calcium nitrate (30 kg ha-1 of Ca) [CN30]; calcium nitrate (60 kg ha-1 of Ca) [CN60]; calcium sulfate (30 kg ha-1 of Ca) [CS30]; calcium sulfate (60 kg ha-1 of Ca) [CS60]; calcium sulfate (180 kg ha-1 of Ca) [CS180]; calcium sulfate + calcium nitrate (180 + 30 kg ha-1 of Ca) [CS180+CN30] and calcium sulfate + calcium nitrate (180 + 60 kg ha-1 of Ca) [CS180+CN60].

Results:

The highest seed cotton yields were achieved on CN30 and CS30,5378 kg ha-1 and 5522 kg ha-1, respectively, and as a result of the increased boll number (CS30) and moderate boll number and high boll weight (CN30). On the other hand, the lowest yields were found for C0 (4383 kg ha-1) and CL30 (4717 kg ha-1) which also resulted in lower number (C0) and weight (CL30) of bolls. These results show the importance of making calcium available and in the appropriate rate to cotton in order to improve yield.

Conclusion:

Both calcium sulfate and calcium nitrate applied at the rate of 30 kg ha-1increased seed cotton yield.

Keywords:

boll number, boll weight, limestone, calcium nitrate, calcium sulfate, gypsum.

Treatment	Boll weight (g)	Bolls m-2	Yield (kg ha-1)
Control (C0)	4,44 a	98,1 c	4383 b
30 kg ha-1 Ca (via calcitic limestone) (CL30)	3,90 a	112,9 abc	4417 b
30 kg ha-1 Ca (via calcium nitrate) (CN30)	4,56 a	118,0 ab	5378 a
30 kg ha-1 Ca (via calcium sulfate) (CS30)	4,28 a	129,2 a	5522 a
60 kg ha-1 Ca (via calcitic limestone) (CL60)	4,26 a	118,0 ab	4994 ab
60 kg ha-1 Ca (via calcium nitrate) (CN60)	4,16 a	123,8 ab	5105 ab
60 kg ha-1 Ca (via calcium sulfate) (CS60)	4,56 a	115,8 abc	5172 ab
Gypsum (1 ton ha-1) (CS180)	4,00 a	117,6 ab	4717 ab
Gypsum + 30 kg ha-1 Ca (via calcium nitrate) (CS180+CN30)	4,38 a	109,7 bc	4811 ab
Gypsum + 60 kg ha-1 Ca (via calcium nitrate) CS180+CN60)	3,98 a	130,1 a	5149 ab
CV(%)	12,4	12,5	14,4

Cotton yield as affected by cover crops and potassium and nitrogen fertilization

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Background:

Sandy soils are poor in soil organic matter increasing the demand for nitrogen to no N-fixing crops. Thus, cover crops such as ruzigrass (Urochloa ruziziensis) provides good soil coverage for cotton under no-tillage, however it has high Carbon/Nitrogen ratio and under sandy soil can increase the need for nitrogen to improve cotton yields. The objective was to evaluate cotton yield grown in a sandy soil under cover crops (single, inoculated, timing of potassium (K) fertilization and nitrogen (N) rates. The experiment was in a split plot randomized block design with five replications. In the plots cover crops were allocated: 1-Mucuna pruriensis (M); 2- Fallow (F); 3- Ruzigrass + Azospirillum (R+A); 4- Ruzigrass + Mucuna; 5- Ruzigrass + Azospirillum + Mucuna (R+A+M) e 6- Ruzigrass; in the subplots the timing of K fertilization (140 kg ha-1 K2O) in pre-planting (on cover crops) or post-planting (on cotton). One experiment was carried out for echa N rate: 80 and 120 kg ha-1. Treatments were compared by LSD test.

Results:

There was no effects of treatments on boll number, boll weight, gin turn-out and on fiber quality parameters such as length. micronaire, short fiber index and fiber strength (Table 1), but bolls were heavier when K was applied at pre-planting. However, the timing of K fertilization and cover crops did not affect yield components and fiber quality at 120 kg ha-1 of N (Table 2).

Table 1. Boll number, boll weight, gin turn-out (GT), length, micronaire (MIC), short fiber index (SFI) and fiber strength (STR) as affected by cover crops, timing of K fertilization at 80 kg ha-1 of N.

	80 kg ha-1 of N						
COVER CROP	Bolls	Boll weight	GT	Length	MIC	SFI	STR
	m2	Grm	%	mm	ug pol-1	-	gf TEX-1
Fallow	72,76	4,31	40,99	30,10	4,67	6,18	32,73
Mucuna	75,07	4,25	41,01	31,04	4,92	7,37	32,84
Ruzigrass+Mucuna	72,12	4,19	40,85	30,92	4,85	6,45	34,24
Ruzigrass+Azospirillum+Mucuna	80,46	4,22	41,25	30,65	4,74	8,01	33,99
Ruzigrass+Azospirillum	74,07	4,30	41,25	30,42	4,90	7,11	33,42
Ruzigrass	79,40	4,40	41,81	30,82	4,89	6,52	33,24
POTASSIUM							
Pre-Planting	74,88	4,38 a	41,22	30,64	4,80	6,84	33,8
Post-Planting	76,67	4,18 b	41,16	30,68	4,85	7,02	33,68
C.C	0,5302ns	0,8488ns	0,4255ns	0,4140ns	0,6002ns	0,1757ns	0,7047ns
K	0,5615ns	0,0355*	0,8158ns	0,9070ns	0,5983ns	0,6629ns	0,7592ns
C.C + K	0,2013ns	0,0115*	0,1930ns	0,9532ns	0,7355ns	0,7125ns	0,8969ns

C.C – cover crop; N – nitrogen; K – potassium. a>b. ** and *: significant at 1% and 5% probability (LSD). ns: not significant.

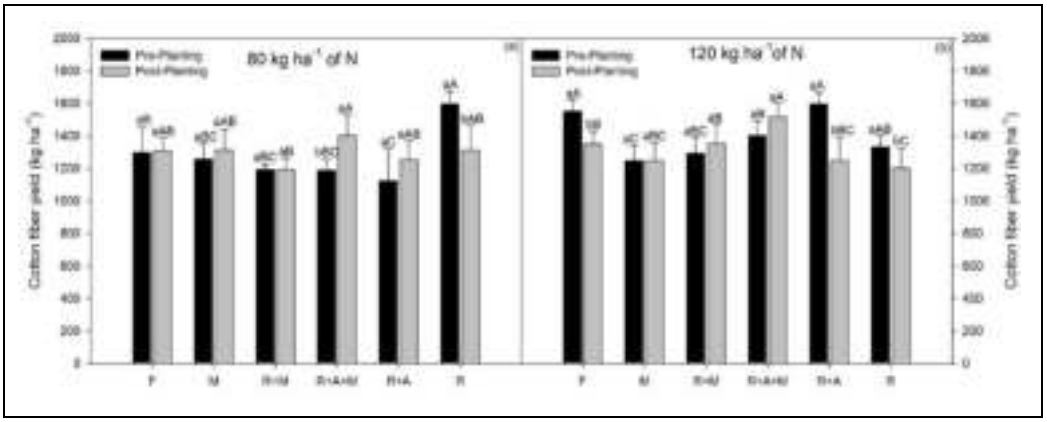
Table 2. Boll, boll weight, gin turn-out (GT), length, micronaire (MIC), short fiber index (SFI) and fiber strength (STR) as affected by cover crops, timing of K fertilization at 120 kg ha-1 of N.

COVER CROP	120 kg ha-1 of N						
	Bolls	Boll weight	GT	Length	MIC	SFI	STR
	m2	G	%	mm	ug pol-1	-	gf TEX-1
Fallow	85,42	4,26	41,97	30,98	4,91	5,99	33,22
Mucuna	78,62	4,30	40,76	31,11	4,8	5,56	33,75
Ruzigrass+Mucuna	75,79	5,01	41,28	30,47	4,71	4,94	33,39
Ruzigrass+Azospirillum+Mucuna	88,81	4,36	41,15	31,12	5,00	5,74	34,15
Ruzigrass+Azospirillum	77,06	4,49	41,6	30,55	4,81	6,04	32,95
Ruzigrass	74,06	4,48	40,96	31,11	4,82	6,35	34,19
POTASSIUM							
Pre-Planting	83,61	4,52	41,46	31,02	4,90	5,51	33,74
Post-Planting	76,31	4,45	41,11	30,76	4,78	6,02	33,47
C.C	0,2069ns	0,1485ns	0,2849ns	0,5145ns	0,6363ns	0,3375ns	0,4015ns
K	0,0666ns	0,6879ns	0,2804ns	0,3278ns	0,2369ns	0,1755ns	0,5074ns
C.C + K	0,4546ns	0,2414ns	0,5962ns	0,9544ns	0,7639ns	0,6100ns	0,3861ns

C.C – cover crop; N – nitrogen; K – potassium. a>b. ** and *: significant at 1% and 5% probability (LSD). ns: not significant.

Highest yields were achieved when K was applied at pre-planting in ruzigrass or post-planting after grown of ruzigrass + Azospirillum + Mucuna at 80 kg ha-1 of N (Figure 1a). However, under 120 kg ha-1 of N (Figure 1b) the highest yields were achieved when K was applied at pre-planting on fallow and ruzigrass+Azospirillum and post-planting on ruzigrass + Azospirillum + Mucuna (Figure 1b).

Figure 1. Cotton fiber yield as affected by cover crops, timing of K fertilization and N rates.



Fallow (F); Mucuna (M); Ruzigrass + Mucuna (R+M); Ruzigrass + Azospirillum + Mucuna (R+A+M); Ruzigrass + Azospirillum (R+A); Ruzigrass (R). Means followed by the uppercase letter in the K time application and lowercase the cover crop, do not differ statistically by T test 5% probability.

Conclusion:

Cotton yields were improved by the association of Ruzigrass+Azospirillum+Mucuna on pre-planting K fertilization at 120 kg ha-1 de N or under K fertilized ruzigrass (pre-planting) at 80 kg ha-1 de N. Fiber quality was not affected by treatments.

Keywords:

No-till, Ruzigrass, Mucuna pruriensis, Fiber Quality.

Acknowledgement:

To Coordination for the Improvement of Higher Education Personnel CAPES – finance code 001 to Rocha, C.H.

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Nitrogen and plant population effects on cotton yield and fiber quality

Fábio Rafael Echer[a], Leonardo Vesco Galdi[a], Bruno Senna[a] e Silva & Elio Jesus de La Torre[b]
[a]Unoeste [b]Instituto Goiano de Agricultura

Background:

The interactive effect of excessive nitrogen rates and high plant population can result in a delay on earliness and decrease fiber yield and quality as a result of the low fruit set at the bottom of the canopy and increased proportion of fruit at the top of the plant. The objective of this work was to evaluate yield and fiber quality of a mid-cycle cotton cultivar under three N levels (80; 120 and 160 kg ha-1 of N) and four plant populations (6.6; 7.7; 8.8 and 9.9 plants m-2) in a factorial randomized block design replicated four times.

Results:

The highest seed cotton yields were achieved at 6.6 plants m-2 (120 and 160 kg ha-1 of N) and 7 plants m-1 (no difference among N rates) and 9.9 plants m-2 at 80 kg ha-1 of N and were associated with the higher boll number in these treatments. Under low N rates, increasing plant population above 8.8 plants m-2 decrease micronaire index. In general, the increase in N rate reduced the micronaire index in plant populations of 6.6, 7.7 and 8.8 and increased at 9.9 plants m-2. Increasing plant population reduced fiber length at 80 kg ha-1 of N and the opposite was observed at a rate of 160 kg ha-1. The short fibers index was higher according to higher dose of N on 6.6, 7.7 and 8.8 plants m-2 but the inverse occurred at the highest plant density. Under low N rate, 90% of yield was accumulated at nodes 17.9 and 18.2 in the plant populations 7.7 and 9.9 plants m-2 respectively; with 120 kg ha-1 of N, 90% of yield was accumulated up to node 17.6 in the highest plant population and at 160 kg ha-1 of N 90% of yield was reached up to node 18.6 with 8.8 plants m-2.

Conclusion:

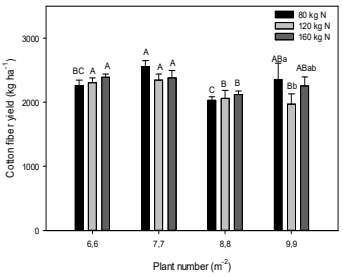
In general, the best yields occurred under low plant population (6.6 plants m-2) combined with 120 kg ha-1 of N; moderate plant population (7.7 plants m-2) irrespective to N rate or high plant population (9.9 plants m-2) and low N rate. Increasing N rates results in an augment of short fibers and a decrease on micronaire. The right choose of N rate and plant population can increase earliness through the accumulation of yield at lower fruiting nodes.

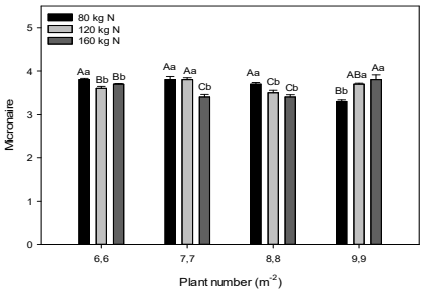
Keywords:

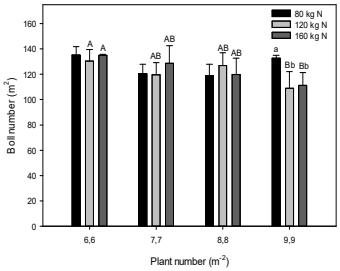
Boll number, Micronaire; Short Fiber Content; Earliness.

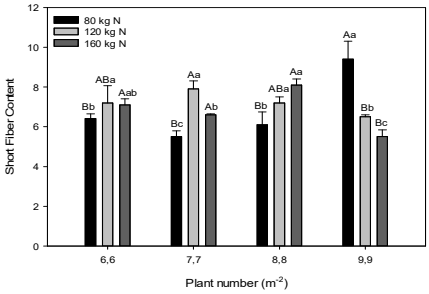
Acknowledgement:

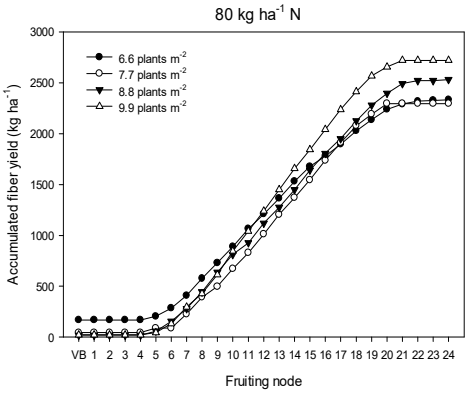
To FAPESP (São Paulo Research Foundation) for providing an undergrad scholarship for Galdi, L.V. (Process 2018/20829-3) and to IGA (Goiano Institute of Agriculture).

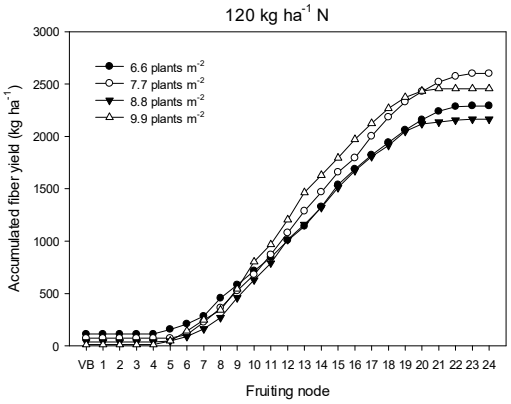

80 kg N
120 kg N
160 kg N
Cotton fiber yield (kg ha-1)
Plant number (m-2)
6,6
7,7
8,8
9,9

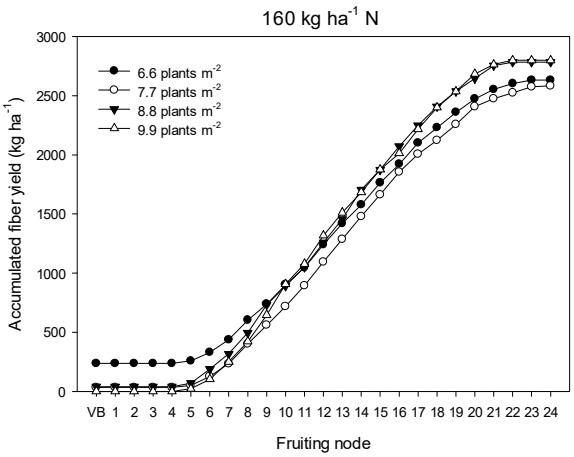

80 kg N
120 kg N
160 kg N
Micronaire
Plant number (m-2)


80 kg N
120 kg N
160 kg N
Boll number (m-2)
Plant number (m-2)


80 kg N
120 kg N
160 kg N
Short Fiber Content
Plant number (m-2)


80 kg ha-1 N
6.6 plants m-2
7.7 plants m-2
8.8 plants m-2
9.9 plants m-2
Accumulated fiber yield (kg ha-1)
VB 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Fruiting node


120 kg ha-1 N
6.6 plants m-2
7.7 plants m-2
8.8 plants m-2
9.9 plants m-2
Accumulated fiber yield (kg ha-1)
VB 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Fruiting node


160 kg ha-1 N
6.6 plants m-2
7.7 plants m-2
8.8 plants m-2
9.9 plants m-2
Accumulated fiber yield (kg ha-1)
VB 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Fruiting node

High Density Planting System – Next Revolution in Cotton Farming in India

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Background:

India has a long history of cultivation of cotton and which can be conveniently divided into Cotton Varietal Era (up to 1970-71), Hybrid Cotton Era (1972-2001) and Bt Hybrid Cotton Era (2002 onwards). Among 53 Gossypium species available, four are cultivable and all four were cultivated commercially in India prior to Bt Hybrid cotton era. At present the major cultivable area falls under G. hirsutum. Apart from this, different categories of cotton; surgical, very short, short, medium, superior medium, long and extra-long staple cottons were produced and were suitable for spinning 6s – 120s,even up to 200s counts yarn during varietal and hybrid cotton era. But now,only one category of superior medium - long staple (28 - 30 mm) cotton is produced in this Bt cotton hybrid era. This is hampering the production of yarn of different categories, and in particular the opened spinning industry is suffering.

During the varietal era, cotton area was to the extent of 6.58 million ha with a production of 8.37 million bales (1.42 m t) and productivity 152 kg lint/ha, whereas during hybrid cotton era the cotton production and productivity almost doubled (17.65 million bales, 3.0 m t& 330 kg lint/ha, respectively with slightincrease in cotton area(9.29 m ha). Introduction of Bt cotton hybrids in India of course reduced the cotton bollworm damage, and increased production and productivity of cotton (6.77m t,565 kg lint/ha respectively). The productivity reached maximum of 565 kg/ha during 2013-14 and later started reducing. This is envisaged due to the development of resistance of pink bollworm to Bt toxins.

The present production of cotton is 36.22 m. bales (6.16 million ton) on an area of 12.65 million ha with productivity of 466 kg lint/ha. The projected requirement of cotton is estimated to be almost 50 per cent more by 2030 (8.95 million ton), nearing to double during 2040 (12.12 million ton) and during 2050 it will be almost 150 per cent more (15.29 million ton). In order to achieve these projections, the productivity of cotton in the country should be enhanced to 746, 1010 and 1274 kg lint/ha during 2030, 2040 and 2050 respectively.

Conclusion:

Strategies to achieve the future projected requirement of cotton production in India:

Development and promotion of high yielding Bt cotton and G. arboreum varieties having early maturity (140-160 days), big boll size (>4.0 gG. hirsutum, > 3.0 g G. arboreum) with higher harvest index (0.4-0.6) and higher ginning out turn (>35% G. hirsutum, > 40% G. arboreum) suitable for HDPS enabling machine picking.

In India,cotton is grown in157 districts and among them,26 are most efficient,16 efficient, 75 less efficient and 40 inefficient cotton producing districts. To increase cotton production and productivity in different districts, especially less efficient districts, it is required to promote short to medium duration Bt cotton and high yielding G. arboreum varieties under HDPS to facilitate double cropping and minimising tillage. It is also needed to follow crop residue management for better soil health, mechanization to reduce cost of cultivation and in irrigated area drip- fertigation cum mulching technique for higher productivity and production in cotton.

Cotton cultivation in India is completely labour oriented, especially picking and harvesting requires maximum labour followed by weeding, pesticide application, sowing and fertilizer application. It is

required to reduce the cost of labour by contract and collective farmingand mechanization of these cultivation practices.

Cultivation of cotton under HDPS requires proper plant canopy management by application of certain PGRs and defoliants and also required to follow precise water, nutrient, weed, pest management and adoption of drip-fertigation cum mulching in irrigated area to enhances the cotton productivity.

Discouraging mono-cropping of cotton by crop rotations and remunerative cotton based inter cropping systems with pulses, cereals, vegetables, oil seed and green manuring crops to maintain soil fertility and sustainable cotton yields. Adoption of double cropping system in irrigated and rainfed (under residual moisture) cotton area with short and medium duration Bt cotton and G. arboreum varietal cultivation.

Weed management can be achieved by application of pre and post emergent weedicides, 2-3 inter cultivations. Adoption of HT- Bt technology if approved in India may help in proper weed management.

Incorporation of resistance/tolerance is essential to enhance the region wise cotton productivity, viz; tolerance to leaf curl virus, whitefly, jassids and pink bollworm in northern region; pink boll worm, jassids and drought in Central and South India and to mirid bug and flower bud maggot in South India by adopting new technologies; introgression, MAS, RNAi, CRISPR- Cas 9 for breeding biotic, abiotic stresses resistance, better fibre quality cotton genotypes to increase the production, productivity and reduction of cost of production.

Study on the Performance of Cotton Varieties on Various Sowing dates under Climatic Conditions of Cotton Research Station Uthal Lasbella, Balochistan Pakistan

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Background:

A field trial were laid out at experimental field of Cotton Research Station, Lasbella Balochistan during Kharif season 2021-22 in Randomized Complete block Design (RCBD) with 03 replications having 3m x 4m ($12m^2$) plot size. The two cotton varieties 'CIM-678' and CRIS-585' were sown on different sowing dates viz., 15th March, 1st April, 15th April and 1st May using hand drilling method to assess the growth performance. The results indicated that the average numbers of bolls per plant, boll weight and plant height significantly decreased slightly as the sowing was delayed to 15th April and 1st May.

Results:

The cotton variety 'CIM-678' produced highest seed cotton yield (3850 kg ha^{-1}) as compared to variety 'CRIS-585' (3350 kg ha^{-1}) when sown on 1st April. Minimum seed cotton yield (3170 kg ha^{-1}) for cotton variety 'CRIS-585'were recorded on 1st May and (3028 kg ha^{-1}) for 'CIM-678"on 15th April. For bolls per plant CIM-678 formed maximum number of bolls (40.0) per plant followed by CRIS-585 (37.2) and maximum boll weight (3.9g) was obtained in variety CIM-678. CRIS-585 had smaller bolls with 3.5 g boll weight. The Ginning out turn was 41.5% in CRIS-585 and 40.0% in CIM-678. CIM-678 produced longer staple length (28.3 mm) followed by CRIS-585 (27.0 mm). Micronaire value of CIM-678 (4.3 µ $inch^{-1}$) was better than that of CRIS-585. CIM-678 showed maximum fiber strength (39.1 g/tex^{-1}) followed by CRIS-585 (24.9 g/tex^{1})). There was significant ($p<0.05$) difference in seed cotton yield for different sowing dates.

Conclusions:

The cotton cultivar 'CIM-678' is recommended to cotton growers for cultivation under climatic condition of Lasbella, Uthal Balochistan.

Keywords:

Sowing dates, Genotypes, Seed cotton yield, cotton, climate

Exploring the potential of high planting density for cotton yield enhancement in Pakistan

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Field investigations were performed at Central Cotton Research Institute, Multan, Pakistan to assess the potential of increased plant population on seed cotton yield and its traits. During 2020-21, the genotypes *Bt.* CIM-775 and *Bt.* CIM-875 were planted at 45, 60 and 75 cm row spacing and 15.0, 22.5 and 30 cm plant spacing. However, the genotypes were replaced with *Bt.* CIM-663 and *Bt.* Cyto-535 during 2021-22 while keeping row and plant spacing same. The experiment was laid out in a split-split-plot arrangement with three replications. The genotypes were kept in main plots, row and plant spacing were allocated in sub and sub-sub plot, respectively. The variations in row and plant to plant spacing had a direct influence on the number of plants per unit area, therefore significant differences were recorded. Like plant population, the seed cotton yield was also influenced by both plant spacing or row spacing. This shows its close association with number of plants per unit area. The yield data collected from first year trial showed maximum yield with *Bt.* CIM-775 planted at 60 cm row spacing and 15 cm plant spacing. However, *Bt.* CIM-875 produced maximum yield with 75 cm row spacing and 15 cm plant spacing.The result of second year trials showed that the highest seed cotton yield was obtained from *Bt.* Cyto-535 with 15-cm plant spacing and 45-cm row spacing. Whereas, genotype *Bt.* CIM-663 produced maximum value for seed cotton yield when planted at 60-cm row spacing and 15-cm plant spacing. The study concluded that reduced row and plant spacing increased the yield over conventional planting system, however, the choice of genotype is more important to explore the full potential of the technology.

Key words:

Plant population, yield traits, seed cotton yield, genotypes

Evaluation of Ten Egyptian Cotton Varieties and Experimental Lines for Yield, Quality and Bacterial Blight Resistance

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Background:

Bacterial blight of cotton caused by *Xanthomonas compestries PV. Malvacearum* (Smith) Dye is a major disease occurring in most cotton growing areas around the world including Sudan. The cultural and climatic conditions under which cotton is grown, favor the development and spread of the disease in Sudan. Use of resistant varieties is the best method for controlling the disease. In this study we evaluated Egyptian cotton (*Gossypium Barbadense* L.) lines for yield, best quality and bacterial blight resistance during period 2011-12 through 2013-14 in the Agricultural Research Corporation, ARC at the Gezira Research Station, Gezira State, Wad Medani, Sudan. Nine 94-B-2, 94-B-19, 96-9, 63-1-3, 96-2, 130-10, 63-2-8, 110-1 and 110-2 belonging to *Gossypium barbadense* L. and Barakat-90 (a popular variety, grown in Gezira as control) in a randomized block design with four replications.

Results:

Significant differences among lines were observed in some of the growth parameters, yield attributes and yield, fibre quality traits and reaction to bacterial leaf blight. Among the genotypes tested, the line 94-B-19 had higher yield with more bolls per plant and better quality, line 96-9 was the earliest maturity and the severity of bacterial leaf blight disease was least in the line 3-2-8 The results further indicated that the line 94-B-2 with a seed cotton yield of 2219 kg/ha had an yield advantage of 19% over Barakat-90 (1868kg/ha). The quality parameters viz. fiber length of 35.1 mm, micronaire value of 3.7 and fiber strength of 37.5 g/tex were better than Barakat-90 . The line 94-B-2 gave 52% of its yield in the first pick compared to 44 % for Barakat-90. The line 94-B-2 has a GOT of 34% compared to 32.6 for Barakat-90. It recorded disease incidence and disease severity of 0.58 and 38.8%, respectively compared to 0.72 and 51.8 for Barakat-90.

Conclusion:

Genotype (94-B-2) emerged as a potential new line with higher yield, more bolls per plant and better quality combined with earliness and tolerance to bacterial leaf blight disease. The lines 94-B-2, 94-B-19 and 96-9 had higher yield, better fiber quality and resistance to bacterial blight disease and can be recommended as new Extra-fine count cotton varieties

Study on the Performance of Cotton Varieties on Various Sowing dates under Climatic Conditions of Cotton Research Station Uthal Lasbella, Balochistan Pakistan

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A field trial were laid out at experimental field of Cotton Research Station, Lasbella Balochistan during Kharif season 2021-22 in Randomized Complete block Design (RCBD) with 03 replications having 3m x 4m ($12m^2$) plot size. The two cotton varieties 'CIM-678' and CRIS-585' were sown on different sowing dates viz., 15th March, 1st April, 15th April and 1st May using hand drilling method to assess the growth performance. The results indicated that the average numbers of bolls per plant, boll weight and plant height significantly decreased slightly as the sowing was delayed to 15th April and 1st May. The cotton variety 'CIM-678' produced highest seed cotton yield (3850 kg ha^{-1}) as compared to variety 'CRIS-585' (3350 kg ha^{-1}) when sown on 1st April. Minimum seed cotton yield (3170 kg ha^{-1}) for cotton variety 'CRIS-585'were recorded on 1st May and (3028 kg ha^{-1}) for 'CIM-678"on 15th April. For bolls per plant CIM-678 formed maximum number of bolls (40.0) per plant followed by CRIS-585 (37.2) and maximum boll weight (3.9g) was obtained in variety CIM-678. CRIS-585 had smaller bolls with 3.5 g boll weight. The Ginning out turn was 41.5% in CRIS-585 and 40.0% in CIM-678. CIM-678 produced longer staple length (28.3 mm) followed by CRIS-585 (27.0 mm). Micronaire value of CIM-678 (4.3 µ $inch^{-1}$) was better than that of CRIS-585. CIM-678 showed maximum fiber strength (39.1 g/tex^{-1}) followed by CRIS-585 (24.9 g/tex^{1})). There was significant ($p<0.05$) difference in seed cotton yield for different sowing dates. The cotton cultivar 'CIM-678' is recommended to cotton growers for cultivation under climatic condition of Lasbella, Uthal Balochistan.

Keywords:
Sowing dates, Genotypes, Seed cotton yield, cotton, climate

Alternate wide-strip intercropping of cotton and peanut improves crop productivity and rhizosphere microbial community diversity

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Background:

Intercropping has been used worldwide to improve crop productivity by making full use of resources that would otherwise not be fully used by a single crop. Advantages of intercropping over monoculture includes control of pests and diseases, improvement of resource-use efficiency, improved nutrient uptake, increasing soil fertility, mitigation of pollution and increased crop productivity. Because most major cotton growing areas are also the dominant production regions for peanut in China, cotton and peanut intercropping and their rotation have been widely studied and adopted. However, traditional cotton intercropping is still faced with continuous cropping obstacles. It is generally believed that the continuous cropping constraints as indicated by inhibited crop growth and development as well as yield decline are due to soil microbial population and nutrient imbalance as well as the decreased soil enzyme activities and accumulation of allelopathic auto-toxic substances in peanut. Rotation of peanut with cotton or cereal crops has been proved to be effective in alleviating continuous cropping obstacles and increasing peanut yield, but the two crops cannot be harvested in the same season. In addition, traditional intercropping with narrow-strip planting is not suitable for mechanization.

To cope with these challenges, we have established an alternate intercropping system (AIS) of cotton and peanut, by using a wide-strip intercropping with inter-annual exchange of the planting zones of each crop, which combined intercropping with rotation of cotton and peanut. In the AIS of cotton and peanut were not only intercropped in a wide strip but also rotated inter-annually, while in the traditional intercropping system (TIS) the two crops were not rotated. Field experiments were conducted to develop a TIS of cotton and peanut, and an AIS of wide-strip cotton-peanut intercropping in combination with strip rotation, using monocultures of cotton (CC) or peanut (PP) as the control. Crop yields, leaf photosynthesis, dry matter accumulation and partitioning, and main nutrient uptake as well as input-output and net returns of the new system (AIS) were evaluated as compared with TIS, CC and PP for two consecutive years. Furthermore, we analyzed the rhizosphere fungal and bacteria community diversity of crops under different cropping systems based on ITS2 and 16S rDNA gene sequencing to understand better the underlying mechanism of the advantages of the alternate intercropping of cotton/peanut from a perspective of rhizosphere microbial diversity.

Result:

1. Alternate wide-strip intercropping increases crop productivity

On average, seed cotton yield was increased by 16.9% and peanut yield decreased by 5.6% under TIS, while seed cotton yield was increased by 21% without sacrificing peanut yield under AIS. TIS and AIS increased the number of bolls per ground area (boll density) by 13.0% and 16.3%, and boll weight by 3.4% and 4.0%, respectively. In contrast to cotton, peanut pod yield decreased by 5.6% and the number of pods per ground area (pod density) by 4.2% under TIS. However, the yield under AIS was comparable to that under PP, being 6.5% higher than that under TIS.

2. Alternate wide-strip intercropping increases biological yield and harvest index

AIS increased the biological yield and harvest index of cotton by 8.5 and 11.6% relative to CC. AIS resulted in the comparable biological yield, harvest index and maximum leaf area index (MLAI) of peanut to PP, but TIS decreased the biological yield by 4.2%. The AIS increased the biological yield of peanut by 3.8% and harvest index by 2.4%; it increased the biological yield of cotton by 3.8% compared

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to TIS. AIS significantly increased uptake of N, P and K in peanut, as well as net photosynthetic rate, chlorophyll content and maximum leaf area index of peanut relative to TIS. AIS produced 4.5% higher crop output value than TIS but the input value was the same; thus, AIS exceeded TIS in the net return by 10%.

3. Alternate wide-strip intercropping improves rhizosphere microbial community diversity

There were significant differences in Shannon and evenness index of fungi and evenness index of bacteria among the rhizosphere microbial community structures of crops under different cropping systems. Composition and abundance distributions of each sample at the phylum level of classification showed that, except for cotton under flowering stage, according to 97% species similarity, 7 eukaryotic and 44 prokaryotic phyla were identified from fungal ITS and 16S rRNA gene sequences, respectively. The abundance of Latescibacteria in the soil of cotton and the abundance of Chloroflexi in the soil of peanut were significantly increased under intercropping systems (TIS and AIS) compared to under monoculture (CC or PP) in the flowering stage. Furthermore, we found that the abundance of cotton pathogenic fungi, such as *Trichothecium roseum*, in the cotton rhizosphere under both intercropping systems (TIS and AIS) significantly decreased compared to that of monoculture cotton in the flowering stage. More importantly, it was found that AIS increased the abundance of Hydrogenedentes and Entomophthoromycota in the soil of peanut and decreased the abundance of Latescibacteria, Planctomycetes, Basidiomycota, Zygomycota in the soil of cotton, compared to TIS in cotton boll-setting stage. These might be the reason for reduced disease severity and the increased crop productivity under AIS.

Conclusion:

Alternate wide-strip intercropping of cotton and peanut not only harvests both crops in a season, but also increases crop productivity compared with traditional intercropping. Although traditional intercropping increased seedcotton yield at the expense of peanut yield, the alternate intercropping produced the similar yield to peanut monoculture with more cotton yield through inhibiting continuous cropping constraints by improving the nitrogen uptake. Increased N uptake was possibly due to the improved rhizosphere microbial community diversity. It was thus concluded that the yield advantage of cotton under alternate cropping over monoculture cotton was mainly attributed to greater partitioning of assimilates to reproductive organs and changes of microbial community composition in the rhizosphere. The net return from alternate intercropping was much higher than that from traditional intercropping because of the considerable increase in crop productivity without additional input. As far as we know, this is the first report on the mechanism of increased crop productivity under the new intercropping system from a perspective of rhizosphere microbial diversity.

Alternate intercropping is a promising alternative cropping system in the Yellow River valley and other areas with similar ecology, because it improved crop productivity and economic benefits without additional input.

Keywords:

Alternate intercropping, Cotton, Economic benefit, Peanut, Rhizosphere microorganism

Cotton yield as affected by cover crops and potassium and nitrogen fertilization

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Background:

Sandy soils are poor in soil organic matter increasing the demand for nitrogen Cover crops such as ruzigrass (*Urochloa ruziziensis*) provides good soil coverage for cotton under no-tillag. However it has high Carbon/Nitrogen ratio and under sandy soil can increase the need for nitrogen to improve cotton yields. The objective was to evaluate cotton yield grown in a sandy soil under cover crops (single, inoculated, timing of potassium (K) fertilization and nitrogen (N) rates. The experiment was in a split plot randomized block design with five replications. In the plots cover crops were allocated: 1-*Mucuna pruriensis* (M); 2- Fallow (F); 3- Ruzigrass + *Azospirillum* (R+A); 4- Ruzigrass + Mucuna; 5- Ruzigrass + *Azospirillum* + Mucuna (R+A+M) e 6- Ruzigrass; in the subplots the timing of K fertilization (140 kg $ha^{-1}K_2O$) in pre-planting (on cover crops) or post-planting (on cotton). Separate experiment was carried out for each N rate: 80 and 120 kg ha^{-1}. Treatments were compared by LSD test.

Results:

There was no effects of treatments on boll number, boll weight, gin turn-out and on fiber quality parameters such as length. micronaire, short fiber index and fiber strength (Table 1), but bolls were heavier when K was applied at pre-planting. However, the timing of K fertilization and cover crops did not affect yield components and fiber quality at 120 kg ha^{-1} of N (Table 2).

Table 1. Boll number, boll weight, gin turn-out (GT),length, micronaire (MIC), short fiber index (SFI) and fiber strength (STR) as affected by cover crops, timing of K fertilization at 80 kg ha^{-1} of N.

COVER CROP	80 kg ha^{-1} of N						
	Bolls m^2	Bollweight G	GT %	Length mm	MIC ug pol^{-1}	SFI -	STR gf TEX^{-1}
Fallow	72,76	4,31	40,99	30,10	4,67	6,18	32,73
Mucuna	75,07	4,25	41,01	31,04	4,92	7,37	32,84
Ruzigrass+Mucuna	72,12	4,19	40,85	30,92	4,85	6,45	34,24
Ruzigrass+*Azospirillum*+Mucuna	80,46	4,22	41,25	30,65	4,74	8,01	33,99
Ruzigrass+*Azospirillum*	74,07	4,30	41,25	30,42	4,90	7,11	33,42
Ruzigrass	79,40	4,40	41,81	30,82	4,89	6,52	33,24
POTASSIUM							
Pre-Planting	74,88	4,38 a	41,22	30,64	4,80	6,84	33,8
Post-Planting	76,67	4,18 b	41,16	30,68	4,85	7,02	33,68
C.C	0,5302^{ns}	0,8488^{ns}	0,4255^{ns}	0,4140^{ns}	0,6002^{ns}	0,1757^{ns}	0,7047^{ns}
K	0,5615^{ns}	0,0355*	0,8158^{ns}	0,9070^{ns}	0,5983^{ns}	0,6629^{ns}	0,7592^{ns}
C.C + K	0,2013^{ns}	0,0115*	0,1930^{ns}	0,9532^{ns}	0,7355^{ns}	0,7125^{ns}	0,8969^{ns}

C.C – cover crop; N – nitrogen; K – potassium.a>b. ** and *: significant at 1% and 5%probability (LSD). ns: not significant.

Table 2. Boll, boll weight, gin turn-out (GT),length, micronaire (MIC), short fiber index (SFI) and fiber strength (STR) as affected by cover crops, timing of K fertilization at 120 kg ha^{-1} of N.

COVER CROP	120 kg ha^{-1} of N						
	Bolls m^2	Bollweight G	GT %	Length mm	MIC ug pol^{-1}	SFI -	STR gf TEX^{-1}
Fallow	85,42	4,26	41,97	30,98	4,91	5,99	33,22
Mucuna	78,62	4,30	40,76	31,11	4,8	5,56	33,75
Ruzigrass+Mucuna	75,79	5,01	41,28	30,47	4,71	4,94	33,39
Ruzigrass+*Azospirillum*+Mucuna	88,81	4,36	41,15	31,12	5,00	5,74	34,15

Ruzigrass+*Azospirillum*	77,06	4,49	41,6	30,55	4,81	6,04	32,95
Ruzigrass	74,06	4,48	40,96	31,11	4,82	6,35	34,19
POTASSIUM							
Pre-Planting	83,61	4,52	41,46	31,02	4,90	5,51	33,74
Post-Planting	76,31	4,45	41,11	30,76	4,78	6,02	33,47
C.C	0,2069^{ns}	0,1485^{ns}	0,2849^{ns}	0,5145^{ns}	0,6363^{ns}	0,3375^{ns}	0,4015^{ns}
K	0,0666^{ns}	0,6879^{ns}	0,2804^{ns}	0,3278^{ns}	0,2369^{ns}	0,1755^{ns}	0,5074^{ns}
C.C + K	0,4546^{ns}	0,2414^{ns}	0,5962^{ns}	0,9544^{ns}	0,7639^{ns}	0,6100ns	0,3861^{ns}

C.C – cover crop; N – nitrogen; K – potassium. a>b. ** and *: significant at 1% and 5% probability (LSD). ns: not significant.

Highest yields were achieved when K was applied at pre-planting in ruzigrass or post-planting after grown of ruzigrass + Azospirillum + Mucuna at 80 kg ha^{-1} of N (Figure 1a). However, under 120 kg ha^{-1} of N (Figure 1b) the highest yields were achieved when K was applied at pre-planting on fallow and ruzigrass + Azospirillum and post-planting on ruzigrass + Azospirillum + Mucuna (Figure 1b).

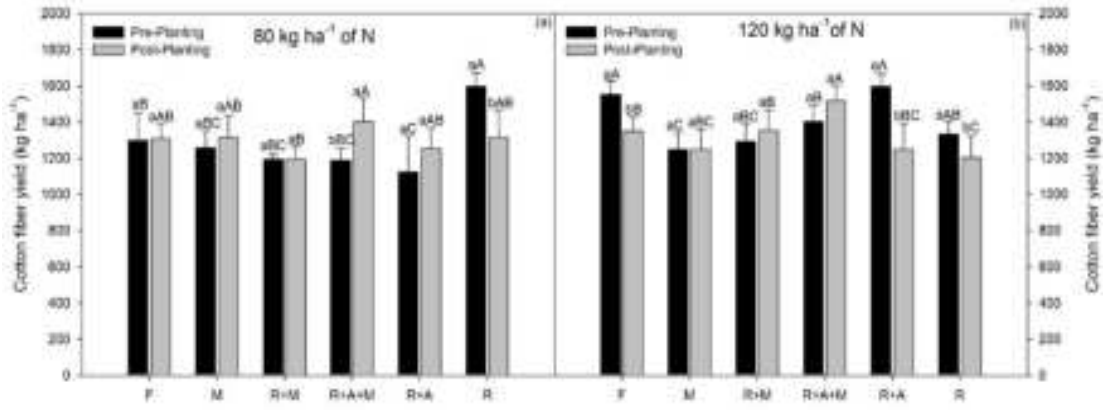

Figure1. *Cotton fiber yield as affected by cover crops, timing of K fertilization and N rates.*

Fallow (F); Mucuna (M);*Ruzigrass* + Mucuna (R+M); *Ruzigrass* + *Azospirillum* + Mucuna (R+A+M); *Ruzigrass* + *Azospirillum*(R+A); *Ruzigrass* (R). Means followed by the uppercase letter in the K time application and lowercase the cover crop, do not differ statistically by T test 5% probability.

Conclusion:

Cotton yields were improved by the association ofRuzigrass+*Azospirillum*+Mucuna on pre-planting K fertilization at 120 kg ha^{-1} N or under K fertilized ruzigrass (pre-planting) at 80 kg ha^{-1} N.

Keywords:

No-till, Ruzigrass, Mucunapruriensis, Fiber Quality.

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Developments in Robotic Weed Management in Cotton

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Exponential increases in machine learning and robotics are beginning their integration into production agriculture through start-up companies and all major equipment manufactures. Implementation is occurring in high value crops and include various aspects of pest scouting, weed management, crop thinning, and harvesting. Labor issues (access and costs), demand for higher production efficiency, and increased sustainability demands will continue to drive advances in autonomous capabilities and machine learning and places row crop agriculture on the cusp of commercially viable products.Cotton should be the entry point into autonomous weed management for row crops due to: 1. High input costs; 2. Decrease in herbicide options, due to herbicide resistant weeds; 3. Highly susceptible to yield loss from early-season weeds; 4. Decrease harvest efficiency and reduced fiber value from end-of-season weeds.

Various sensor platforms are currently on the market as “see-and-spray” technologies. These are currently available and economically viable but target primarily fallow fields (Weed-It® and WeedSeeker®). On-going advances in sensors, autonomous precision driving systems (RTK GPS and row sensors), and precision nozzles are being implement on a small scale and are on the cusp of scalable herbicide weed management systems in cotton (Swarmfarm©, BlueriverTechnology©). To date, these see-and-spray and/or detect-and-avoid technology appear to be the most economical and energy feasible option along with the broadest adaptability but are dependent upon effective herbicides and minimal herbicide resistant weeds. On-going research is occurring in the private and public sector with these technologies.

Non-herbicidal site-specific management (rogueing and lasers) are using the same weed detection systems and machine movements (Smallrobotcompany© and TheWeedZapper™), but with limitations of their own. Lasers will require considerably more in-the-field power, may have focal point limitations, and may have limited mortality on some many troublesome weed species.Robotic rogueing and precision tillage have comparable non-crop recognition sensors but will require a more complicated mechanicisms and flexibility for physically removing the weeds. Companies like Garford©and VisonWeeding©systems are mounted on traditional tractors with the precision tillage implement being camera controlled. The weeds best fit for these various systems are listed in the poster.

In summary, large investments and advancements in various precision weed management technologies will drive adoption by growers. However, the economic feasibility will remain highly dependent on the in-field weed populations and species. In the near future, these robotic weed management will need to target low weed density fields or implement management combinations that reduce weeds emergence, such as broadcast pre-emergence herbicides, broadspectrum tillage, and/or cover crops.

Key words:

robotics, weeds, precision tillage, application technology, autonomous

Effects of calcium sources and rates on cotton yield

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Background:

Calcium (Ca) uptake is about 71-155 kg ha^{-1} in high yielding cotton crops. In Brazil, limestone is the main source of Ca and magnesium for both crop uptake and acidity neutralization of typical soils from the Cerrado region. For those lime amended soils (ph 5.5-6.0) with low Ca saturation (below 50%) in the CEC (Cation Exchange Capacity) there is still a need for Ca fertilization. Ca availability in soil solution and uptake by cotton plants depend on the type of sources and their solubility. The objective of this study was to evaluate the effects of different sources and rates of Ca on cotton yield. Dolomitic limestone was applied in all treatments to raise base saturation to 50% and Ca to 30% of CEC. The other macro and micronutrients (eg. sulfur, potassium and phosphorus) were applied as needed and balanced within treatments. The experimental design was a randomized block with five replications: control (C0), calcitic limestone (30 kg ha^{-1} of Ca) [CL30]; calcitic limestone (60 kg ha^{-1} of Ca) [CL60]; calcium nitrate (30 kg ha^{-1} of Ca) [CN30]; calcium nitrate (60 kg ha^{-1} of Ca) [CN60]; calcium sulfate (30 kg ha^{-1} of Ca) [CS30]; calcium sulfate (60 kg ha^{-1} of Ca) [CS60]; calcium sulfate (180 kg ha^{-1} of Ca) [CS180]; calcium sulfate + calcium nitrate (180 + 30 kg ha^{-1} of Ca) [CS180+CN30] and calcium sulfate + calcium nitrate (180 + 60 kg ha^{-1} of Ca) [CS180+CN60].

Results:

The highest seed cotton yields were achieved on CN30 and CS30,5378 kg ha^{-1} and 5522 kg ha^{-1}, respectively, and as a result of the increased boll number (CS30) and moderate boll number and high boll weight (CN30). On the other hand, the lowest yields were found for C0 (4383 kg ha^{-1}) and CL30 (4717 kg ha^{-1}) which also resulted in lower number (C0) and weight (CL30) of bolls. These results show the importance of making calcium available and in the appropriate rate to cotton in order to avoid yield restrictions.

Conclusion:

Both calcium sulfate and calcium nitrate applied at the rate of 30 kg ha^{-1} increased seed cotton yield.

Keywords:

boll number, boll weight, limestone, calcium nitrate, calcium sulfate, gypsum.

Treatment	Boll weight (g)	Bolls m^{-2}	Yield (kg ha^{-1})
Control (C0)	4,44 a	98,1 c	4383 b
30 kg ha^{-1} Ca (via calcitic limestone) (CL30)	3,90 a	112,9 abc	4417 b
30 kg ha^{-1} Ca (via calcium nitrate) (CN30)	4,56 a	118,0 ab	5378 a
30 kg ha^{-1} Ca (via calcium sulfate) (CS30)	4,28 a	129,2 a	5522 a
60 kg ha^{-1} Ca (via calcitic limestone) (CL60)	4,26 a	118,0 ab	4994 ab
60 kg ha^{-1} Ca (via calcium nitrate) (CN60)	4,16 a	123,8 ab	5105 ab
60 kg ha^{-1} Ca (via calcium sulfate) (CS60)	4,56 a	115,8 abc	5172 ab
Gypsum (1 ton ha^{-1}) (CS180)	4,00 a	117,6 ab	4717 ab
Gypsum + 30 kg ha^{-1} Ca (via calcium nitrate) (CS180+CN30)	4,38 a	109,7 bc	4811 ab
Gypsum + 60 kg ha^{-1} Ca (via calcium nitrate) CS180+CN60)	3,98 a	130,1 a	5149 ab
CV(%)	12,4	12,5	14,4

Evaluation the effects of different climates on cotton seed traits

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Background:

Abiotic stress resulting from climate change, particularly high temperature and water stress, will reduce cotton seed yield and quality. For this study, three regions according De Martonne climatic classification were investigated. Then, this study was based on two cottonseed genotype Golestan and Bakhtegan which were harvested from Fars province (arid) and two cottonseed genotypes Golestan and Latif from Golestan province (Mediterranean) and five cottonseed genotypes including Khorshid, Khordad, Kashmar and Varamin from Khorasan province (semi- Arid). A complete factorial block design with three replications was performed.

Result:

The results revealed that the Bakhtegan genotype obtained from the Fars province had the highest yields with respect to seed 100 weights, seed coat and endosperm. Moreover, seeds with the most damage (63.3%) were from the Golestan genotype (Fars) with the least seed damage being observed in Khordad from arid region. Cottonseed from the highest levels of immaturity was Golestan from Fars and Kashmar genotype in Khorasan province. Increased rate germination was observed in the Golestan genotype in Golestan province, these seeds were also intact. Khorshid and Khordad from arid region and Golestan genotype of Fars had the least percentage of intact seed. The Varamin genotype (Khorasan) had the minimum content, whereas the protein concentration of seed harvested from Fars was more than others.

Conclusion:

Cottonseed of genotypes were harvested from arid climates had the best seed characteristics for feed and delinting in comparison to those from other provinces. Seeds with the best vigor were obtained from seeds in the Mediterranean regions.

Keywords:

Climate Variation, Cotton, Seed immature, Vigor.

High cover crops diversity and controlled-released urea increase soil nitrogen and cotton fiber yield under moderate nitrogen rate

Carlos Felipe dos Santos Cordeiro; Daniel Rodela Rodrigues; Fábio Rafael Echer

Background:

Sandy soils are poor in soil organic matter and nitrogen which limits cotton fiber yield and increases fertilizer responses and also the chance of leaching. Thus, crop rotation systems and a better N management can increase soil nitrogen availability improving fiber yield. The objective was to evaluate the effects of crop rotations systems and nitrogen fertilization on soil nitrogen content and cotton fiber yield. The study was carried-out in PresidenteBernardes-SP, Brazil in a sandy loam soil (Rhodustult, sandy loam). Crop rotation systems were implemented during 2015/2016 season. The experimental design was a randomized block with five replications, in a split-split-plot scheme. Crop rotation systems were allocated in the plots as follow: fallow, single grass, mix of cover crops, grass+legume, grass+grass; nitrogen rates were in the subplots: 70, 100 and 130 kg ha^{-1}; and in the sub-subplots the sources of N: urea (45% N) and controlled-release urea, with elemental sulfur (40% N + 8% S), applied at 25 and 45 days after cotton emergence.

Result:

Before cotton sowing, the total soil N concentration was higher in the system with two grasses (203 mg kg^{-1}); MIX had the highest soil ammonium content (6.7 mg kg^{-1}) and fallow the lowest (3.7 mg kg^{-1}).At late flowering stage, soil nitrogen content was higher on MIX (total N - 214 mg kg^{-1}; inorganic N-10.8 mg kg^{-1} and ammonium - 5.8 mg kg^{-1}). Increasing N rates (70-130 kg ha^{-1}) increased total soil N, inorganic N, ammonium and nitrate by 5, 30, 24 and 27%, respectively (average of N sources). Controlled-release urea increased the total soil N concentration by 6.4%, but reduced the availability of inorganic N, ammonium and nitrate at flowering. The highest fiber yield was achieved in the mix of cover crops with 100 kg ha^{-1} of N (1400kg ha^{-1}), and yield decreased in the highest N rate applied.

Conclusion:

Controlled-release urea can reduce the N applied rate by 30% under cropping systems of high cover crop diversity (MIX) through an the increase in soil N availability.

Keywords:

Sandy soils. Cover crops. Nitrogen. Controlled-release urea.

Acknowledgement

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Impacts of low irrigation and fertilization on cotton yield and fiber quality in the Mediterranean basin: Performance of an African cultivar compared to Greek cultivars

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Background:

Climate change may have impact on cotton growth and development and the Mediterranean Basin will be among the areas to be most adversely affected in terms of higher frequency of extreme climatic events. The aim of this study, which is part of the projectARIMNet2/TomorrowS, is to compare the resilience of an African cultivar (Stam 129A from Togo) exclusively cultivated under rainfed conditions, compared to commercial Greek cotton cultivars under four levels of irrigation and two levels of mineral fertilizers. A set of experiments was conducted in randomized blocks with three replicates for two years (2018 and 2019).

Result:

The seed cotton yield stability along with fiber quality traits were evaluated over the range of cropping conditions. The African cultivar exclusively cultivated under rainfed conditions in Africa with mean rainfall falling below 600mm, was expected to be more resilient that Greek cultivars. However, it never significantly out performed the Greek cultivars irrespective of the level of irrigation and fertilization. In 2018, Zeta 2 or Assos were best ranked and under the mid-range irrigation levels of 50 and 75%, the best performing cultivar was Assos. Under normal irrigation Zeta 2 were superior of all varieties both under low and high fertilization. Regarding environmental index, no cultivar was more stable than the others to the tested range of conditions. The results showed that Zeta 2 was the most productive and the most unstable while Stam 129A was the least productive and the most stable.

Conclusion:

The African cultivar (Stam 129 A) does not contribute to an increase in production under low inputs conditions in Greece. However, the cultivars Zeta 2 and Assos were relatively stable and produced high yield across the range of environments and should be tested in Africa under rainfed conditions.

Key Words:

Cotton, lower inputs, crop modelling, climate change

Influence of Micro nutrients on Morpho-Physiological and Biophysical parameters for enhancing the Productivity in Bt Cotton through Foliar Application

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Background:

Micronutrients deficiency in cotton increases abscission of boll and finally affects the yield of cotton. Micronutrients play an important role in physiology of cotton crop and these are being a part of enzyme system or catalyst in enzymatic reactions. They are required for plant activities such as chlorophyll formation, photosynthesis, transpiration rate and proline synthesis.

A field experiment was conducted to study the effect of foliar application of micro nutrients on morpho-physiological, bio-physical and bio-chemical parameters for enhancing the productivity in Bt Cotton at the Agricultural Research Station Dharwad, University of Agricultural Sciences, Dharwad, Karnataka. The experiment consists of nine treatments *viz.,* $FeSO_4$, $ZnSO_4$, $MgSO_4$, $MnSO_4$, Boron and combination of $MnSO_4$ + $ZnSO_4$, $MgSO_4$ + $ZnSO_4$ and $FeSO_4$+ $ZnSO_4$ foliar spray of all these at 70 and 90 DAS. The experiment was laid out in randomized block design with three replications.

Result:

Among all the treatments, foliar application of $MgSO_4$ 1% + $ZnSO_4$ 0.5% at 70 and 90 DAS recorded significantly highest plant height, monopodia, sympodia, total dry matter production, number of bolls per plant and seed cotton yields as compared to other treatments. It was on par with the treatments $FeSO_4$ 0.5% + $ZnSO_4$ 0.5% and treatment $MgSO_4$ 1% and the minimum yield and yield components were recorded under control. Significantly highest seed cotton yield (2393 kg ha^{-1}) was recorded in foliar spray with $MgSO_4$ 1% + $ZnSO_4$ 0.5% compare to control (1788 kg ha^{-1}).

The foliar application of $MgSO_4$ 1% + $ZnSO_4$ 0.5% recorded higher biophysical parameters *viz.,* Photosynthetic rate, Transpiration rate, Relative water content compared to control. Among all the treatments $MgSO_4$ 1% + $ZnSO_4$ 0.5% recorded higher Chlorophyll content and proline content compare to control.

Conclusion:

Application of foliar spray with $MgSO_4$ 1% + $ZnSO_4$ 0.5% at 70 and 90 DAS was effective in increasing the yield in Bt- cotton as compared to other treatments.

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Nitrogen and plant population effects on cotton yield and fiber quality

Fábio Rafael Echer[a], Leonardo Vesco Galdi[a], Bruno Senna[a] e Silva &Elio Jesus de La Torre[b]
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Background:

The interactive effect of maturity nitrogen rates and high plant population can a delay and decrease fiber yield and quality as a result of the low fruit set at the bottom of the canopy and increased proportion of fruits at the top of the plant. The objective of this work was to evaluate yield and fiber quality of a mid-cycle cotton cultivar under three N levels (80, 120 and 160 kg ha^{-1} of N) and four plant populations (6.6, 7.7, 8.8 and 9.9 plants m^{-2}) in a factorial randomized block design replicated four times.

Results:

The highest seed cotton yields were achieved at 6.6 plants m^{-2} (120 and 160 kg ha^{-1} of N) and 7.7 plants m^{-2} (no difference among N rates) and 9.9 plants m^{-2} at 80 kg ha^{-1} of N. The increased yields were associated with the higher boll number in these treatments. Under low N rates, increasing plant population above 8.8 plants m^{-2} decreased micronaire index. In general, the increase in N rate reduced the micronaire index in plant populations of 6.6, 7.7 and 8.8 plants m^{-2} and increased at 9.9 plants m^{-2}. Increasing plant population reduced fiber length at 80 kg $ha^{-1}$of N and the opposite was observed at a rate of 160 kg ha^{-1}. The short fibers index was higher according to higher dose of N on 6.6, 7.7 and 8.8 plants m^{-2} but the inverse occurred at the highest plant density. Under low N rate, 90% of yield was accumulated at nodes 17.9 and 18.2 in the plant populations 7.7 and 9.9 plants m^{-2} respectively; with 120 kg ha^{-1} of N, 90% of yield was accumulated up to node 17.6 in the highest plant population and at 160 kg ha^{-1} of N 90% of yield was reached up to node 18.6 with 8.8 plants m^{-2}.

Conclusion:

In general, the best yields occurred underlow plant population (6.6 plants m^{-2}) combined with 120 kg ha^{-1} of N; moderate plant population (7.7 plants m^{-2}) irrespective to N rate or high plant population (9.9 plants m^{-2}) and low N rate. Increasing N rates resulted in increased of short fibers and a decrease in micronaire.The right choice of N rate and plant population can increase earliness through the accumulation of yield at lower fruiting nodes.

Keywords:

Boll number, Micronaire; Short Fiber Content; Earliness.

Acknowledgement

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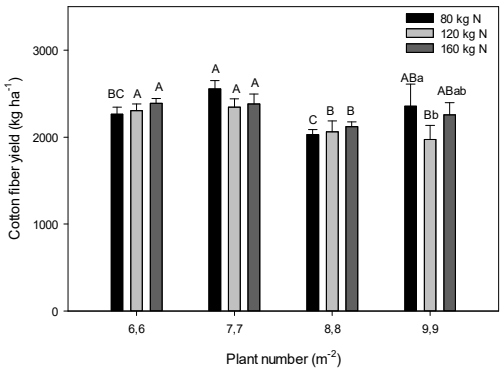
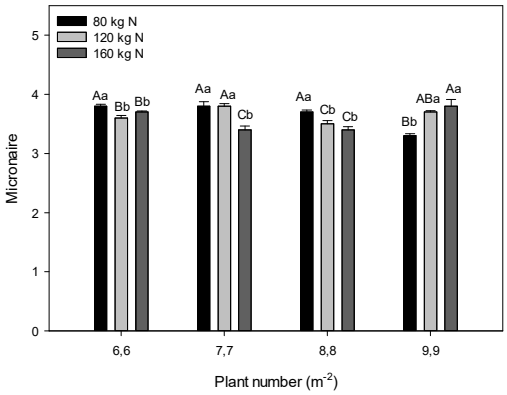
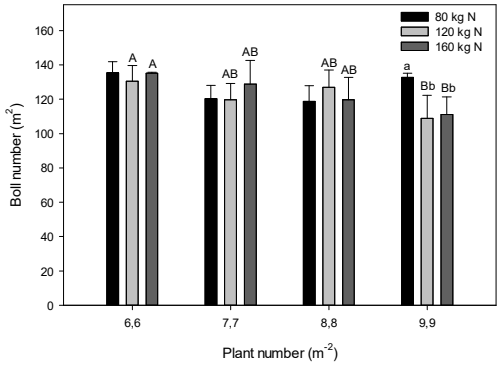
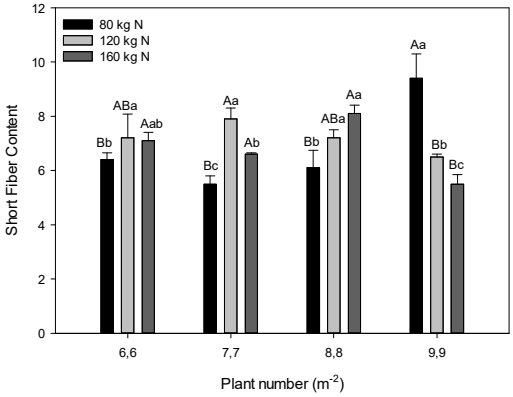
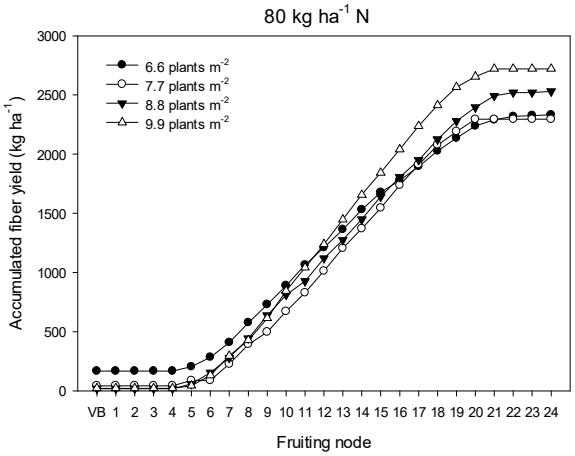
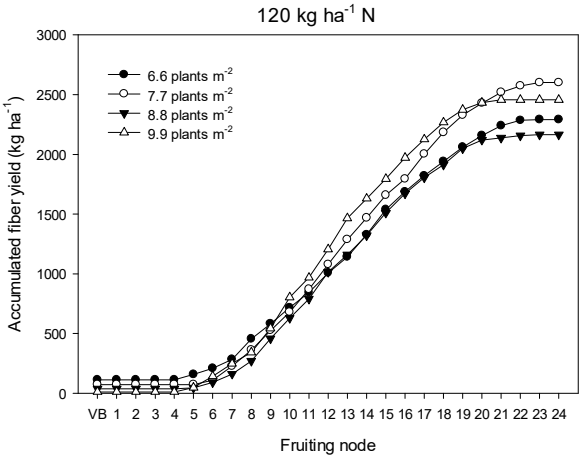

80 kg N
120 kg N
160 kg N
Cotton fiber yield (kg ha-1)
Plant number (m-2)
6,6
7,7
8,8
9,9
BC A A
A A A
C B B
ABa Bb ABab

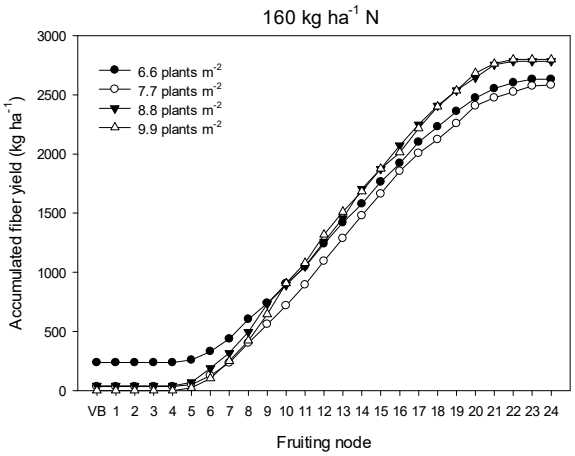

80 kg N
120 kg N
160 kg N
Micronaire
Plant number (m-2)
Aa Bb Bb
Aa Aa Cb
Aa Cb Cb
Bb ABa Aa


80 kg N
120 kg N
160 kg N
Boll number (m2)
Plant number (m-2)
A A A
AB AB AB
AB AB AB
a Bb Bb


80 kg N
120 kg N
160 kg N
Short Fiber Content
Plant number (m-2)
Bb ABa Aab
Bc Aa Ab
Bb ABa Aa
Aa Bb Bc


80 kg ha-1 N
6.6 plants m-2
7.7 plants m-2
8.8 plants m-2
9.9 plants m-2
Accumulated fiber yield (kg ha-1)
Fruiting node


120 kg ha-1 N
6.6 plants m-2
7.7 plants m-2
8.8 plants m-2
9.9 plants m-2
Accumulated fiber yield (kg ha-1)
Fruiting node


160 kg ha-1 N
6.6 plants m-2
7.7 plants m-2
8.8 plants m-2
9.9 plants m-2
Accumulated fiber yield (kg ha-1)
Fruiting node

Nitric Oxide Plays Novel Roles in Cotton Response to Waterlogging Stress

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Waterlogging stress is a major abiotic stress that negatively influences the growth and development of cotton. Considerable yield loss or even crop failure may follow when heavy waterlogging occurs. How to improve the adaptation of cotton to waterlogging stress and alleviate its damage has become an important approach. In this study, the experiments were conducted using a commercial cotton (*Gossypium hirsutum* L.) variety K836 in an electrically powered rain shelter at Experimental Station of Shandong Cotton Research Center at Linqing from 2018 to 2019. Cotton was subjected to 10-d waterlogging at flowering stage, and the NO donor sodium nitroprusside (SNP) or NO scavenger 2- (4-carboxyphenyl) -4, 4, 5, 5- tetramethyl- imidazoline- 1- 1- oxy1- 3-oxide (cPTIO) was foliar applied to waterlogged cotton to examine the effects of NO on waterlogging tolerance and its possible mechanism.

1. Effects of NO on growth, development and yield of waterlogged cotton

Compared with non-waterlogged control, the dry weight of root, stem, leaf, boll and the whole plant of waterlogged cotton was reduced by 33.2%, 22.0%, 17.4%, 14.2% and 19.0%, respectively. The boll density was decreased by 27.7% while slight decrease was observed in boll weight. The seedcotton and lint yield were decreased by 32.3% and 34.2%, respectively. Compared with waterlogging treatment without spray of NO regulator, dry weight of root, stem, leaf, boll and the waterlogged whole plant with SNP application was increased by 31.1%, 11.4%, 18.4%, 6.6% and 14.0%, respectively; boll density, seedcotton and lint yield with SNP application were increased by 9.0%, 10.0% and 11.5%, respectively. Dry weight of roots, stems, leaves, boll and the whole waterlogged plant with cPTIO application was decreased by 5.3%, 11.1%, 5.4%, 5.1% and 7.4%, respectively; boll density, boll weight, seed cotton and lint yield were decreased by 8.9%, 8.8%, 9.6% and 9.0%, respectively. These results indicate that SNP could increase biomass accumulation, reduce the loss of boll density, and alleviate the yield loss after waterlogging, while the NO scavenger cPTIO could aggravate the inhibitory effect of waterlogging stress on cotton growth and yield.

2. Effects of NO on physiological characteristics of waterlogged cotton

Compared with non-waterlogged control, the alcohol dehydrogenase (ADH) and Pyruvate decarboxylase (PDC) activity were increased by 67.7% and 4.5 times, respectively; the Superoxide dismutase (SOD), Peroxidase (POD), and Catalase (CAT) activity were decreased by 26.5%, 10.1% and 34.8%, respectively; the Malondialdehyde (MDA) and H_2O_2 level were increased by 58.7% and 2.1 times, respectively; the IAA and GA concentration were decreased by 44.6% and 22.5%, respectively; the ABA and ethylene content were increased by 20.9% and 9.0%; Chlorophyll (Chl) and Photosynthetic (Pn) rate were decreased by 34.2% and 25.5%, respectively. Compared with waterlogging without spray of NO regulator, waterlogging with SNP application increased NO concentration by 58.6%; reduced the ADH and PDC activity by 8.4% and 9.3%, respectively; increased the SOD, POD and CAT activity by 23.4%, 6.1%, and 10.6%, respectively; decreased the MDA and H_2O_2 level by 10.6% and 6.1%, respectively. Waterlogging with SNP application also increased IAA and GA content by 23.3% and 7.8%, respectively; reduced ABA and ethylene content by 39.8% and 9.5%, respectively; and increased Chlt and Pn of main-stem leaves by 19.8% and 24.7%, respectively.

In contrast, cPTIO application decreased NO concentration by 31.4%; increased the ADH and PDC activity by 26.5% and 15.8%, respectively; decreased the SOD, POD and CAT activity by 10.8%, 7.5% and 10.5%, respectively; increased the MDA and H_2O_2 concentration by 10.6% and 6.1%, respectively.

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Waterlogging with cPTIO application also reduced auxin (IAA) and gibberellic acid (GA) by 9.5% and 24.9%, respectively; increased abscisic acid (ABA) and ethylene content by 1.2 times and 16.4%, respectively; and reduced Pn of the main-stem leaves by 12.1%.

3. Effects of NO on gene expression of waterlogged cotton

Under waterlogging stress, the expression levels of NO synthesis gene (*GhNIR*) and *GhGA*3*ox*2 were down-regulated by 32.9% and 17.1%, respectively; the expression levels of genes related to glycolysis and fermentation (Gh*ADH*2 and Gh*PDC*), ABA synthesis (Gh*NCED*2), and ethylene production (*GhACO* and *GhACS*8) were up-regulated. However, foliar application of NO regulator considerably enhanced or reduced gene expression under waterlogging. Compared with waterlogging treatment without foliar spray of NO regulator, SNP treatment regulates the expression level of the above related genes in waterlogged plants. The expression levels of *GhNIR* and *GhGA*3*ox*2 in the main-stem leaves were up-regulated by 21.2% and 21.2%; the expressions levels of *GhNCED*2, *GhACS*8, *GhRBOHC* and *GhADH* were down-regulated by 28.2%, 44.8%, 59.1%, and 58.5%, respectively. In contrast, the expression levels of *GhNIR* and *GhGA*3*ox*2 in the main-stem leaves with cPTIO treatment were down-regulated by 19.6% and 19.6%; and the expressions levels of *GhNCED*2, *GhRBOHC* and *GhADH* were up-regulated by 14.2%, 79.3%, and 34.6%, respectively.

These results indicate that the 10-d waterlogging stress significantly reduced the NO content in cotton plants, accompanied with damage to the membrane system and inhibition of photosynthetic system as well as hormone imbalance in waterlogged cotton. Such a series of physiological changes ultimately reduced dry matter accumulation and lint yield. Foliar application of NO regulators effectively changed NO content in waterlogged cotton plants. Specifically, foliar spray of SNP significantly increased NO content of cotton plants compared with non-spray control under waterlogging. Moreover, SNP spray significantly inhibited the activity of anaerobic metabolic enzymes, and thus relieved peroxidation of membrane lipid. Leaf photosynthesis was improved, which ultimately reduced biological and lint yield losses under waterlogging stress. In contrast, foliar spray of cPTIO significantly reduced NO content of cotton plants, and thus aggravated the damage of membrane systems and photosynthetic systems, which further reduced cotton growth and yield losses.

In conclusion, waterlogging stress resulted in yield loss by disrupting the cell membrane system, photosynthetic system and hormone balance. Increased NO content in waterlogged cotton plants by foliar spray of SNP can significantly reduce membrane lipid peroxidation and hypoxia damage caused by waterlogging stress, induce expression of genes related to hormone metabolism to maintain hormone balance, promote the recovery of photosynthetic production capacity, improve the adaptability of cotton to waterlogging stress to a certain extent, and reduce yield loss. Therefore, NO plays an important role in regulating the response of cotton to waterlogging at the molecular, physiological and plant levels.

Keywords:

cotton; waterlogging stress; nitric oxide; yield; physiological response; gene expression

Plant topping effects on cotton growth, yield and earliness as mediated by plant density and ecological conditions

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Background:

Manual topping by removing the growth tips of stem can effectively inhibit cotton (*Gossypium hirsutum* L.) apical dominance and allow more assimilates to be partitioned to reproductive organs, leading to more harvestable bolls and lint yield (Li et al., 2006; Hosny et al., 1995). This traditional practice has been widely applied in China since 1950, but it is currently facing great challenges due to the decrease of rural labor force and increase of labor cost (Dai and Dong, 2014). Chemical topping have been conducted to control axillary shoot growth and maximize yield in field crops including cotton (Taylor et al., 2008; Mahmood et al., 2007; Su et al., 2012; Ye et al., 2017; Kang et al., 2015), but it is still unclear if it is modified by plant density. To this end, a three-year field experiment was conducted in three ecological cotton growing regions of China.

Field experiment was conducted from 2016 to 2018 at Hutubi (44°68′N, 87°12′E) of the northwest inland cotton region, Linqing (115°42'E, 36°61'N) and Jinxiang (116°7′ E, 34°52′ N) of the Yellow River valley region. Xinluzao 64 as experimental material was sown at Hutubi on 11-18th April, K836 at Linqing on 24-27th April, and Lumian 532 at Jinxiang on 24-27th May, respectively. A split-plot design with four replications was used for the study. The main plot was assigned to low, medium and high plant densities (9, 18 and 27 plants m^{-2} of full-season cotton at Hutubi; 3, 6 and 9 plants m^{-2} of full-season cotton at Linqing and 4.5, 9 and 13.5 plants m^{-2} of short-season cotton at Jinxiang), while plant topping pattern including non-topping (NT), manual topping (MT) and chemical topping (CT) was assigned to the subplots. Manual topping (MT) was established by removal of growth tips on the main stem by hand at mid- or late-July when the number of fruit branches achieve 8-10 per plant, while chemical topping was set up by spraying high concentration of mepiquat chloride (90-135 g hm^{-2} at Hutubi, 75-90 g hm^{-2} at Linqing and 90-105 g hm^{-2} at Jinxiang) in early- or mid-July.

Result: Results showed that manual topping reduced plant height and increased yield and earliness regardless of plant density and ecological conditions, compared with non-topping control. However, the effect of chemical topping on lint yield was significantly dependent on plant density or ecological conditions. At low plant density, chemical topping produced comparable yield to non-topping and slightly lower (0.8-4.8%) yield than manual topping among three experimental sites. At moderate and high density, chemical topping produced comparable yield to manual topping but considerably higher yield than non-topping control regardless of ecological conditions. Compared with non-topping control, seed cotton yield of chemical topping was increased by 12.8% and 14.2% under moderate and high plant density at Hutubi of the northwest inland cotton region, by 8.6% and 16.1% at Linqing, and 11.9% and 13.8% at Jinxiang, of the Yellow River valley region. This increased seed cotton yield by chemical or manual topping was attributed to more partitioning of assimilates to bolls and the increased boll density (the number of bolls per ground area).

Conclusion:

Chemical topping is not beneficial to cotton yield formation under low plant density. However, chemical topping considerably reduced plant height, improved earliness and seed cotton yield under moderate and high plant density, exhibiting similar beneficial effects to manual topping. Therefore, chemical topping can be a potential alternative to traditional manual topping for high population density cotton.

Keywords:
Cotton, Plant topping, Plant density, Yield, Ecological condition

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Isolation of gossypol degrading bacteria from Spodoptera litura and optimization of culture conditions for solid state fermentation of cottonseed meal

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Cottonseed meal is the by-product of cotton obtained after the seeds are crushed to extract oil. Cotton seeds are rich in high quality protein. However, the consumption of cottonseed is limited due the presence of gossypol which is highly toxic to monogastric and ruminant animals which may cause growth depression, and abnormalities to intestine, reproductive and other internal organs. In this study we have isolated gossypol degrading bacteria from the gut of Spodoptera litura and implicate them in biodegradation of gossypol in cottonseed meal by solid state fermentation. About 280x102 cfu/ml microbial load was isolated from the gut of S. litura on LB medium, among which seven isolates could able to grow on LB medium containing gossypol. Among the seven isolates, two were potent in utilizing gossypol as sole carbon source and identified as Lysinibacillus fusiformis (L13) and Bacillus xiamenensis (L19) by 16S rRNA sequencing and phyolgenetic analysis. The isolated strains were evaluated for biochemical tests. The biodegradation of gossypol in cottonseed meal was maximum when the incubation period was 48 h, pH 8.0, temperature 30 oC, and moisture content of 70%. The amount of gossypol degraded by the isolate L13 and L19 at optimized conditions was 86 and 79% respectively. The results indicated that the isolated bacterial isolates were able to utilize gossypol as sole carbon source and thus can be implicated in biodegradation gossypol in cotton seed meal.

Keyword:

Spodoptera litura, gut bacteria, gossypol, cottonseed meal, solid state fermentation.

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Heat Tolerant Phosphate Solubilizing Bacteria of Cotton Rhizosphere and their Effect on Plant Growth

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The rhizosphere hosts a diverse group of bacteria which can have a beneficial association with plants. But little work has been done to explore cotton crop rhizosphere for heat-tolerant phosphate solubilizing bacterial (PSB) diversity indigenous to hot and arid climates. The current study aimed to isolate heat-tolerant PSB from the cotton rhizosphere and their characterization for plant growth promoting attributes on cotton. The results showed that phosphate solubilization efficiency of isolated strains on National Botanical Research Institute's Phosphate (NBRIP) agar and liquid media varied from 22.5 to 134.5% and 594 to 2623%, respectively. For heat tolearance assay, the efficient bacterial growth (0.130 to 1.459 OD) was recorded at 40°C, moderate (0.133 to 0.951 OD) at 45°C, and slow (0.068 to 0.332 OD) at 50°C. The isolates TPB4, TPB19, and TPB30 improved cotton growth for all recorded parameters in the pot experiment, whether used alone or in combinations, compared to uninoculated control. But the consortia of TPB4, TPB19, and TPB30 indicated the highest increase in shoot length (29%), root length (30%), shoot fresh weight (37%), shoot dry weight (41%), root fresh weight (68%), root dry weight (81%), net photosynthetic rate (35%), transpiration rate (23%) and chlorophyll content (30%) as compared to control. The bacterial isolates were identified to be related to the genera Bacillus (16 isolates) and Alcaligenes (1 isolate). The findings imply that the cotton rhizosphere contains a sufficient range of heat-tolerant culturable PSB that might be used for cotton production in phosphorus-deficient soils of the arid climate

Keywords:

PGPR inoculation, arid agriculture, global warming, alkaline soils, heat stress, rhizobacteria.

Climate Smart Initiatives for Doubling Seed Cotton Yields of Smallholder Cotton Farmers in Zambia

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This article was written by Martin L. Simasiku the trialing lead of the project. Authors Sandhya Kranthi and Keshav Kranthi supervised the execution of project, analysis of the data and guided the writing of the article.

Cotton is a major cash crop in Zambia grown by a more than 100,000 small scale farmers in Zambia. It is a source of livelihood grown in three provinces of Zambia namely Southern, Central and Eastern Province. In all these cotton growing areas, the average seed cotton yields are low ranging from 300kg per hectares to 600kg per hectare. The major challenge of many small-scale farmers leading to these low yields are associated with both biotic and abiotic factors. The major biotic factors are pest infestations. Abiotic factors are associated with drought, low soil fertility and so on. However, another major reason for the low seed cotton yields are the poor agronomic practices that farmers have been engaged in for the many years, such as low-density planting. The International Cotton Advisory committee (ICAC) has partnered with the International Trade Centre (ITC) and European Union (EU) in bringing a project to Zambia to introduce prudent cotton growing practices meant to mitigate the low yields and double it. The main objective of this paper is to elaborate the four simple steps introduced to the Zambian cotton smallholder farmers meant to double their average cotton yields. These principles are (i) Seed health, (ii) High density planting (iii) Integrated Pest Management and (iv) Soil health. A total of 350 demonstration plots with these principles were planted and managed and their yields compared with the yields of ordinary farmers' fields. It was found that more than 60% of the demonstration plots obtained more than 1500kg per hectare while the majority (more than 70%) of ordinary farmers' seed cotton yields were around 500kg per hectare. In addition to this, the number of effective sprays were reduced by half in the demonstration plots as compared to the ordinary fields. Therefore, many small-scale farmers in Zambia can double their yields and income by following the four simple cotton growing steps.

Key words:

High Density Planting, Cotton seed treatment, Biochar, Manure, Compost, Cotton yields, Biopesticides

Assessment of climate change impacts on cotton and designing adaptation strategies through decision support system

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Background:

The Decision Support System for Agro-Technology Transfer (DSSAT 4.7) was used to assess the climate change impacts on cotton to design adaptation strategies. For this two years (2017 and 2018) field data was collected from experiments in which cotton genotypes (Cyto-179, CIM-602 and FH-142) were sown on May 10 th , May 25 th , June 09 th and June 24 th . The model calibration and validation was performed with the experimental data to simulate growth and yield response of cotton. The model simulations were performed under optimum growth conditions, current climate, and climate change scenarios. The model was run with baseline weather data from 1980-2019. Five general circulation models GCMs (CCSM4, GFDL-ESM2M, HadGEM2-ES, MIROC5 and MPI-ESM-MR) at representative concentration pathways RCP 8.5 were used for assessment of climate change during cotton growing season to the end of mid-century (2069).

Results:

The climate change scenario reveals that future climate will be totally different from current climatic conditions. The temperature will likely to increase from 1.9 to 3.8 °C by the end of mid-century. The model sensitivity analysis was performed for CO 2, rainfall, temperature and nitrogen rates. The sensitivity analysis showed that model was less sensitive to CO 2 in comparison with rainfall, temperature and nitrogen rates. The seed cotton yield was likely to improve with reduction in ambient temperature, improvement in rainfall and nitrogen rates.

Conclusions:

In these circumstances, designing of adaptation strategies are very crucial to minimize the negative impacts of climate change. The earlier planting about 15-20 days in comparison with current sowing window would compensate the negative impact of climate change.

Keywords:

Simulation, CO 2 , Rainfall, Temperature, Yield, Adaptation

Climatic Conditions of Cotton Research Station Uthal Lasbella, Balochistan Pakistan

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Background:

A field trial were laid out at experimental field of Cotton Research Station, Lasbella Balochistan during Kharif season 2021-22 in Randomized Complete block Design (RCBD) with 03 replications having 3m x 4m (12m2) plot size. The two cotton varieties 'CIM-678' and CRIS-585' were sown on different sowing dates viz., 15th March, 1st April, 15th April and 1st May using hand drilling method to assess the growth performance. The results indicated that the average numbers of bolls per plant, boll weight and plant height significantly decreased slightly as the sowing was delayed to 15th April and 1st May.

Results:

The cotton variety 'CIM-678' produced highest seed cotton yield (3850 kg ha-1) as compared to variety 'CRIS-585' (3350 kg ha-1) when sown on 1st April. Minimum seed cotton yield (3170 kg ha-1) for cotton variety 'CRIS-585'were recorded on 1st May and (3028 kg ha-1) for 'CIM-678"on 15th April. For bolls per plant CIM-678 formed maximum number of bolls (40.0) per plant followed by CRIS-585 (37.2) and maximum boll weight (3.9g) was obtained in variety CIM-678. CRIS-585 had smaller bolls with 3.5 g boll weight. The Ginning out turn was 41.5% in CRIS-585 and 40.0% in CIM-678. CIM-678 produced longer staple length (28.3 mm) followed by CRIS-585 (27.0 mm). Micronaire value of CIM-678 (4.3 µ inch-1) was better than that of CRIS-585. CIM-678 showed maximum fiber strength (39.1 g/tex-1) followed by CRIS-585 (24.9 g/tex1)). There was significant ($p<0.05$) difference in seed cotton yield for different sowing dates.

Conclusions:

The cotton cultivar 'CIM-678' is recommended to cotton growers for cultivation under climatic condition of Lasbella, Uthal Balochistan.

Keywords:

Sowing dates, Genotypes, Seed cotton yield, cotton, climate

Chemo-profiling of secondary metabolites from Pochonia chlamydosporia (Goddard) Zare & W. Gams 2001 and identification of novel nematicidal biomolecule for the management of Reniform nematode, Rotylenchulus reniformis .

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Background:

Reniform nematode, Rotylenchulus reniformis is an important nematode pest of cotton causing an annual yield loss of up to 10 %, which is managed mainly through the application of chemical nematicides. Several widely used fumigant and non-fumigant nematicides have been banned owing to their hazardous impact on the environment. Thus, there is an urgent need to have novel eco-friendly biomolecules against plant-parasitic nematodes, especially R. reniformis. Several fungal and bacteria antagonists are known to secrete metabolites with the nematicidal property. Among them, Pochonia chlamydosporia is being widely used as a potential bionematicide. Out of different solvents tried, ethyl acetate was found to be the best solvent for the extraction of metabolites, and the hatching inhibition and juvenile mortality were significantly more in ethyl acetate fraction than in crude metabolite. Chemo-profiling of ethyl acetate fractions of P. chlamydosporia by GC-MS yielded 38 compounds. Molecular docking was performed between the virulent protein targets of R.reniformis and the 38 metabolites obtained from P. chlamydosporia to identify the best one having highest efficacy against R. reniformis. Protein sequence for targets β-1,4-endoglucanase and Cytochrome c oxidase subunit 1 were retrieved using the UniProt database and molecular modeling was done using SWISS-MODEL.To predict the binding energy of ligand and target protein, structurally validated protein targets of R. reniformis have been docked with biomolecules through Auto Dock Vina module in PyRx 0.8 software. Nematicide, carbofuran 3G was used as a positive check to compare the binding affinity.

Results:

Docking analysis revealed that among all the metabolites lavendustin-C was having the highest binding affinity for β-1,4-endoglucanase (- 4.1 kcal/mol) and Cytochrome c oxidase polypeptide I (- 5.0 kcal/mol) compared to -3.6 and -4.8 kcal/mol for the nematicide, carbofuran 3G. Besides, lavendustin-C also had the maximum binding energy for the target sites. The novel molecule, lavendustin-C produced by P. chlamydosporia served as a potential inhibitor of the target sites associated with interrupting the functions of β -1,4-endoglucanase and Cytochrome c oxidase polypeptide I in the reniform nematode. Besides, the increased binding affinity of lavendustin-C with the protein target-sites facilitated exploring it, as a novel nematicidal-biomolecule for management of reniform nematode.

Conclusion:

However, further investigation is required to confirm the nematicidal properties of lavendustin-C in wet lab and to test the efficacy under pot culture conditions.

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Effect of different combinations of planting dates and varieties on crop phenology, whitefly population and incidence of CLCUD under different conditions

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Background:

Whitefly, Bemisia tabaci, (Gennadius), being the most serious insect pest of cotton in recent times in Pakistan is found under influence of crop phenology, cultural practices and the climate change. Therefore, a comprehensive study was conducted to determine effect of planting dates, varieties, climatic factors, crop phenology and thus whitefly along with associated leaf curl virus disease. These interactions were aimed for reasoning the need of effective management of whitefly and thus better cotton production for two consecutive years (2018, 2019).

Results:

Population of whitefly, infestation of cotton leaf curl virus disease (CLCuD) and effect of weather factors on the both were examined through seeding of transgenic and non-transgenic cotton varieties in three planting dates (1st week of April, May and June) at distant locations (Multan, Rahim Yar Khan and Layyah). Plant phenological stages (early: 1st 60 days, mid: 61-120 days and late: 121-200 days) were found quite critical with respect to whitefly infestation, whereas no significant effect of varieties was observed. Early planted crop showed better growth and development under conducive environment, that it coped well against infestations of whitefly and CLCuD. However, higher whitefly population was recorded in critical phenological stages, i.e. flower to boll opening and boll opening to harvest in the mid and late planted crops, which ultimately affected the growth and yield of the crop. All phenological stages were severely affected by the pest in late planted cotton crop. Moreover, infestation of CLCuD was significantly higher on the late planted crop as compared to infestations observed on crops of first and second planting dates in both years of the study. Key climatic factors including temperature, humidity and rainfall were found affecting significantly the whitefly population under all three planting dates. Whitefly population was positively correlated with relative humidity during both study years.

Conclusion:

The changing climatic conditions demand a real shift in cultural practices particularly the planting time, to better withstand having good plant vigor to tolerate against pest pressure.

Keywords:

cotton crop, planting time, varieties, crop phenology, Bemisia tabaci, CLCuD

Pink bollworm, Pectinophora gossypiella (Saunders) (Lepidoptera:Gelechiidae) resistance and management strategies to transgenic cotton in India

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Background:

Pink bollworm, Pectinophora gossypiella (Saunders) is the most notorious pest on cotton. During 2002, transgenic Bacillus thuringiensis cotton (Bt-cotton) expressing a Crystal-1Ac (Cry1Ac) protein was introduced and commercialized for cultivation. At the time of its introduction this single gene containing BG-I cotton was toxic to the different cotton bollworm species viz., Helicoverpa armigera (Hubner), Pectinophora gossypiella (Saunders), Earias vitella (Fabricius) and Earias insulana (Boisduval). To enhance the efficacy and durability of the technology for bollworm control, a second-generation Bt-cotton-II (BG-II) expressing two Bt proteins 'Cry1Ac+Cry2Ab' was introduced into India in 2006. Though the initial control was promising, the pest got adapted to Bt toxins. Field evolved resistance was first reported against Cry1Ac toxin from populations of Gujarat in 2010. Subsequently, in 2014 resistance against BG-II was reported by ICAR-CICR, Nagpur. ICAR-CICR conducted surveys from 2010 to 2021 across country to monitor and track the resistance status of populations from different geographical locations in India. Understanding the resistance status will enable us to formulate need-based management strategies and also enable refinement of present management tools accordingly. The impact of the pest and its economic importance demands extensive management practices. The resistance status is an eye opener and demands dynamic management strategies. Here, we present the scenario of current management strategies for the management of pest, encompassing several approaches that have immediate and long-term impact.

Results:

Pink bollworm resistance to the Cry toxins, Cry1Ac and Cry2Ab in Bt-cotton was monitored by ICAR-CICR from 2010 in India. Frequently, the larvae were collected from cotton fields of different districts across India during September-December. Pink bollworm infestation was recorded by random sampling of green bolls from cotton fields across the country. The percent infestation in green bolls was calculated based on the presence of live larvae in the green bolls. Log dose probit analysis with various concentrations was carried out for the different populations across the country. The results of log dose probit assays showed that pink bollworms have developed resistance to both BG-I and II. The susceptible population maintained at the laboratory was taken as reference to compare and depict the resistance status of pest in terms of resistance ratios. The significant resistance levels against Cry1Ac and Cry 2Ab were recorded over period of time and the increasing trend was noted. Hence, management of the pest from the beginning is required. The adoption of early maturing cultivars will escape the pink bollworm infestation and also deprive the pest form availability of host to multiply. Hence, the infestation window will be closed early resulting in decreased carry over of the pest. This tactic can be used in combination with other tools for increased efficiency of management. Other approaches for management of the pest through the use of semiochemicals like pheromones in trapping moths for monitoring, mass trapping and mating disruption technology is emerging under current scenario. Several novel pheromone formulations like wax-based and dispensers have got ample of potential in area wide management of the pest. Natural pest control with biological control agents like Trichogramma and Bracon was also reported and evident. Ultimately the Integrated Pest Management module and the resistance management module need to be adopted by the growers for the all-round management of the pest.

Conclusion:

This study is the comprehensive report of the resistance status of the pink bollworm against the cry toxins. It is evident from the study that, the resistance ratios are very high against both the toxins, results in the higher cost of protection and yield losses. In order to sustain cotton production, it is necessary to

find an efficient alternative to overcome this serious problem and strict implementation of these tools is the need of the hour. Hence various management tactics available at present scenario were mentioned below. In the end the Integrated approach for the management of the resistance as well as pest was also presented. All the above means of management tools were found effective in managing the pest.

Keywords:

Pink bollworm, resistance, Bt cotton, Cry toxins, management strategies

Evaluation of indigenous the nucleopolyhedrovirus (NPV) of Spodoptera litura (Fabricius) (Lepidoptera: Noctuidae) in combination with chlorantraniliprole against Spodoptera species

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Background:

The armyworms, Spodoptera exigua (Hübner), and S. litura (Fabricius) (Lepidoptera: Noctuidae) are polyphagous pests of many cash crops. Heavy crop losses have been reported for the fruit and vegetable crops each year owing to the diverse impact on global economies. The present study was aimed to sort out a novel method of pest control using the insect's own nucleopolyhedrosis virus (NPV) alone and in combination with a new chemistry insecticide chlorantraniliprole.

Results:

In the study, the effect of indigenous isolated nucleopolyhedrovirus (NPV) and the chemical insecticide (chlorantraniliprole) formulations against the 2nd and 4th larval instars of S. litura and S. exigua, collected from the different geographical region of Punjab (Pakistan) province, was evaluated. Three concentrations of the NPV isolate, sub-lethal (1 × 104, 6 × 104 POB ml-1), lethal (3 × 105 POB ml-1), and chlorantraniliprole 0.01 µl l-1, were applied alone and in combination against the 2nd and 4th larval instars of both pest species. The lethal concentration of NPV + chlorantraniliprole exhibited synergistic interaction and caused high larval mortality against both instars, while in all other combinations, additive effect was observed. Moreover, NPV + chlorantraniliprole at lethal concentration exhibited decreased pupation, adult emergence, and egg eclosion. Conclusion: The implications of using NPV alone and in combination with an insecticide are discussed briefly in this study.

Keywords:

Nucleopolyhedrovirus, Chlorantraniliprole, Spodoptera exigua, S. litura, Combined effect.

Development of Eco-friendly Management of Sucking Insects of Cotton

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Background:

Cotton is an insect loving crops. Jassid and whitefly are the main sucking pests of cotton that reduce cotton yield significantly. To control the sucking pest populations considerable amount of insecticides are being used in cotton field which is detrimental to environment.

Results:

An experiment was conducted at five Cotton Research Centers of the Cotton Development Board, Bangladesh to develop environment-friendly management practice against sucking pests of cotton. The experiment consisted of 6 treatments viz. T1- application of Azadirachtin (Bioneem plus 1% EC) @1ml/liter of water + yellow sticky trap, T2 – application of Abamectin (Biomax-M 1.2% EC) @ 1ml/ litre + tobacco leaf extract + yellow sticky trap, T3-application of Azadirachtin (Bioneem plus 1% EC) @ 1 ml/ L of water + Spinosad (Success 2.5 SC) @ 1 ml / litre of water + yellow sticky trap, T4- Akondo leaf extract (50%) + tobacco leaf extract (50%) + yellow sticky trap, T5-farmers practice (Hemidor @ 0.3 gm/litre), and T6 -untreated control following RCB design with three replications. For each treatment five sprays were done based on ETL. Incidences of sucking pests were recorded before spraying and after 24, 48 and 72 hours of spraying. In case of Jassid population, application of Azadirachtin (Bioneem plus 1% EC) @ 1 ml/ L of water + Spinosad (Success 2.5 SC) @ 1 ml / liter of water + Yellow sticky trap give the highest reduction rateand in case of white fly population, application of Azadirachtin (Bioneem plus 1% EC) @1 ml/L of water + Yellow sticky trap showed better next performance. Highest yield was found in T5 followed by T3.

Conclusion:

This experiment suggested that, from environmental point of view we may consider T3 as best management practices for Jassid and T1 for whitefly. As sucking pest are the major cotton yield reduction, pest management approaches were developed to control sucking insect pests of cotton and for the benefit of farming community.

Key words:

Eco-friendly, Sucking pest, cotton.

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Sustainable Technologies for Enhancing Cotton Productivity in the Northern Zone of India

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Background:

Cotton productivity in northern zone of India has been fluctuating since past two decades. However, technologies are available and if implemented in the right earnest can bring about sustainability in productivity.

Results:

The northern cotton zone of India consists of a contiguous, essentially irrigated tract, cultivating cotton in 1.3 to 1.8 million hectares area for the past two decades. During 2021-22, cotton was planted on 1.706 million ha and the production was 1.02 million tones with a productivity of 597 kg lint/ha. Bt cotton was approved for cultivation in this zone in 2005. If we analyze the performance of cotton in the north zone during the decade of pre-Bt era (1995-96 to 2004-05) and the past decade of Bt cotton (2010-11 to 2019-20), the productivity range for above two periods was 171-552 and 433 to 729 kg lint per ha respectively. There was a mean net increase in productivity by 297 kg /ha during the last decade under Bt cotton over the pre-Bt phase.

Further, if we look at the Bt cotton era, an epidemic of whitefly, a sucking insect, was observed in the north zone during 2015-16 leading to a severe reduction in the productivity to 433 kg/ha as compared to 579 kg/ha during 2014-15. At that juncture, a new whitefly management technological package was finalized and implemented rigorously which helped in managing this pest successfully and contributed significantly to yield improvement and productivity stabilization. Consequently, the productivity increased to 577 kg/ha in 2016-17, 573 kg/ha in 2017-18, 602kg/ha in 2018-19 and 678 kg/ha in 2019-20. This underlines the importance of sustainable technology development, deployment and adoption for successful management of white fly, productivity enhancement and stabilization.

Another example the was successful management of the dreaded cotton leaf curl virus disease caused by a whitefly transmitted begomovirus which appeared in 1990's and started affecting cotton yield. Technological package consisting of tolerant BG II hybrids, weed eradication and vector (whitefly) management were evolved and implemented on a large scale from 2015-16 leading to significant disease reduction and productivity improvement. Screening methodologies were standardized through multi-location trials and molecular tools were used for identification of weeds that acted as carrier of the virus. These technologies are discussed in detail in the paper.

Conclusion:

Improving soil health management protocols, development and deployment of short duration (150-165 days duration), sympodial, high GOT genotypes and convergence of integrated nutrient, water and pest management are envisaged to bring further stability in the northern cotton zone of India. The occurrence of resistant population of pink boll worm is once again challenging cotton production in this zone and this also calls for large scale adoption of sustainable technological interventions.

Key Words:

Productivity, stability, Bt cotton, biotic stress management technologies

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Seasonal population dynamics of whitefly, *Bemisia tabaci* (Gennadius) and abundance of their natural enemies in *Bt* transgenic and non-transgenic cotton

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Background: Whitefly *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is a major sucking pest of agricultural and horticultural crops. It causes economic damage directly by feeding plant foliage and indirectly serves as a vector for deadly plant viruses. An extensive work on the abundance of natural enemies of whitefly has been done worldwide, although the assemblage of natural enemies in *Bt* transgenic and non-transgenic cotton in Indian condition needed.

Results: We studied the population dynamics of *B. tabaci* and the associated natural enemies in Bt and non-Bt cotton ecosystems. Through the three years of investigation, the population of *B. tabaci* appeared and remained for 23 weeks both in Bt and non-Bt cotton. The population of adults and nymphs of *B. tabaci* was higher during the last week of July (30th week; 13.47 ± 8.03 adults leaf^{-1}) and mid of August (33rd week; 91.16 ± 82.67 nymphs leaf^{-1}), respectively in Bt cotton. In non-Bt cotton, the higher population of adults and nymphs was found during the last week of July (30th week; 7.73 ± 3.64 adults leaf^{-1}) and the last week of August (34th week; 35.66 ± 33.37 nymphs leaf^{-1}), respectively. We recorded, 25 species of natural enemies (NEs) of *B. tabaci*, of which 23 were predators and one species of parasitoid and the entomopathogenic fungi in Bt and non-Bt cotton. The aphelinid parasitoid *Encarsia lutea* (Masi) was more abundant (71.29%) followed by coccinellid predator, *Serangium parcesetosum* Sicard (7.76%). There were no significant differences in the abundance of the NEs observed between the Bt and non-Bt cotton. In general, climatic variables morning and evening relative humidity influenced the *B. tabaci* population and the abundance of NEs both in Bt and non-Bt cotton. Rainfall has a positive influence on the nymphal densities of *B. tabaci* in Bt and non-Bt cotton fields. The maximum temperature was negatively correlated and showed negative effect on NEs population.

Conclusion: Our study shows that the Bt cotton harbour a higher population of *B. tabaci* and NEs than non-Bt cotton, and pest abundance was strongly influenced by the NEs and the prevailing climatic conditions of the region. Thus, the NEs community and population dynamics of *B. tabaci* need to be taken into consideration for the development of IPM. Conservation of wide arrays of NEs could further help in the effective and sustainable management of this pest in cotton ecosystem.

Keywords: *Bemisia tabaci*, whitefly, natural enemies, cotton, population dynamics

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Cotton pest management revival strategies in Pakistan

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Background:

Since cotton replaced jute as an export commodity, cotton is an important crop of Pakistan and a major foreign exchange contributor. Cotton yield has faced a significant decline in the past ten years from 12 million bales (2010 – 2011) to 7.06 million bales (2020–2021). Poor pest management, shift in cotton area to other crops, climate variability, early sowing, poor quality Bt cotton seed, traditional methods of spraying and gap between farmers and extension staff have been realized as the possible reasons behind cotton yield reduction despite the introduction of genetically modified varieties.

Result:

A plan to revive cotton production has been developed to improve pest management. Although increased cotton support price together with the implementation of breeding property rights in Pakistan resulted into increase in area under cultivation. For this, so far studies reported since the independence of Pakistan would be highlighted from grey material.

Conclusion:

However, combination of whitefly control strategy including the use of botanicals in addition to the awareness on use of biopesticides and updating the curriculum of universities in connection with current agricultural issues faced by farming community may provide sustainable cotton production in Pakistan.

Keywords:

Bt cotton, Jassids, Pink bollworm, Insecticide

Potentiality of Essential Oils of Ocimum Gratissimum, Lippia Multiflora, Cymbopogon Citratus and Cymbopogon Nardus for the Development of Biopesticide for Organic Cotton Production

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ABSTRACT

Background: *Chemical insecticides have contributed to the success of cotton cultivation in most producing countries. However, today, various environmental problems are attributable to them. Therefore, the search for alternative control methods is necessary. Thus, the overall objective of the present work was to evaluate the insecticidal efficacy of essential oils extracted from nine aromatic plants (Ocimum gratissimum, Ocimum canum, Melaleuca leucadendron, Hyptis suaveolens, Lippia multiflora, Cymbopogon citratus, Cymbopogon nardus, Eucalyptus globulus and Citrus sp.) on three important carpophagous pests of cotton (Helicoverpa armigera, Pectinophora gossypiella and Thaumatotibia leucotreta).*

Methodology: *After extraction and characterization by gas chromatography/mass spectrometry (GC/MS), the essential oils were applied at different concentrations (0.25; 0.50; 1; 2; 4; 8; 16; 32 and 64 %) by topical application method using a micro applicator (Arnold Burkard) on the different pests.*

Results: *The results obtained revealed that the essential oils used are mostly monoterpenic. Moreover, they all have insecticidal properties on adults of P. gossypiella and T. leucotreta on the one hand, and on larvae of H. armigera on the other hand. Referring to the values of lethal concentrations, the study revealed that the essential oils of O. gratissimum, L. multiflora, C. citratus and C. nardus were the most toxic to P. gossypiella and T. leucotreta. On H. armigera larvae, essential oils of O. gratissimum, L. multiflora were the most effective (LC50 = 6.92 % and 7.20 % respectively; LC90 = 17.14 % and 21.94 % respectively). The least toxic were those of O. canum, E. globulus and Citrus sp. Hierarchical ascending classification (HAC) detected the essential oils of O. gratissimum, L. multiflora, C. citratus and C. nardus as the most effective against all the tested pests.*

Conclusion: *Insecticide formulations based on essential oils of the four aromatic plants mentioned above should be developed for use in cotton production in order to limit the use of synthetic insecticides.*
Key words: Cotton, Organic production, Essential oil, Insecticidal activity, Ivory Coast.

Controlled Release Emission Mating Interruption Technique (CREMIT): A novel and viable approach for area wide management of pink bollworm, Pectinophora gossypiella (Saunders) in Bt cotton ecosystem

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Background:

A novel mating disruption technique through the wax-based pheromone formulation CREMIT-PBW for area-wide management of pink bollworm, *Pectinophora gossypiella* (Saunders) was exploited in Bt cotton ecosystem.

Results:

The efficacy studied of CREMIT-PBW was carried out over an area of 154 acres (2017-18) and 206 acres (2018-19) in Raichur district of Karnataka, India. Dose optimization study comprising of 500, 750 and 1250 g/acre were evaluated during the first season. In the subsequent season, the optimum dosage of 500g per acre was split and applied at 40, 70, 100 and 130 days after sowing. The outcome of the investigation is quite promising and recorded minimum rosette flower (11.76%) and green boll damage (10.20%). During the second season, the rosette flowers and green boll damage was further reduced to 4.70 % and 4.52 %, respectively. Similarly, locule damage of 8.65% and8.18% was recorded during first season, and second seasons, respectively. Ultimately, the higher yield of 33.59 q/ha was obtained from CREMIT treated plots in contrast to farmers' practice who even after 5-6 rounds of spray have got 22.33 q/ha of yield. CREMIT being a mating disruptant has direct impact on moth trap catches, wherein, the number of pink bollworm male moths caught per trap per week was minimum at higher doses viz., 1250 and 750g per acre. At optimum dose the moth trap catches were 9.29 in the first season and an average of 18.92 male moths caught per trap per week in the second season. On the contrary, the average numbers of male moths caught were highest in conventional practice (240.38/trap/week) and (155.03/trap/week) indicating that incompetence of insecticides to deliver expected level of control in comparison with CREMIT-PBW.

Conclusion:

Impact of CREMIT-PBW is prominent at all the applied dosages which is clearly depicted in terms of lower bollworm incidence and higher cotton yields. The highest yield of 43.33 q/ha was recorded from plots treated with the highest application rate of CREMIT- PBW i.e., 1,250 g/ha. While, the cotton yields obtained from the fields treated with other two dosages (750 g/ha and 500 g/ha) of CREMIT-PBW, were almost similar, recording 42.50 q/ha and 40.50 q/ha, respectively in the first season. In contrast, the cotton yields obtained from the conventional farmers' practice plots were 24.68 q per ha and 20.00 q per ha from two seasons respectively. This trend clearly depicts the effectiveness of CREMIT-PBW in managing the pest, reflecting in terms of increased yield as compared to the conventional farmer's practice. The gain in crop yield ranged from 15.80 to 18.63 q per ha in the first season and additional gain of 6 to 7 quintals per hectare in the next season which is outstanding result making the mating disruption as breakthrough tool in the field of pest management.

Keywords:

Pink bollworm, *Pectinophora gossypiella*, Bt cotton, Mating disruption

Artificial diet as alternative to natural diet: evaluation of *Pectinophora gossypiella* Saunders (Lepidoptera: Gelechiidae) fitness using age-stage two-sex life table tool

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Background:

Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is one of the economical pests of cotton crop globally instigating quantitative and qualitative losses. Basic studies of *P. gossypiella* are very important and helpful to the development of integrated management strategies. Traditional life table characteristics, which exclusively provide information on female age-specific populations while age-stage two-sex life table traits explain the both sex (male and female). The biology and fitness parameters of *P. gossypiella* have been studied on natural and artificial diets via traditional life table tool but to have a better knowledge of this pest, age-stage two-sex life table parameters studies of this pest on artificial diet is lacking.

Results:

Impact of artificial diet (seed cotton based) as compared to natural diet (cotton bolls) on life traits of *P. gossypiella* was evaluated. The results indicated that the larval development period of *P. gossypiella* was shorter 8.81 ± 1.65 days on artificial diet as compared to natural diet 9.95 ± 2.65 days. The total fecundity of *P. gossypiella* was maximum when reared on artificial diet i.e., 195.70 eggs female^{-1} in comparison to natural diet 113.30 eggs female^{-1}. The intrinsic rate of increase (r) (0.104 /time unit), finite rate of increase (λ) (1.109 /time unit), gross reproductive rate (GRR) (54.155 offspring/individual), and net reproductive rate (R_0) (67.54 offspring/individual) of *P. gossypiella* were highest on cotton based artificial diet in comparison to natural diet r (0.098 /time unit), λ (1.091 /time unit), GRR (44.145 offspring/individual), and R_0 (47.44 offspring/individual).

Conclusion:

This study explains the age-stage, two-sex life table traits of *P. gossypiella* on seed cotton based artificial diet for the first time. Results concluded that the cotton based artificial diet was most suitable for rearing and molecular studies of *P. gossypiella*. These outcomes will be useful for future studies of *P. gossypiella* management in cotton growing areas.

Keywords:

Pectinophora gossypiella, cotton, artificial diet, life table, fitness

Management of Pink Bollworm, *Pectinophora gossypiella* (Saunders) using Pink Bollworm Manager (PBWM)

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Background:

Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is considered one of the most destructive pests of cotton globally. In Pakistan, losses due to *P. gossypiella* infestation in cotton have been estimated to be US$1.2 billion annually. Considering the economic importance of *P. gossypiella,* Central Cotton Research Institute (CCRI) Multan, Pakistan has designed Pink Bollworm Manager (PBWM) machine to pick the left-over bolls from cotton sticks which are the main source of *P. gossypiella* infestation in next season.

Results:

Efficacy of PBWM was evaluated in the ten different cotton varieties (CIM-875, CIM-663, CIM-664, CIM-758, Cyto-536, Cyto-775, Cyto-533, Cyto-535, Cyto-537, and CIM-632) at CCRI, Multan, Pakistan. An untreated check (no-PBWM operated) of each variety was kept as control. Results indicated that PBWM picked all the left-over bolls from cotton sticks of ten varieties in treated (PBWM-operated) plots as compared to untreated check. While, in the untreated check of the same varietal plots 3-16 bolls/plant remained unpicked harboring 25-45% larvae of pink boll worm.

Conclusion:

This study concluded that PBWM is most suitable for picking the left-over bolls from sticks of all types of cotton varieties either bushy or erect and short or long statured. It is an ideal machine to manage *P. gossypiella,* with additional advantage of safe sticks storage to be used as fuel purpose and timely wheat sowing along-with socioeconomic benefits to farming community.

Key Words:

Pectinophora gossypiella (Saunders), Pink Bollworm Manager (PBWM), cotton, varieties, left over bolls

Using sulfur as a disinfecting agent for cottonseeds

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Seed disinfection is the coating of seeds with a substance or chemical to reduce, control, or repel insects, pathogens, and other organisms that damage the seed or plant. Fungi that are present with seeds or in the soil, cause seed rot and plant death whether in storage or on the field. Seed treatment with fungicides and insecticides is the most economical and easiest choice to reduce the damage. Up to three weeks after planting, the plants are protected, are sufficiently resistant and usually after this date are able to tolerate and compensate for the damage. Among different chemicals the sulfur due to its fungicidal, insecticidal properties, in expensiveness, ease of storage , low toxicity to humans and other mammals and providing in part to the plant's nutritional needs is one of the most suitable compounds for disinfecting cottonseeds. In case of disinfection of cottonseeds with sulfur, storage pests are also being controlled and the remaining seeds can be used to feed livestock after washing.

Keywords:

cottonseed, disinfection, sulfur, plant death and seed rot.

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Geographical distribution of the main cotton pests in six West African countries during the period 2019-2021

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Background :
Cotton cultivation is under pressure from several pests in West Africa. without a good phytosanitary protection, crop losses can vary between 30 and 70%. In recent years, spatial and temporal variations in pest populations have been observed. These changes are likely to make the phytosanitary protection strategies recommended in the different countries inadequate. There is therefore a need to update knowledge for a better pest management.

Results:
Pest monitoring was carried out in six West African countries for three years, from 2019 to 2021: Benin, Burkina Faso, Côte d'Ivoire, Mali, Senegal and Togo. Each year, observations were conducted from the 30th to the 122nd day after the emergence of the cotton, in 100 to 500 producer fields depending on the administrative and technical divisions of the countries. The results highlighted a dozen main pests. Their levels vary from country to country. The first group, formed by Benin, is characterized by high levels of Helicoverpa armigera, Earias spp, Diparopsis watersi, Spodoptera littoralis and Plyphagotarsonemus latus specese. The second group consists of Senegal and Mali. It is characterized by high levels of Jacobiella fascialis, Bemisia tabaci, Anomis flava, Dysdercus spp and Haritalodes derogata. The third group consists of Côte d'Ivoire and Togo. These countries are characterized by the endocarpic lepidoptera (Thaumatotibia leucotreta, Pectinophora gossypiella) and also the presence of aphid (Aphis gossypii).

Conclusion:
This study showed similarities and also peculiarities between countries. This information could contribute to the development of integrated phytosanitary protection strategies.

Keywords:
Cotton, pest monitoring, West Africa, PR-PICA.

The Development of Bollworm Resistance and Its Influence on Variety Performance and Profitability

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Background

Modern cotton varieties are rapidly released onto the market with little prior third-party evaluation of yield, yield stability, trait performance, or other growth characteristics. Competition among seed brands, advances in breeding techniques, and the increased development of herbicide and insect tolerant traits further accelerate the release, and subsequent removal of varieties from the market. Yet, most growers in the U.S. consider variety selection to be one of the most important economic decisions they make each year. As such, the NC On-Farm Cotton Variety Evaluation Program was established in 2015, which continues to effectively evaluate yield potential and stability on cotton producers farm, across a broad range of environments, planting dates, soils, rainfall patterns, management practices, etc. Since its release in 2016, this program has illustrated that one particular 2-gene Bt variety, Deltapine 1646 B2XF, continues to portray a high degree of yield stability, and frequently outperforms competitor varieties of both 2-gene and 3-gene insect technologies. Prior to 2016, 2-gene varieties provided adequate bollworm control with minimal or seldom additional sprays needed for caterpillar control. Beginning in 2016, widespread resistance of bollworms to 2-gene Bt traits became prevalent across the primary cotton-producing regions of NC, which increased in 2017, necessitating additional and costly diamide sprays to achieve acceptable control, which is now considered to be a relatively common practice. Simultaneously, 3-gene Bt varieties became commercially available in 2017. The alarming costs of additional diamide sprays, needed to manage bollworms in 2-gene varieties, incentivized many growers to transition to 3-gene varieties, however, Deltapine 1646 B2XF continued to yield greater than some of the top-performing 3-gene varieties. In many cases, the yield advantages of this 2-gene variety were thought to be high enough to cover the costs of additional required diamide sprays while still returning greater profits to producers. The objectives of this research were to determine if 2-gene varieties provide yield advantages over 3-gene varieties that may justify the added cost of spraying diamides for bollworms, and to quantify changes over time regarding variety advancements in yield potential that may close the yield gap between 2- and 3-gene varieties.

Results

Large-plot replicated trials were conducted in cooperating producers' fields across NC during 2017-2019, including all of the predominate cotton-producing regions within the state. The NC On-Farm Cotton Variety Evaluation Program was designed to capture as many representative regions, soil types, planting dates, tillage practices, and environments etc. as possible within a given year, as a means of effectively evaluating yield potential and stability of predominate varieties in a single year. This program includes the top 2 varieties, considered to be the generally best varieties each brand has to offer NC growers, from each seed company as determined by participating seed companies. All varieties and replicates within a trial were managed equally for all practices throughout the year. Cooperating growers were asked to utlilize a mild to moderate PGR program and defoliation timing as to avoid penalizing varieties of specific maturities. Bollworm management decisions were made according to thresholds in 2-gene varieties or plots within a trial. Percent damaged bolls were measured by cooperating entomologists near the time of defoliation or shortly after, but prior to harvest. 2017 was considered to be a "heavy" year with regard to bollworm pressure; 2018 experienced relatively lighter pressure, and 2019 experienced very little bollworm pressure.

When comparing yields for varieties in the on-farm trials, varieties are ranked according to average yield across all locations. Trials are sorted progressively according to the average yield of all varieties within each trial. Yield means are highlighted to indicate that yield for that variety was statistically no different than that of the highest yielding variety in each trial

($p \leq 0.01$). For the purposes of this research, only yield and economic value/acre for the highest-yielding 2- and 3-gene varieties (averaged across all on-farm trials) were compared in each year, only in trials where a statistical difference in yield between the two varieties was observed. Value was calculated as yield x $0.75/lb, adjusted for the cost of each diamide spray applied to the 2-gene variety ($18/A per application, assuming the 2-gene variety should be sprayed in every environment, but not the 3-gene variety). In 2017, the highest yielding 2-gene variety (on average) resulted in greater value per acre, even after considering the additional cost of both one ($108/A) and two ($90/A) diamide sprays in 43 % of trials. The highest yielding 3-gene variety (on average) resulted in greater value per acre ($250.50/A for one diamide application; $268.50/A for two applications) than the 2-gene variety in only 7% of trials. There were no difference in yields between the highest yielding 2- and 3-gene varieties in 43% of trials, and neither yielded in the statistically highest group in 7% of trials. In 2018, the highest yielding 2-gene variety (on average) resulted in greater value per acre, even after considering the additional cost of both one ($86.65/A) and two ($68.65/A) diamide sprays in 38 % of trials. The highest yielding 3-gene variety (on average) resulted in greater value per acre ($81.38/A for one application; $99.38/A for two applications) than the 2-gene variety in only 15% of trials. There were no difference in yields between the highest yielding 2- and 3-gene varieties in 31% of trials, and neither yielded in the statistically highest group in 15% of trials. In 2019, the highest yielding 2-gene variety (on average) resulted in greater value per acre even after considering the additional cost of both one ($141.19/A) and two ($123.19/A) diamide sprays in 25 % of trials. The highest yielding 3-gene variety (on average) resulted in greater value per acre ($113.50/A for one application; $131.50/A for two applications) than the 2-gene variety in 19% of trials. There were no difference in yields between the highest yielding 2- and 3-gene varieties in 31% of trials, and neither yielded in the statistically highest group in 25% of trials.

Conclusions

In conclusion, prior to 2019, one 2-gene variety, Deltapine 1646 B2XF, had consistently provided enough yield advantage over the highest yielding 3-gene variety to justify the added costs of either one or two diamide sprays in approximately 40% of trials. Over the last 3 years, but particularly in 2019, some of the newer 3-gene varieties have more frequently and increasingly closed the yield gap between 2- and 3-gene varieties, allowing for maximum profitability by planting a competitive 3-gene variety without currently requiring additional diamide sprays. Although, Deltapine 1646 B2XF continues to be the highest-yielding variety across trials, the more recent newer 3-gene varieties have either more frequently out-performed this 2-gene variety or narrowed the difference in yield between it and the most competitive 3-gene variety, to the point at which the economic returns of spraying diamides on the 2-gene variety are very little, none, or unclear.

This research was conducted across three years, all of which resulted in noticeably higher than average yields in many regions of North Carolina. Continued research needs to be conducted in lower-yielding, drought-stressed environments where yield potential is noticeably lower, to determine if these yield advantages are repeatable in lower yielding environments, or if yield of newer 3-gene Bt varieties is as stable and consistent as some of the currently high-yielding 2-gene Bt varieties.

Key Words:

Cotton, variety, bollworm, 2-gene, 3-gene, diamide

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Genetic divergence of *Rhizoctonia solani* associated with cotton seedling

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Rhizocionia solani is a major cause of cotton seed rot, as well as pre- and post-emergence damping-off. *R. solani* isolates were collected from plains and hills in Bangladesh. A pot experiment was carried out using the soil inoculation technique to determine the genetic divergence of 50 isolates of *R. solani* associated with cotton seedling disease.The experiment's soil was sterilized with a 1.0% formalin solution. Each earthen pot contained 3 kg of sterilized soil. Each isolate's inoculum was thoroughly mixed with sterilized soil at a rate of 20 g/kg soil. Each isolate received four pots. In addition, four pots of sterilized soil with no inocula were included in the experiment as a control. In this experiment, the susceptible cotton variety Hill Cotton -1 was used. Pre-emergence and post-emergence seedling mortality and severity of mortality were recorded. Data on germination was collected at 10 days after seed sowing. Ungerminated seeds were regarded as pre-emergence mortality. Mortality was measured immediately after emergence and continued for 30 days after germination. A 0-5 indexing scale was used to determine the severity of seedling morality. The genetic diversity of 50 R. solani isolates was examined using a multivariate analysis based on pathogenicity components in terms of pre- and pot-emergence seedling mortality. Multivariate analysis techniques included principal component analysis (PCA), principal coordinate analysis (PCO), cluster analysis (CLSA), and Canonical variate analysis (CVA). The multivariate analysis was carried out using the computer program GENSTAT. The findings revealed that PCAI, PCAII, and PCAIII accounted for 81.56%, 17.40%, and 1.05% of the genotype variability, respectively. The fifty genotypes were assigned based on pathogenicity to five distinct clusters. Clusters I, II, II, IV, and V each had 10, 5, 8, 16, and 11 isolates.The majority of the isolates from hilly areas were divided into three groups: I, II, and III. Group III isolates were the most pathogenic, followed by groups I and II. Group V isolates were all isolated from upland cotton. Three of the sixteen isolates in Group IV were obtained from hilly cotton, while the remaining thirteen were obtained from upland cotton. The inter-cluster distance between groups II and III was low, indicating that they were closely related. However, their intra cluster distances were high, indicating that the isolates within a group were more diverse. Inter-cluster distances were high between groups of hilly isolates and plain land isolates, indicating a distant relationship between hilly isolates and plain land isolates.The inter-cluster distance between clusters III and V was the greatest, followed by clusters I and V, III and IV, and II and V. Clusters IV and V had the shortest inter-cluster distance. Cluster I had the greatest intra-cluster distance of 0.952, while Cluster V had the smallest distance of 0.575.Higher inter-cluster and intra-cluster distances indicate greater genetic variability between isolates from two clusters and within the same cluster, respectively. Lower inter- and intra-cluster distance, on the other hand, indicates closer relationships of isolates among groups and within groups.

Unlocking the socio-economic potential of cotton for global prosperity

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Background:

During season 2021-22, Indian cotton production fell from 5.95 million tons to 5.35 million tons. Indian cotton prices reached their historic highest level in 2022, an increase of over 100% during last one year. Textile industry was compelled to drastically reduce consumption and divert to man-made fibres.

The questions like whats wrong with textile industry and reasons of slowdown in cotton sector have been discussed and deliberated in various media and most of the recent conferences, delegations' meetings and special meetings of various Associations like Confederation of Indian Textile Industries (CITI), Texprocil, Cotton Association of India (CAI), etc. Most of them failed to get the right answer as they failed to realise the true potential of cotton and did not take a holistic approach to tackle the issues.

For getting the right answers to above questions, we need to understand the economics of cotton to determine the right economic value of cotton which could secure both consumers and producers. Cotton is not only a cash crop but a social crop in many countries, especially India. Cotton in India provides direct livelihood to 6 million farmers and about 50 -60 million people are employed in cotton trade and its processing. Cotton finds utility in food, fuel and clothing. In fact, Cotton is not just a commodity in India but an asset for India.

The textile market in India is majorly driven by the easy availability and low prices of cotton that is widely used for manufacturing apparel. On the other hand, the increasing cost of agriculture, the risks involved and fall in yields are a big deterrent for cotton farmers to invest in the crop.

These issues can be resolved only by engaging farmers directly with the supply chain through Farmer Producer Organisations (FPOs) and the involvement of Textile industry in integrated projects with Public Private Partnership (PPP) or through contract farming. Effective technology evaluation and transfer and a collective approach of marketing Indian cotton can be a win-win situation for the cotton farmers as well as the entire textile industry. Cottonguru's various farm projects with FPOs and Corporates in both conventional and sustainable cotton had given us deeper insight to unlock the true socio-economic potential of cotton.

Conclusions:

This paper highlights a historic approach that has brought prosperity to all the stakeholders engaged in the cotton value chain. Similar models can be followed in other countries with small cotton holdings so that the supply chain becomes more robust, sustainable and profitable.

Women's wealth status and factors on cotton farms in West Africa

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Background:

Gender mainstreaming in rural development has mainly led to appraise women's performance in agricultural production comparatively to men. Studies are rare in understanding the impact of women's agricultural role on their own economic plight, even in Africa where women often have the opportunity to carry out various economic activities and to produce for their own account in fields. Our study in 2014 compensate for the lack by analyzing the characteristics, economic activities, income and assets of women on cotton-growing farms in relation to the characteristics of their husbands who headed farms. It was conducted in three countries with distinct cotton production evolution: continuous and great increase in Burkina Faso, chaotic in unstable cotton sector in Benin and stagnating in Togo having been put aside for decades by the international community.

Results:

The economic fate of heads –men– on cotton farms was somewhat related to the status of cotton production in the studied countries, but much less clearly when that of women's was considered. Men in Togo lagged behind but men in all countries had their wealth positively influenced by their number of wives. The economic situation of women was generally weak but it was better particularly with regard to animal assets in Benin. Several factors affected women's wealth, notably that of their husbands.

Conclusion:

Tradition keeps on, through the status of polygamy, but the observed men-women synergy in wealth accumulation is a positive sign that should persist because of a context of increasing economic exchanges in rural areas. The mentioned synergy deserves to be integrated into the approaches to deal with gender and development issues.

Keywords:

Women, gender & development, household, polygamy, economic activities, poverty, assets, animal production

World Cotton Trade: Post Covid-19 Dynamics

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Background:

Cotton is an important and highly traded agricultural commodity across the world. It is produced in more than 100 countries and traded among around 150 countries. It has become a political crop because of its significance in world trade and in improving the economies of many developing countries. Cotton exports are viewed as a key contributor to foreign exchange earnings and a significant part of GDP and tax income. Due to economic and logistic factors, the global trade of cotton has taken a downturn, affecting every link of the supply chain. The main producers of the cotton are India, China, Brazil, USA and Australia which account for more than 73% of the global production during 2021-22. Global cotton average yield has witnessed a stagnant or decreasing trend during the last decade, mainly in many leading countries (United States, China, Pakistan and India).

It is anticipated that the world's consumption of cotton will exceed the production which will reduce the world's stock of cotton by 2.5 million bales 2022-23. World cotton production is expected to increase by 3.2% in 2022/23 mainly due to an increase in area in some developing countries. As per the rising global trends of the population and incomes of the developing countries and rising demand from the developing regions and incomes will exert pressure on the consumption of the cotton. Since the consumption of textile and apparel is more income responsive than the consumption of the food commodities therefore, this deviation from the economic conditions could lead to the significant changes in the production, consumption, trade and prices projections. The prices of the cotton dropped significantly during the first wave of the covid-19 which affected the consumers and producers. However, this price drop did not affect the planting decisions of cotton.

Conclusions:

These patterns are expected to continue for another year. However, prospects are there for post Covid recovery during the year 2022 & 2023. This papers thus, explores the trends in the Global cotton trade and identifies the global supply and demand gaps and prospects for recovery of global cotton trade in coming years.

Keywords:

Cotton production, consumption, world Trade in cotton.

What lessons from the motorization program of the National Union of Cotton Producers of Burkina Faso for a sustainable development of motorization in cotton areas?

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Background:

This article analyzes the effects of the introduction of the tractor on the management and performance of family farms benefiting in 2014 from the "motorization" program of the National Union of Cotton Producers in the Hauts Bassins region of Burkina Faso. Tractors replaced animal traction and labor for soil preparations.

Results:

In FAE, there is an increase in cultivated area and labor productivity for soil preparation, lower yields and incomes. The fragmentation and remoteness of some plots lead to additional time and operating costs for tractors. Overall breakdowns and repairs on equipment are numerous especially for lack of training and skills of tractor drivers and farmers. As a result, many farmers are failing to reach their early planting goal because of failures that can immobilize tractors for several days. The result is an increase in tractor operating costs and difficulties for farmers to meet their financial commitments. This study shows that it is not enough to distribute / sell tractors to make the engine viable and sustainable. To this end, there is a need to: i) promote sustainable soil and land management techniques in FAE, ii) build capacity of actors on the maintenance and use of motorization, iii) conduct studies thorough prerequisites before the introduction of any agricultural motorization program, iv) to reflect on other forms of use of tractors and on the mechanization of other agricultural operations, v) to solicit the State to support sustainable development motorization through incentives, support to the private sector for the development of after-sales services, training and support-advice, and reflections on land management.

Keywords:

motorization, performance, maintenance, skills, management, cotton, Burkina Faso.

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A Private/Public Sector Partnership to address FOV4

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Upland cotton production across the United States is under serious threat from a soil-inhabiting, density dependent fungus, called *Fusarium oxysporum* f. sp. Vasinfectum race 4 (FOV4), which causes fusarium wilt.A unique public/private sector partnership between Clemson University, O & A Enterprises, and Cotton Incorporated was started in 2018 to address the discovery of FOV4 in Texas, the largest cotton producing state in the U.S. This presentation will describe why this has been a highly productive partnership and what has been learned about breeding for FOV4 resistance. Specifically, it will cover a) the genetic architecture underlying resistance to FOV4 and b) delivery of resistant germplasm to allied scientists, cotton breeders, and growers. Even with Covid-19 restrictions for most of the 2020 and 2021 field seasons, this work has been extremely successful for the community and growers alike. Notable outcomes include the following: 1) public release of the four highly resistant Upland lines, 2) development of three bi-parental RIL F8 populations, 3) a unique phenotyping approach that integrates surface interpolation statistics with rigorous field check multi-year performance data that mathematically predicts spore density and distribution in the screening field, and 4) a fast and reproducible *in vitro* co-culture method that facilitates controlled, sterile host/pathogen challenge system to study transcriptomics, metabolomics, and other 'omic' datasets in a tightly controlled environment.

Public Sector Research for the Benefit of Cotton Growers and Society

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Public sector research has long been the backbone of agricultural advancements, helping farm families with improved cultivars and cultural practices. Investment in public research traditionally went unquestioned and was justified by its benefit to the large farming population. As farming communities become more efficient, allowing society to grow beyond the farm, this original justification has expanded to include broader societal benefits, such as food security, human nutrition, environmental impacts, resource stewardship, and work force opportunities. Even where public sector research receives some private sector funding (such as from commodity organizations), broader society continues to provide substantial, if not the lion's share, of investment.

For this reason, investments in public sector research to advance agriculture need to address both on-farm and broader societal benefits. How this combined goal is achieved and communicated varies from country to country because agriculture is the most site-specific major industry and is intertwined in local customs and traditions.

However, several themes are common:

- Coordination and complementation of investments avoids duplication and maximizes smart technology adoption. To achieve this requires an understanding of the investments made by other commodities and institutions. Since most of the technology adopted by mechanized cotton growers is delivered by the private sector, smart technology adoption requires public-private partnerships that deliver objective evaluations, understanding of Freedom to Operate (FTO) restrictions, and cost-efficient adoptions.
- Addressing immediate agricultural concerns while looking down the road promotes rapid adoption of beneficial innovations and creation of future innovations. To be relevant, public sector research must address immediate grower concerns with the best available expertise and knowledge. And, it's the public sector that places long term bets - without first requiring a path to monetize their investment - on new science that eventually lead to useful agricultural innovations.
- Applying sustainability metrics to agricultural research enhances both on-farm profitability and societal benefits, thereby supporting and encouraging ongoing investment. Environmental benefits of agriculture parallel farm profitability when yields on cultivated land are maximized, inputs are directed only to where they are needed, and stewardship of natural resources allow preservation of water, land, and biodiversity for future generations.

In resource poor African and Asian cotton growing countries, public sector research is generally viewed as the investment of public money for the benefit of the greater public good.Non-profit, public sector technologies are designed to support sustainable, long-term growth in yields and farmer profits driven by a primary mandate to provide technologies, inputs, and services specifically to small-holder farmers at an affordable cost. Products developed by the public sector,such as improved seeds, testing kits, small-scale implements/machinery,biofertilizers, biopesticides, and other crop protection technologies are trusted and valued by farmers because of the government certified quality and affordability. Further, there are several challenges, such as climate change, soil health, and water quality, that have long term implications on environmental sustainability and which affect developing and least developed countries the most, but that are not necessarily attractive for the private sector because of the lack of profit in the related solutions. Investment in public sector research not only leads to affordable agrarian technologies that improve farmer sustenance and livelihood, but also has the potential to provide solutions for long term social, economic, ecological, and environmental challenges.

This paper will explore the diverse strategies currently utilized by investors in public sector research for the combined benefits of cotton growers and society.

Plastic Imaging, Detection, and Ejection System (PIDES) for Cotton Gins: Results from Commercial Testing and System Updates

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Background:

Plastic contamination in cotton lint costs the U.S. cotton industry approximately $750 million per year. Consequently, the removal of plastic contamination in cotton lint is an issue of top priority to the U.S. cotton industry. One of the main sources of plastic contamination showing up in marketable cotton bales, at the U.S. Department of Agriculture's cotton classing office, is plastic from the module wrap used to wrap cotton modules produced by the new John Deere round module harvesters. Despite diligent efforts by cotton ginning personnel to remove all plastic encountered during the unwrapping of the seed cotton modules, plastic still finds a way into the cotton gin's processing system. To help mitigate plastic contamination at the cotton gin, ARS and industry partners developed a Plastic Image Detection and Ejection System (PIDES), which efficiently detects and removes plastic contamination during post-harvest processing of cotton. Because cotton gins have extremely low-profit margins, the PIDES system was specifically designed to be much less expensive than the detection and removal technologies used in food crop industries, such as almonds and soybeans. PIDES is a "bolt-on" system, built using off-the-shelf parts, such as cell phone cameras and embedded processors with custom machine-vision software. These detectors are coupled to a pneumatic ejection system, via custom electronics, which blows plastic contamination out of the cotton-processing stream.

Results:

The PIDES system was evaluated at the USDA-ARS gin lab in Lubbock, Texas at two ginning rates, 9 bales/hr and 13 bales/hr, using three colors of plastic (blue, yellow, and pink) and three sizes (5x5, 10x10, and 10x20 cm). Three replications of each color and size of plastic were evaluated. Overall removal efficiency at 9 and 13 bales/hr across all sizes of plastic for the yellow, pink, and blue colors were 97%, 98%, 94%, 96%, 90%, and 80%, respectively. The drop in overall efficiency from 94% to 80% for the blue wrap was primarily due to the smaller 5x5 cm samples being highly transparent which allows significant bleed of the underlying cotton colors through the plastic. When the system was tested in a commercial cotton gin, two colors (pink and yellow) and three sample sizes (5x5, 10x10, and 10x20 cm) were evaluated at a maximum ginning rate of 15 bales/hr per gin stand. Three replications of each color and size of plastic were performed. Overall efficiency for the 5x5, 10x10, and 10x20cm samples for both colors was 75%, 90%, and 94%, respectively. The difference in efficiency between colors (pink and yellow) of each sample size was negligible. The combined system protection, including extraction by the feeder, for all sizes was greater than 90%.

Conclusion:

To address the issue of plastic contamination primarily occurring from round module plastic wrap, a system was developed (PIDES) to detect and eject the contamination before the seed cotton enters the gin stand. Lab testing of the system indicated results ranging from 80% to 97% efficiency depending on the size and color of the plastic contaminant. During commercial testing, the PIDES technology, which is now being sold commercially by a leading cotton gin machinery manufacturer VIPRTM, demonstrated an overall system efficiency across sample size and color of greater than 90% for protection from plastic contamination. The technology was transferred to industry partners under a research agreement that began in October 2018 with the first commercial units sold in December 2019 and successfully tested in January 2020. Improvements, such as autocalibration, image capture, velocity measurement, and other features, to the PIDES technology, continue to reduce labor and enhance the functionality of the ginner.

Keywords:
Cotton, Plastic, Contamination, Ginning, Module Wrap

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Cotton, more than what you wear: cottonseed oil and human health

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Although cotton is primarily considered for its fiber production, cottonseed oil has been pressed for its edible oil for over one hundred years. Cottonseed oil is the second most valuable harvested cotton component and the only component that is currently a human nutrition source. Its culinary benefits include a neutral taste, shelf-stability, high smoke point, and versatility in the kitchen. Over the last several years, Cotton Incorporated has engaged with human nutrition scientists to evaluate the health outcomes of cottonseed oil consumption through human and animal models. The results of these studies have provided a foundation and case for continuing this area of research. Through national and international research, Cotton Incorporated aims to develop robust evidence of the health impacts of cottonseed oil consumption. Cotton byproduct utilization is critical as the world moves towards sustainable agriculture and looks to the circularity of crops. Further research of cottonseed oil is paramount to investigate how this byproduct of cotton production can provide for health of people and the planet. This presentation will provide a review of recent research.

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Development of Reference Materials for Checking the Micro-Ginning Machines for their Fiber Quality Preservation Performance.

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Monitoring the fiber quality preservation in industrial ginning plants avoids the losses that may arise due to improper settings along with wear and tear of machineries. For this purpose, fibre quality parameters obtained from the ginning plants can be compared with that of micro-gins by processing same cotton lot. However, users and stakeholders remain in state of dilemma with respect to performance of micro-gins to preserve the fiber quality due to the lack of reference material. Hence, there is a need to develop standard seed cotton reference material with known fiber characteristics in order to perform periodical checks of the micro-gins. In this work, a reference material was developed and measured for its homogeneity. Study displayed that that reference material is suitable for the micro gins employed to monitor the fiber quality preservation performance of industrial plants.

Keywords:

Reference materials, Micro-ginning machines, Fiber quality, Preservation performance, Fiber characteristics

Odor control in cotton fabrics treated with silver nanoparticle in aqueous extract from banana peel

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Background:

Body odors are the result of bacterial activity and can be described by their chemical compounds. Odor which is "Perm stink" the unpleasant smell that won't wash out of textile products has become a topic of conversation for consumers and brands alike. The type of odor treatment usually uses heavy metals like silver, zinc, sometimes copper and other chemicals. Consumers love the odor control, they don't like bacteria, but they also do not like chemicals.

Results:

The innovation is to use biosynthesis of silver nanoparticles (AgNPs) in combination with natural plant extracts from Banana peel and thus, can be an economic and efficient alternative for the large-scale synthesis of nanoparticles.

Conclusion:

The produced new composite shows a clear microbial resistance against different species of Bacteria. The treatments on cotton not only improve its antimicrobial efficiency but also natural biocidal effect, which forms in cotton textiles, so it's green and its odor control at the same time.

Keywords:

Banana peel, silver nanoparticle, Cotton, odor control, microbial resistance

A Review of Recent Research Indicates that Daily Consumption of Cottonseed Oil Has Potential Health Benefits

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Cottonseed oil should beconsidered a novelty oil due to the fact that it ranks 7thin terms of volume of all vegetable oils produced globally. With the worldwide production of cottonseed oil at less than 6 million metric tons, its volume is similar to that of the specialty oils, such as olive, peanut, coconut, etc. However, it is priced as though it isa large volume commodity oil like soy, palm, rapeseed, etc.Cottonseed oil marketing needs more compelling points of differentiation that will help stimulate demand and separate it from competing with commodity oils for the lowest price.Research is underway to find compelling sustainability data that will highlight the sustainability of this byproduct of cotton production, while ongoing research continues to confirm the health benefits from consuming a diet rich in cottonseed oil. Crude cottonseed oil contains three fatty acids that have been shown to inhibit the activity of various desaturase enzymes. These fatty acids are known as cyclopropane fatty acids (CPFA). The oil refining process produces an edible oil with only one remaining CPFA, Dihydrosterculic acid (DHSA). Itis consistently present in refined oil at 0.3%.Recent research has shown that human diets, that are rich in cottonseed oil containing DHSA, produce unexpected health benefits. These health benefits include a significant reduction in blood cholesterol, triglycerides, LDL, while also observing an improvement in HDL.Studies with mice attribute this improvement in blood lipids to dihydrosterculic acid (C19:1).DHSA apparently exerts its positive effect on blood lipids by suppressing the activity of a desaturase enzyme that is involved in lipid metabolism.Since cottonseed oil is a byproduct of cotton production the sustainability metrics for it are excellent. As this research continues to show health benefits from consuming cottonseed oil, there will be an increase in the demand for cottonseed oil as a specialty oil and its price will rightfully reflect its health benefits and specialty status.

Key words:

cottonseed oil, health, DHSA, fatty acids, cholesterol, triglycerides

Developing HVI calibration standards for elongation measurements

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Background:

Cotton breeders must take into account the complete fiber quality profile in order to improve yarn quality in their programs.Among several essential fiber properties to consider, improving tensile properties represent a particular challenge. Indeed, a low but statistically significant negative correlation exists between bundle tenacity and bundle elongation. It has been observed on commercial bales of cotton with diverse genetic backgrounds as well as research samples from several breeding programs. Nevertheless, the low coefficient of correlation observed should not hinder the improvement of both tenacity and elongation.

The challenge gains in complexity when improving tensile properties based on HVI (High Volume Instrument) measurements because, in addition to the negative correlation reported above, HVI elongation lacks calibration cotton standards.Therefore, since the inception of HVI testing in breeding programs, elongation has been largely ignoredby the cotton breeding community. This apparent lack of interest in fiber elongation results from the absence of HVI calibration cottons for elongation. Indeed, how could breeders and geneticists improve a property they cannot measure? Developing calibration cottons for HVI is, therefore, of the utmost importance to develop germplasm with improved tensile properties.

Typically, results from multiple HVIs across multiple days are used to evaluate entries in breeding programs. HVI measurements are calibrated across instruments using USDA cotton calibration standards making it possible to compare results from different instruments over a long period of time. In addition, cotton testing laboratories use cottons of known values throughout the day to check for a possible drift in measurements over time. While calibration cottons are available for most HVI fiber properties, none are available for HVI elongation. This prevents the comparison of elongation measurements between separate HVI instruments and over time.

Since several years, we focused our efforts on a series of projects aimed at addressing the industry need for measuring fiber elongation. Our group, as well as several cotton breeders, provided evidence that fiber elongation is heritable, and can be improved through traditional breeding methods. More importantly, fiber elongation can be improved while simultaneously improving fiber strength leading to significant improvements in work-to-break. While HVI testing does provide a measure of fiber bundle elongation, it is currently not calibrated. Therefore, measurements between instruments cannot be reliably compared.

Material and methods:

The need for elongation calibration led to the development of elongation reference material. High and low elongation calibration cottons were produced and tested every day for several weeks on three HVIs (Testing from 04/03/2019 through 08/27/2019 with 10 combs per sample and from 10/23/2019 through 12/17/2019 with 2 combs per sample).

Results:

- After calibration, the three HVIs exhibit comparable elongation levels.
- The CV% between testing days are very good for all HVIs even with only two measurements per sample.
- The calibration is stable over a long period of time. Therefore, frequent calibration is not needed (Figure 1).

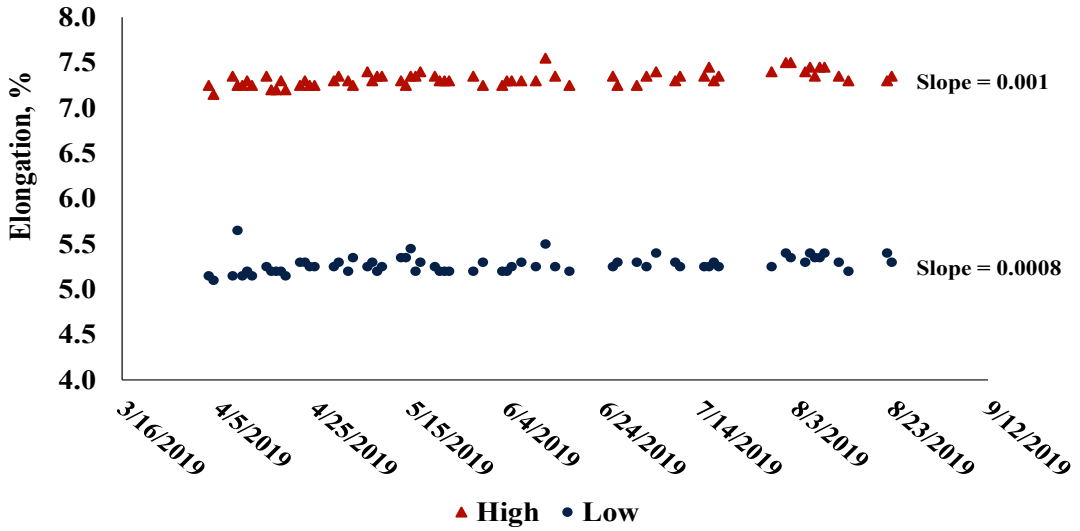

Figure 1. *Variation of HVI elongation over the testing period*

Conclusions:

We have developed a protocol to produce HVI elongation calibration standards. Testing these standards on several HVIs over a long period of time revealed that the elongation measurement levels are very stable for all HVIs. The correction procedure developed is effective. Therefore, breeders and geneticists can now target the improvement of fiber elongation. As demonstrated previously, it will result in better work-to-break (energy needed to break a bundle of fibers), less fiber breakage, fewer yarn defects, and better weaving efficiency.

Keywords:

Tensile properties, bundle elongation, calibration

Acknowledgement:

The authors want to thank Cotton Incorporated for funding this project.

Effect of fibre length characteristics on the drafting performance during yarn manufacturing process

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Cotton fibre length, and length uniformity are most important characteristics, which directly influence the quality of yarn and cause costly interruption/breakage in yarn manufacturing process. Fiber length and length uniformity directly effects the irregularity and strength of yarn. With longer fibers higher tenacity of yarn can be achieved with minimum fiber quantity.

The amount of force required to pull fibres for attenuation in drafting zones is called drafting force. This force is direct outcome of the frictional forces between different fibre lengths. In order to analyse the behaviour of fibres length characteristic with drafting force, a system (draftometer)has been stablished. Utilizing data from this online draftometer installed at back drafting zone of drawing frame, this research discussed the interaction between two cottons of different fibrelengthswith required drafting force. These two selected cotton were having almost same physical properties except different in short fiber content i.e.8.8 % and 5.3 % undergoes drawing process with different back ratches. The results showed that drafting force increases with the increase in short fiber content. The magnitude of CV% of drafting force was lower in case of high short fiber content. As the back gauge increased the drafting force decreased and its variability was increased, irrespective of short fiber content.

Key words:

fiber length, Short fiber content, drafting force, drawing frame, and cotton.

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Periodic inter-laboratory round trials for comparing results of various measuring methods of the 'entomological stickiness'on cotton fibers

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Background:

Stickiness is the results of insect honeydew secreted by insects living in the cotton fields, which is considered as a contamination. Stickiness is observed when insect honeydew droplets stick together with cotton fibers onto spinning machine parts, thus creating quality and productivity degradations, which defines the 'stickiness in practice' (SIP). Several methods claim to measure stickiness, but no true reference exists yet for calibrating or adjusting results within and between these methods. Therefore, results do not always match within instruments of a same method nor between methods. To initiate a harmonization process, periodic inter-laboratory round trials (RTs) are carried out every six months since 2017. These RTs allow comparing many kinds of results from stickiness measuring methods obtained for given raw cotton materials covering a range of stickiness.

Results:

The first and important finding is that not all methods are measuring the actual stickiness, although this is expected by the cotton industry. Indeed, some measure sugar content (in total or partially), some measure changes in fibercolor after some heat treatment, some measure honeydew components, some measure sticky points or sticky grades, etc. and results are not always in line or corresponding. The second finding is that any harmonization effort should first start by choosing the relevant methods that measure SIP during specific cotton spinning experiments. Results of six RTs (2017-1 to 2019-2) with in sum 26 samples indicate that only mechanical and thermo-mechanical methods provide results that are in good correlation to each other and are well related to SIP effects in micro-spinning trials. These methods will first benefit from further harmonization efforts: 1) intensifying the within-method / between laboratories harmonisation activities, and 2) developing inter-method relationships for improving the comparability between the different methods.

Conclusions:

The six first RTs results allow a first selection of methods that measure stickiness to start a worldwide harmonization effort. Road map for this harmonization is under preparation within the International Cotton Committee on Testing Methods, a working group of the International Textile Manufacturers Federation (ICCTM-ITMF).). For the success, it is important to include as many stickiness testing laboratories as possible.

Keywords:

Cotton, Fibre, Honeydew, Entomological stickiness, Measurement harmonization, Measuring methods.

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Visual Imaging Plastic Removal System (VIPR); Commercial Field Trials

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Background:

Plastic contamination is a driving force behind the loss of $750 million U.S. in market value. As such the removal of plastic contamination from cotton is a top priority to the U.S. cotton industry. One of the main sources of plastic contamination is the plastic module wrap from the John Deere round module harvesters. Plastic still finds a way into the cotton that is brought to the processing plant, despite diligent efforts by plant's personnel to remove all plastic encountered during the unwrapping process of the incoming seed cotton storage modules.

Results:

To help mitigate plastic contamination at the gin, we developed two systems; a passive system using low-cost ethernet security cameras to see plastic on the module feeder dispersing cylinders and an active system, which detects and ejects plastic from the seed cotton at the gin stand feeder. The first system provides video monitoring of the dispersing cylinders in the module feeder so that the gin crew can readily see any plastic on the cylinders. The second system utilizes a bank of embedded computers, that are each coupled with a low-cost cell-phone color imager to view the incoming cotton and automatically detect any plastic in the cotton. The units are gang mounted on the feeder apron above the gin stand (Vision Imaging Plastic Removal System, "VIPR"). When one of the embedded processors detects plastic, it actuates one or more pneumatic air knives to eject the plastic, out of the seed cotton and onto the floor in front of the gin stand. These systems were developed at the USDA-ARS cotton gin laboratories. The technology was tested at several commercial cotton gins and the results of the testing found the enhanced protection was elevated to over 90% efficacy.

Conclusions:

The commercial field trials provided evidence that the use of low-cost cell-phone camera imagers, when coupled with embedded processors, have sufficient accuracy and speed to accomplish high efficacy detection and removal of plastic contamination on the gin-stand feeder apron. Results of the development and field evaluations are to be presented.

Keywords:

cotton, machine-vision, plastic contamination

Acknowledgement:

Special thanks to Cotton Incorporated for providing funding for this research.

Evaluation Reactive Groups of Reactive Dyes on Dyeing Egyptian Cotton Fabrics

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Abstract

Background *Cold reactive dyes were studied for their dye fixation and color strength on cotton fabric. Three Reactive dyes namely: procion Mx, Levafix E, and Drimarine with the reactive functional groups, (Di-chlorotriazine), (Di-chloroquinoxaline), and (Di-fluoro chloropyrimidine) respectively were applied on to extralong stable Egyptian cotton fabric of Giza 94 to explore the role of their functional groups on color strength and fastness properties. Exhaustion-fixation method with different reaction times and temperatures revealed that reactive dyes with different functional groups have different reactivity and affinity to the color strength and fastness properties for the cotton fabric.*

Results: *The results obtained revealed that the reactive dyes exhibited high color strength, and fastness properties at optimum conditions of temperature, and reaction time. Among dyes under investigation, the results obtained showed that Procion Mx dye having the reactive group structure Di-chlorotriazine offer higher reactivity at the optimum condition 30ºC at 60 mins. for exhaustion and 30ºC at 5 min. for fixation followed by Levafix E dye having the reactive group structure Di-chloroquinoxaline and finally Drimarine dye having the reactive group structure Di-fluoro chloropyrimidine).*

Conclusion: *The highest dye fixation (%) was about 85% for all reactive dyes used. The fastness properties of cotton fabric for all reactive dyes used were good to excellent at the optimum dyeing process.*

Keywords: *Cotton fabric, Reactive dyes, functional groups, color components, fastness properties*

Spi-07: Dyeing performance of super-giza 97 egyptian cotton yarns

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ABSTRACT

Background and Rationale: *This investigation was carried out to evaluate the dyeability of the new Egyptian cotton variety and its effect on yarn mechanical properties during 2020 season. The relationship between various yarn properties and natural and synthetic dye types was investigated. The newest commercial Egyptian cotton variety from the Delta area, G. barbadense namely Super-Giza 97 as long staple (LS) was used.*

Methods: *All tests for this new cultivar to determine the physical, mechanical and chemical fiber properties were done at the Cotton Technology Research Laboratories, Cotton Research Institute, Agricultural Research Center (ARC). Fibers were processed to yarns using ring spinning system, and dyed using different dyestuffs, which are natural dye extracted from outer onion skin, reactive dye named Drimarin K-4BL and basic dye (Methyl violet 2B). Yarn Mechanical Properties as yarn strength and yarn elongation was determined before and after dyeing. Evaluation of color measurements and color strength were measured. Furthermore, the changes in surface morphology of cotton yarns after dyeing were identified by Fourier Transform Infrared Spectroscopy (FTIR) analysis.*

Results and Conclusions: *The results revealed that all characteristics of cotton yarns such as color measurements, color strength, color coordinates, tensile strength and elongation differed according to the dyestuff used. An important advantage of using the natural dye extracted from onion skin is the economical and environmental impact by using an agricultural waste for dying. Also, our study helps in understanding the relation between a new Egyptian cotton yarn and different kinds of dyestuff*

Keywords*: Egyptian cotton variety, natural dye, reactive dye, basic dye*

Water Deficit and Salt Stress Tolerance: Common Identified Quantitative Trait loci in Cotton (*Gossypium hirsutum* L.)

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Abstract

Background: *Cotton is the major source of natural fiber in the world. Gossypium hirsutum L. is the main species producing more than 90% cotton worldwide. This species is prune to a number of abiotic stresses. Among these abiotic stresses, water deficit and salt stress are the most damaging for cotton production. As a result of climate change, water deficit conditions have become frequent in major cotton producing countries of the world, and this has intensified already existing problem of salt stress. In view of this, it is imperative to find chromosomal regions associated with water deficit and salt stress tolerance simultaneously in cotton. A research project was planned to identify quantitative trait loci (QTLs) associated with water deficit tolerance in cotton through genome-wide association (GWA) approach and find out commonality in genetic architecture for water deficit and salt stress tolerance in cotton by comparing findings of present study with our already completed project of association mapping for salt stress tolerance in cotton. Plant material consisted of 76 cotton genotypes which originated from Pakistan, Australia, China, USA, and Uzbekistan.*

Results: *Cotton genotypes were phenotyped under normal and water deficit conditions in greenhouse and data were recorded at the seedling stage. Cotton genotypes showed significant differences for the morphological and physiological traits. Genotyping of the plant material was carried out with 95 polymorphic simple sequence repeats (SSRs) markers. Marker-trait associations were identified through TASSEL 3.0 software by using both general linear model (GLM) and mixed linear model (MLM). Some common QTLs for water deficit and salt stress tolerance were identified. Associated markers to these QTLs were NAU1167 (A3-Chr3), NAU3414 (A9-Chr9), NAU462 (A9-Chr9), and NAU1141 (A13-Chr13). These markers were located on chromosomes 3, 9 and 13. Phenotypic variance explained (R^2) value for these QTLs ranged from 9.39% to 20.38%.*

Conclusion: *These findings suggest that there are important genes in the flanking regions of these markers involved in water deficit and salt stress TOLERANCE simultaneously. These findings also suggest that it is possible to pyramid water deficit and salt stress tolerance in an elite cotton genotype simultaneously.*

Keywords: *Cotton, Abiotic stress, Water deficit, Salt stress, Genome-wide association mapping, Quantitative trait loci*

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Changing Paradigms in Technology Transfer for Bridging Gaps in Smallholder Cotton Farms*

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Extended Summary

Cotton is grown in Asian and many African countries in arid and semi-arid areas and it provides the major economic activity to the farming community. It is grown mostly by small land holder farmers. While developed countries like USA, Brazil and Australia produce cotton in large farms (average farm size of 450 to 1339 ha) and achieve higher productivity with access to precision farming techniques to manage cotton production, developing countries in Asia and Africa face numerous problems for technology uptake and adoption in view of small holdings and subsistence farming. It is in this context the approach to technology transfer for small holder farmers holds the key to production enhancement in these countries. Communication, information sharing and advisory services are thus very useful for small holder farmers to successfully manage cotton production. In India 82 percent farmers out of 7.5 million cultivate cotton on an average of 1.4 ha land. New extension approaches were adopted recently for technology transfer to small holder farmers, to boost their farm productivity and build their confidence in cotton cultivation. For example, technologies such as High-density planting system (HDPS) and mating disruption for management of pink have reached the small holder farmers in a short span of time using different information, education and communication (IEC) techniques. The new nutrient Unlock Technology of CROPTEC-SOLUTION, where three micronutrients (Zn, Bo and Fe) and two secondary nutrients (Mg & S) are coupled with the major nutrients (NPK) in one granule is likely to revolutionize the Integrate nutrient management (INM) technology in cotton once it reaches the small holder farmers.

To create awareness about such novel technologies, instead of traditional modes of technology transfer several new approaches were found highly useful. Along with selective demos, group meetings, use of social media, dedicated websites, messages through travelling floats in cotton intensive areas during the season, circulation of posters, pamphlets, attractive cartoons booklets to farmers through village Panchayats, radio jingles, local televised information through public-private partnership initiatives were more effective either containing a new outbreak of pest, disease or promoting adoption of new techniques of cultivation, irrigation or cotton nutrition.

Virtual Reality (VR) is now an additional powerful tool for technology transfer. It has the potential to bridge the gaps, cutting across the boundaries of distance, countries, languages etc. In cotton, pesticide usage increases not only cost of production but also creates environmental issues. Pesticide use in cotton is still higher (20% share) and there is much scope to rationalize its use in cotton to not only reduce cost of cultivation but also prevent health hazards and ensure environmental safeguards. Recently ICAC along with GIZ developed VR tools for IPM in cotton and launched for cotton TOT in 8 African countries. This IEC digital tool can supplement the existing extension techniques for effective technology transfer to small holder farmers.

The paper describes the technology transfer successfully done to promote the adoption of HDPS, management of pink bollworm and sensor-based water and nutrient use in small holder farmers and future use of VR tools in technology transfer.

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