

ABSTRACT

International Symposium “Book of Paper”

Symposium papers “Global Cotton Production Technologies *vis-a-vis* Climate Change”

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Chemical aids for mechanical harvest

D. STEVEN CALHOUN

Bayer CropScience, International Cotton and Asia Rice Breeding Mgr., Lubbock, TX, USA

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Utilizing genetic diversity, molecular breeding and biotech traits to increase sustainability of India cotton production in an era of changing climate and cultural practices

KEIM, DON L

Monsanto, USA

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Status of emerging pests on *Bt* cotton in Karnataka and their management

B.V.PATIL, M.BHEEMANNA, S.G.HANCHINAL AND A.C.HOSAMANI

University of Agricultural Sciences, Raichur-584102

bheemuent@rediffmail.com

Abstract : *Bt* cotton was introduced in the year 2002-2003 in Karnataka and since then area under cotton and yield levels increased drastically. *Bt* cotton has suppressed bollworms which were major threat but at the same time minor sucking pests have become major pests in the recent past. Among them important emerging pests on *Bt* cotton are mealy bug *Phenacoccus solenopsis* Tinsley, mirid bug, *Poppiocapsidea biseratense* (Distant) and yellow mite *Polyphagotarsonemus latus* Bank. Distribution, seasonal incidence, bio ecology and management of these pests are discussed in this article.

Transformation of cotton against biotic and abiotic stresses at CEMB Lahore, Pakistan

TAYYAB HUSNAIN, ABDUL QAYYUM RAO, IDRESS AHMAD NASIR, BUSHRA RASHID, AYSHA LATIF AND AHMAD ALI SHAHID

National Centre of Excellence in Molecular Biology (CEMB) University of the Punjab, Lahore 53700

E-mail : dr.idrees@gmail.com

Abstract : Being pioneer in the development of transgenic technology in local cultivars, CEMB has developed various products which are insect's resistant, physiologically improved (High Photosynthetic rate), heat shock resistant and herbicide resistant cotton. CEMB has developed advanced facility to monitor genetically modified cotton with any trait at various levels *i.e.*, DNA, mRNA and protein. Local cotton varieties were transformed by Cry1Ac, Cry2A, Cry1Ab (Insect resistant), Phy B (High photosynthetic rate), GHSP26 (Heat shock resistant), and GTGene (Herbicide resistant) genes cloned under different promoters by using specific protocols optimized at CEMB. The presence of the genes was confirmed by using polymerase chain reaction (PCR). The expression of genes was evaluated by directly exposing the transgenic plants against their targets *i.e* Insect bioassay, Spray assay, Photosynthetic rate measurement and Heat shock resistance evaluation. Insect bioassays showed 100 per cent mortality of *Helicoverpa armigera* in transgenic plants of cotton. Phytochrome B transgenic cotton plants showed more than two-fold increase in photosynthetic rate as compared to control. This increase in Photosynthetic rate ultimately resulted in an increase in the production of cotton by improving the cotton plant growth, with 35 per cent more yield.

Cotton plants transformed with GHSP26 gene taken from *Gossypium arboresum* have showed two fold more resistance to heat shock as compared to parent cotton variety when placed at 55°C for one hour. CEMB codon optimized GTGene transformed in local cotton variety have showed promising result when exposed against 1900 ml/ acre spray of glyphosate. Discoloration and necrotic spot with ultimate death was observed in control cotton plants when compared with CEMB GTGene transformed cotton plants after five days of spray assay.

Ecological impact of cotton textile production

SAROJ S. JEET SINGH

I. C. College of Home Sciences, CCS Haryana Agricultural University, Hisar – 125 004

E-mail : sarojisj Singh@gmail.com

Abstract : Cotton is the most important, popular and versatile natural fibre used in the textile industries worldwide. Its production and processing provide some or all of the cash income of over 250 million people worldwide. In recent years there is an increasing concern about the significant environmental footprint of cotton generating potential environmental and occupational hazards. The impacts of cotton production on the environment are easily noticeable and have diverse faces. Environmental costs originate from the use of agro chemicals during crop production and industrial chemicals in cotton processing. Excessive consumption of water and water pollution is a major concern in both the stages. Cotton processing utilizes a number of chemicals in desizing, mercerizing, bleaching, dyeing, and finishing and thus associated with a number of environmental problems. The main source of pollution is the discharge of untreated effluents into water bodies and soils. Liquid effluents from different processing operations contain organic and inorganic chemicals, as well as suspended solids (such as fibre and grease). These effluents are generally hot, alkaline, smelly, coloured and toxic. The effluents lower dissolved oxygen levels in receiving water bodies threatening aquatic life, and damaging the aesthetic value and quality of water downstream. These problems affect the environment in two ways, those that affect the health of the final consumer and those that affect the local

environment in the production process. The former effects are caused generally by particular persistent organic chemicals used in the production process and use of few carcinogenic azo dyes in dyeing of cotton textile. In addition, due to the lack of modern plant and machinery and poor working conditions workers in cotton processing industries get exposed to the risk of lung diseases and asthma. It is imperative to minimize and eliminate the environmental costs of these processes. These concerns have led to a number of measures to induce a change to sustainable alternatives like production of organic cotton, naturally coloured cotton and genetically engineered cotton, agricultural techniques like integrated pest management (IPM) integrated crop management (ICM), low external input sustainable agriculture (LEISA) and biodynamic agriculture. A switch to cleaner production would require the introduction of in-plant control mechanisms as well as end of pipe treatment. Eco friendly and chemical free textile processing like using natural instead of synthetic dyes or bleaches and effluent of quality standards should be used to reduce the affect of production process on environment. The treatment of industrial effluent can be classified into primary, secondary (or biological), and tertiary (or advanced physico-chemical) processes.

Key words : Effluent, environmental costs, environmental footprint, pesticide and processing

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An account of lifetime achievements of cotton improvement through interspecific hybridization-cytogenetical and molecular aspects

SUBHASH S. MEHETRE

Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722

E-mail : drssmehetre@gmail.com

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The multiplicative analytic hierarchy process (MIAHP) as a quality criterion determining the technological value of the Egyptian cotton varieties

KHALED M. HUSSEIN*, ABDELBASET A. HASSAN, MOSTAFA M. KAMAL

Cotton Research Institute, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Giza, Egypt.

E-mail : kkhelio@hotmail.com

Abstract : This study was undertaken to develop a numerical process that can be used as a quality criterion to determine the technological value of the Egyptian cotton varieties, which in turn would denote the end-use of their fibres. However the material used in the study comprised the 6 Egyptian cotton varieties Giza70, Giza80, Giza86, Giza88, Giza90 and Giza92. According to the local practice in Egypt, Giza70, Giza88 and Giza92 belong to the extra long staple (ELS) category, while Giza80 Giza86 and Giza90 are included under the long staple (LS) category. The regression analysis of the relationships between fibre properties and yarn skein strength (lea product) of the 2 carded ring counts 40 and 50 Ne, was employed to drive an equation for calculating the Multiplicative Analytic Hierarchy Process (MIAHP) values. The values of the MIAHP have been used as numerical determinations of the technological values of the Egyptian cotton varieties. Nevertheless, the findings of this study clarified that with respect to the criteria weights, the pairwise comparisons denoted that fibre length properties of Egyptian cotton ranked first where they revealed the most dominant effect on yarn strength, while tensile properties ranked second with a relative weight close to that of fibre length. On the contrary, the relative weight of fibre fineness (micronaire reading) was found to be marginal. With regard to the relative weight of sub criterion, the pairwise comparisons indicated

that the role of fibre tenacity as a determinant of yarn strength is much superior to that of fibre elongation. Further the global weights of the sub criterion of fibre length pointed out that the UHML (upper half mean length) plays an important role in determining yarn strength of the Egyptian cotton comparing with either the UI (uniformity index) or the SFC (short fibre content). In conformity with the values of the MIAHP, it was found that in the order of descending rank, Giza88 ranked first, followed by Giza92, Giza70, Giza86, Giza80 and finally Giza90.

Keywords: Analytic hierarchy process, cotton fibre quality, technological value

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Estimation of combining ability in F₂ population of upland cotton under drought and non drought regimes

MUHAMMAD HUSSAIN SOOMRO, GHULAM SARWAR MARKHAND AND AMIR AHMED MALLAH

Department of Botany, Shah Abdul Latif University, Khairpur, Sindh, Pakistan
E-mail : dr_wamiq@yahoo.com

Abstract : A six-by-six complete *Gossypium hirsutum*, L. diallel cross was evaluated for general and specific combining abilities in F₂ generation during 2006 under drought and non drought conditions at Shah Abdul Latif University Farm, Khairpur. The characters considered were plant height, leaf area, leaf fresh weight, leaf dry weight, number of leaves per plant, number of sympodial branches per plant, number of bolls per plant, boll weight and seedcotton yield per plant. Irrigation treatments were three; normal seven irrigations schedule upto 150 days of crop maturity, four irrigations (medium stress) upto 150 days of crop maturity and two irrigations upto 150 days of maturity (stress conditions). General and specific combining ability analysis revealed that the mean squares for *gca* and *sca* were significant for all the characters under all the irrigation treatments. The general combining ability estimates of parents for all the characters under study and under all the irrigation treatments were highest for CRIS 134 except for boll weight under four irrigations where CRIS-52 excelled all the parents. Similarly, CRIS-9 followed CRIS 134 in *gca* estimates scoring, and ranked second in all irrigation treatments and for all the characters except for boll weight under seven irrigations (where MARVI was second highest), under four irrigations here CRIS 110 was second highest) and under two irrigations where CRIS 52 was second highest. Thus *gca* estimates of parents for boll weight are affected by drought conditions and therefore in the selection of desirable parents to give desirable combinations for boll weight, only those combinations be selected with highly significant difference for boll weight towards bigger boll size. Testing of such combinations is recommended to continue upto F₅ and F₆ generations to get homogeneity of high performing lines/advance strains. As regards to specific combining ability estimates, hybrid CRIS 9 x CRIS 134 gave highest *sca* value of 11.54 for seedcotton yield under seven irrigations treatment, while CRIS 9 x CRIS 191 gave highest *sca* value of 9.91 under four irrigations treatment for seedcotton yield. Under stress conditions (two irrigations), CRIS-9 x CRIS-134 gave highest *sca* value of 12.35 for seedcotton yield. As the seedcotton yield is the main and important attribute for almost all the stakeholders, therefore it is suggested that the particular hybrid CRIS-9 x CRIS-134 may be produced which in present study, has been isolated to give highest *sca* values under normal as well as under drought conditions (only two irrigations). The analysis of *gca* and *sca* as described by Griffing using method 1 and model 2.

Future of F₂ Bt cotton hybrids in Pakistan, Are these really high yielding to be utilized commercially ?

CHAUDRY MUHAMMAD HANIF

Four Brothers Group, Pakistan

E-mail : ch.hanif@4bgroup.com, Ch_haneef@yahoo.com

ABSTRACT : Heterosis works as basic tool for improvement of crops in the form of F₁ and F₂ populations. Exploiting heterosis is one of the methods to increase cotton yields that have stagnated in recent years. Thus, an experiment was conducted during the years 2009-2011 to explore the possibilities of utilization of some F₁ hybrid combinations for commercialization. Fifteen F₁ and F₂ hybrids and their 8 parents were tested in a four replicated randomized complete block design for their economic traits at Four Brothers Seeds Research Centre, Multan. Results revealed that out of 15 F₁ hybrids, 13 gave positive mid parent heterosis for seed cotton yield in F₁ generation during the year 2010¹, whereas positive heterosis over better parent was observed in 9 hybrids for seed cotton yield. Regarding percent increase or decrease of F₁ over F₂, it was observed that out of 15 F₁ hybrids, only 2 gave increased yield over F₂ hybrids. Combination CIM 496 x MNH 886 produced 19.90 per cent higher yield in F₁ than F₂ hybrids followed by FBS 26 x M-1 which recorded 13.67 per cent increase of F₁ over F₂ generation². The maximum increase of 13.76 per cent over mid parent was exhibited by the F₁ hybrid combination CIM 496 x MNH 886 and the same combination gave 19.90 per cent seed cotton yield increase of F₁ generation than F₂. It is interesting to note that two combinations have shown increased hybrid vigour (heterosis) in F₁ than F₂ hybrids. Thus the combinations CIM-496 x MNH-886 and FBS 26 x M-1 may be used commercially because of the fact that the F₁ seed production is very expensive hence these combinations may serve the purpose of high yields through heterosis breeding and almost 19.90 per cent yield increase in F₁ generation is quite satisfactory. These encouraging results suggest there is sufficient heterosis for yield to use F₁s in Pakistan.

Global climate change: Challenges and opportunities for sustainable cotton production

N. GOPALAKRISHNAN, A.H. PRAKASH AND S. E. S. A. KHADER

Indian Council of Agricultural Research, New Delhi - 110 014

E-mail : gopal55@rediffmail.com

Abstract : Climate change is one of the most complex challenges that humankind has to face and overcome in the coming decades. As the change process seems to be complex, it is significant and urgent to develop sound adaptation processes to the current and future shifts in the climate system. Climate change is projected, with high degrees of certainty, to have noticeable negative impacts upon agricultural production, food security and economic development, especially in developing countries. Cotton has certain resilience to high temperatures and drought due to its vertical tap root. The crop is, however, sensitive to water availability, particularly during flowering and boll formation. Rising temperatures favour cotton plant development, unless day temperatures exceed 32° C. Limited increases in atmospheric CO₂ also favour the cotton plant's development. The impact of climate change has also been studied on cotton productivity. Effect of elevated CO₂ on cotton growth and development is more apparent due to significantly greater leaf area, higher leaf and canopy, net photosynthetic rates, lower dark respiration and lower light compensation point than plants grown in ambient CO₂. Insects are expected to adapt to climate change through their capacity to adapt their body temperature to the temperature of the environment. It is expected that the insects currently plaguing cotton are expected to possibly pose more problems in new environmental conditions. The effect of Climate change on Indian cotton production scenario is viewed as increasing CO₂

concentration could help to increase cotton production in all three zones. However, increasing precipitation with decreasing temperature may prolong the vegetative growth and extend the crop duration, which pose difficulties in timely sowing of succeeding rabi crops in north zone. The expected increase in temperature and decreasing rainfall with erratic distribution in central and south zone shall lead to frequent wet and dry spell with high evapotranspiration demands. Prolonged dry spell during critical crop growth periods may affect yield. The projected drought followed by waterlogging due to increasing intensity of rainfall may further induce reddening in Bt cotton. Shortening of crop growth periods induced by increasing temperature may facilitate to fit cotton crop into rice fallow cotton system in South zone. Mitigation of the causal factors and adaptation of the crop to suit changing climate are the two broad strategies to restrain and cope with the changing climate. Whereas mitigation strategy aims at reducing the emission of CO₂ and other greenhouse gases into the atmosphere, adaptation strategy aims at enabling the plant to perform well under the changing climatic conditions by cultural and genetic strategies.

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Morpho physiological concept of ideotype in cotton (*Gossypium hirsutum* L.) under rainfed conditions

B. S. JANAGOUDAR
University of Agricultural Sciences, Raichur
Email : bjanagoudar56@gmail.com

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Bt cotton cultivation: Farmers perspectives

A K DHAWAN
Punjab Agricultural University, Ludhiana -141 004
E-mail : ashokdhawan@yahoo.com

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Cotton production and consumption of Bangladesh

MD. IMRAN ALI
Dhaka Commerce College, Department of Finance and Banking, Dhaka, Bangladesh

Avoidable losses due to cotton diseases in India

D. MONGA, P.S. SEKHON, JAGADISH BENIWAL, DALJEET SINGH, P.V. PATIL, P.K. DHOKE, O.V. INGOLE, R.R. PERANE, S.N. CHATTANAVAR, B. SREE LAKSHMI, M.S.L.RAO

Central Insitute for Cotton Reserach, Regional Station, Sirsa - 125 055

E-mail : dmonga2009@gmail.com

Abstract : Studies carried out under All India Coordinated Cotton Improvement Project over the years at selected locations have demonstrated avoidable losses due to important diseases like cotton leaf curl virus, bacterial leaf blight, *Alternaria* leaf spot, grey mildew, *Myrothecium* leaf spot, *Helminthosporium* and rust. Losses due to Cotton leaf curl virus disease on *Bt* cotton hybrids in north zone during 2009-12 ranged between 25.2-46.6 per cent. In pooled data of three years (2010-2012) at Dharwad, Guntur, Surat and Akola, five sprays of copper oxy chloride and streptomycin at 35, 50, 65, 80 and 95 days after sowing showed reduction of bacterial blight PDI from 28.8 to 12.0 and reduction of yield loss upto 22.0 per cent. *Alternaria* leaf spots can cause loss upto 26.6 per cent based on results (2006-2007 to 2008-2009) of study conducted in central India at Rahuri and south zone locations at Guntur and Dharwad. Five sprays of Propiconazole (0.1%) at 35, 50, 65, 80, and 95 DAS decreased percent disease index (PDI) from 31.59 to 20.85 per cent thereby reducing yield loss due to *Alternaria* leaf spots in variety LRA-5166. In case of grey mildew disease also, a reduction of loss due to grey mildew disease up to 29.2 per cent with the application of five sprays of carbendazim (35, 50, 65, 80 and 95 days after sowing) in *Bt* cotton hybrid Bunny was demonstrated based on a study (2008-2009 to 2010-2011) conducted across central and south zone, (Dharwad, Guntur and Nanded). PDI showed reduction to 8.1 as compared to 20.9 in control. In another important fungal disease, *Myrothecium* leaf spot, reduction of loss up to 29.1 per cent with the application of five fungicidal sprays of Propiconazole (@ 0.1 per cent) at an interval of 35, 50, 65, 80 and 90 DAS in variety JK-4 was observed on the basis of trial in central zone at Khandwa (2007-2008 to 2009-2010). Percent disease index (PDI) showed reduction to 7.4 as compared to 22.5 in control. Losses to the tune of 33.8 per cent with 0.1 per cent propiconazole spray at 35, 50, 65, 80 and 95 days after sowing due to *Helminthosporium* leaf spot disease could be avoided in cotton variety LRA-5166 based on (2007-2008 and 2008-2009) studies carried out at Guntur in south zone. Three years pooled results on avoidable losses due to cotton rust disease at Dharwad and Guntur showed four sprays of propiconazole (0.1%) at 15 days interval from 75 days after sowing showed reduction of PDI from 32.8 to 7.7 and 29.0 to 10.7 and reduction of yield loss upto 21.7 and 34.0 respectively. The implications of these studies in disease management are discussed.

Key words : Avoidable losses, carbendazim, copper oxychloride, diseases, propiconazole, streptomycin

Molecular diversity and association of STMS markers to bacterial blight resistance in working germplasm of cotton (*Gossypium hirsutum* L.)

A. B. DONGRE, B. V. SONAWANE, B. R. RODE, PUNIT MOHAN AND K. R. KRANTHI
Central Institute for Cotton Research, Nagpur 440 001
E-mail : abdcicr@gmail.com

Abstract : Bacterial blight caused by *Xanthomonas campestris* is one of the most important diseases of cotton. To produce high yielding resistant cultivars, information on available resistant accessions from the cotton genetic resources is important. In the present study, molecular diversity and association of sequence-tagged microsatellite site markers (STMS) for bacterial blight resistance was detected in twenty working germplasm of cotton. Major parameters, i.e. polymorphism information content (PIC), resolving power (Rp) and marker index (MI), indicated highly informativeness of STMS markers to discriminate among the accessions. Cluster analysis (UPGMA) revealed four main clusters separated based on Jaccard's similarity coefficient according to bacterial blight resistance. Locus by locus ANOVA identified significant association of three STMS markers with bacterial blight resistance, and further significance was confirmed by Kruskal-Wallis one way ANOVA and simple linear regression analysis. These markers can be further validated on large populations and employed in cotton molecular breeding and improvement.

Key words: ANOVA, MI, PIC, Rp, Sequence tagged microsatellite site (STMS)

Multi tier cropping systems and its weed control methods for higher resource utilization, profitability and sustainability in *Bt* cotton

K. SANKARANARAYANAN, P. NALAYINI, AND K. RAJENDRAN
Central Institute for Cotton Research, Regional Station, Coimbatore - 641 003
E mail: sankaragro@gmail.com

Abstract: Climate change and its likely impact on cotton crop is fast gaining momentum because of fact an importance of cotton in national economy for providing livelihood security to 60 million people including all the stake holders of cotton value chain. Thus, keeping in view of climatic vulnerability, market fluctuation and better resources use, cotton based multi tier vegetable intercropping system was evaluated with integrated weed management. A field trial was conducted during 2009-2010 and 2010-2011 at Central Institute for Cotton Research, Regional Station, Coimbatore. The experimental soil was clay loam in texture, low in available N (214 kg/ha), medium in available P (14.6 kg/ha) and high in available K (741.2 kg/ha) with a pH of 8.3. The experiment was laid out in a factorial randomized block design with three replications. The treatment combinations comprised of three systems (S₁.cotton+coriander+vegetable cowpea +cluster bean, S₂.cotton+radish+beet root+ coriander and S₃.sole cotton) combined with three weed control methods (W₁.Hw @15,30 &60 DAS, W₂.Pendimethalin @0.75 kg/ha +HW 30DAS+Pendimethalin@1.25 kg/ha (lay by) and W₃.Pendimethalin@0.75kg/ha+HW30DAS+ Quizalofop-ethyl @50g/ha). *Bt* cotton hybrid (RCH 20Bt) was planted at spacing of 120 x 45 cm. Two ridges at 60 cm apart were formed making 120 cm. Cotton, and multi intercrops (three) were planted on 4 sides of the 2 ridges in sequence.

Pooled results revealed that seed cotton yield was not significantly influenced by multi-tier systems as compared to sole cotton. Amongst weed control, hand weeding thrice at 15,30 and 60 DAS had been harvested significantly highest seed cotton yield (2332 kg/ha), which was on par with by pre emergence

application of pendimethalin @ 0.75 kg / ha followed by hand weeding at 30 DAS and application of pendimethalin @ 1.25 kg / ha as lay by method (2229 kg/ha). The economics of multi tier system revealed that multi tier system of , cotton intercropped with coriander, radish and beet root had been arrived with the significantly highest net return of Rs1,36,235/ha . Amongst weed control methods the highest net return (Rs1,02,806/ha) had been calculated with weed control by pre emergence application of pendimethalin @ 0.75 kg / ha followed by hand weeding at 30 DAS and application of pendimethalin @ 1.25 kg / ha as lay by method for weed control. Nutrient uptake had been significantly higher with multi tier systems and significantly highest soil available nitrogen status (182.2 kg/ha) was analyzed by cotton+ coriander+ vegetable cowpea +cluster bean.

Key words : Integrated weed management, multi tier cropping, net return, pendimethalin, quizalofop-ethyl, seed cotton yield

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Overexpression of a Cys2/His2-type zinc finger protein gene from *Arabidopsis thaliana* confers tolerance to drought stress in transgenic cotton

J. AMUDHA, A. SHEEBA, R. B. SINGANDHUPE, C. SWETHA AND G. BALASUBRAMANI
Central Institute for Cotton Research, Nagpur - 440 010
E.mail : jamudhacir@gmail.com

Abstract : Water stress is by far the leading environmental stress limiting crop yields worldwide. Genetic engineering techniques hold great promise for developing crop cultivars with high tolerance to water stress. In this study, the *Gossypium hirsutum* var. LRA 5166 and LRK 516 were transferred with zinc finger gene through *Agrobacterium* mediated transformation. The transgenic status and transgene expression of the transgenic plants was confirmed by polymerase chain reaction (PCR) analysis, dot blot hybridization and semi-quantitative one step RT-PCR analysis, respectively. Subsequently, the growth status under water stress, and physiological responses to water stress of transgenic plants were studied. The results showed that the transgenic plants exhibited better growth status under water stress condition compared to the wild type plants. In physiological assessment of water tolerance, transgenic plants showed higher levels of relative water content (RWC), leaf water potential (LWP), and proline content along with increasing levels of water stress than the wild type plants. This study shows that *ZF1* gene is a candidate gene in the engineering of crops for enhanced water stress tolerance.

Key words : Hybridization, overexpression, physiological response, transformation

Impact of intercropping technology transfer on knowledge, adoption and net profit of cotton farmers in Vidharbha region of Maharashtra

S. M. WASNIK AND S. USHA RANI

Central Institute for Cotton Research, Nagpur- 440 010

E-mail : wasniksm2012@gmail.com

Abstract : Results obtained at research stations and demonstrations conducted on farmer’s fields have proved that intercropping with cotton is beneficial over growing of cotton alone. Cotton being a long duration crop and having a slow growth in early growth stages is ideally suited for growing of scientifically sound and practically feasible intercrops *viz.* mungbean, cowpea, soybean, etc. However, the technology are not being adopted at the rate at which these are being generated by the researchers though the intercropping system has several advantages like enhancing productivity of land, suppressing weeds in the inter row spaces, enriching soil fertility, additional production and increasing income/unit area. However, the grower apprehensive of yield reduction in both cotton and intercrops due to problems in intercultural operations. Also the other problems encountered were lack of awareness and sufficient knowledge of intercropping, training, access to credits and farm inputs. Keeping the idea in view and to popularize intercropping technology among farmers, a comprehensive programme of transfer of intercropping technology through ‘farmer to farmer’ technology dissemination was introduced at farmer’s field in Vidharbha rainfed region of Maharashtra State. The farmers were motivated and educated about worth of intercropping technology. They were also provided on-farm technical support. Since soyabean is extensively grown in Vidharbha region, the crop was chosen as intercrop with cotton varieties NHH 44 and Bunny *Bt* Soyaben variety JS 335 was selected as suitable variety for intercropping (1:1) and laid out trial at farmer’s field. The study showed very encouraging results in motivation, diffusion and promotion of cotton intercropping. The results show that there was significant improvement in knowledge, adoption and net profit due to implementation of programme. The increase in knowledge and adoption was 44.32 and 56.79 per cent as a consequence of intercropping technology transfer. Further there has been significant gain in profit as the farmers were able to get 32 per cent additional yield and 26 per cent additional returns over the years in intercropping system from same piece of land compared to sole cotton. The neighbouring young and educated farmers of the area were positively influenced towards intercropping mainly due to economic profitability. Further they themselves started convincing other farmers for adoption of intercropping technology to strengthen their economy.

Developmental breeding in *Gossypium hirsutum L*

T.R.LOKNATHAN , R.B.BAGDE, PRAFULLA RAUT AND B.R.RODE

Central Institute For Cotton Research, Nagpur - 440 010

E-mail : loknathantr@sify.com

Impact of exclusion of solar UV-B/UV-A radiation on growth, photosynthesis and yield of cotton (*Gossypium hirsutum* L.) varieties

SUNITA KATARIA, P. DEHARIYA, K.N. GURUPRASAD AND G.P. PANDEY

School of Life Sciences, Devi Ahilya University, Indore – 452 017

Email: sunitakataria@hotmail.com

ABSTRACT : The influence of solar UV-B or UV-A radiation on the growth, photosynthesis and yield of four varieties of cotton (*Gossypium hirsutum* L.); JK-35, IH-63, Khandwa-2 and Vikram was investigated by the exclusion of solar UV-B/UV-A radiations. Cotton plants were grown from seeds in specially designed UV exclusion chambers, which were lined with selective UV filters to exclude either UV-B (280-315 nm) or UV-A/B (280-400 nm) from solar spectrum under field conditions. Excluding UV-B and UV-A/B significantly increased plant height, leaf area, dry weight accumulation and yield parameters (number and weight of bolls and length of fibres) in all the four varieties of cotton. The photosynthetic pigments were significantly enhanced while UV-B absorbing substances were significantly decreased by the exclusion of solar UV-B and UV-A/B. Enhancement in the vegetative growth and yield of the plants could be related to the enhanced rate of photosynthesis in all the varieties of cotton. UV exclusion also enhanced the stomatal conductance and intercellular CO₂ concentration and reduced the stomatal resistance. Total soluble proteins were also higher after UV exclusion in all four varieties of cotton. Considerable variation in the sensitivity to ambient solar UV-A/UV-B exists between the varieties and according to UV sensitivity index, the sensitivity can be arranged in increasing order as; JK 35>IH 63>Khandwa 2>Vikram. Thus Vikram was the most sensitive and JK-35 the least sensitive to current level of solar UV radiation at Indore. Experiments indicated the suppressive action of ambient UV on carbon fixation and yield of cotton plants. Exclusion of solar UV proved to be beneficial in enhancing the growth and yield of cotton plants.

Key words : Biomass; cotton; photosynthesis; Pigment system II; UV exclusion; yield

Quality assessment of indian cotton harvested using spindle picker *vis-a-vis* effectiveness of cleaners in its processing

S. K. SHUKLA, P. G. PATIL, JYOTI M. NATH, V. G. ARUDE AND G. MAJUMDAR

Ginning Training Centre, Central Institute for Research on Cotton Technology, Nagpur – 440 023

E-mail: skshukla2000@gmail.com

Abstract : Present study assesses the quality of machine picked cotton and evaluates the performance of pre-cleaners specially developed at GTC, Nagpur to process the machine picked cottons. The moisture content and temperature in cotton were 5 per cent and 39°C, respectively. The trash content present in the control sample was separated manually so as to avoid its damage in the ginning machinery. A set of pre-cleaning machinery consisting of a cylinder type pre-cleaner, a 3-stage stick removal machine and a saw band cleaner has been used for pre-cleaning of machine picked cotton. A double roller gin was used for ginning of the pre-cleaned cotton. The fibre quality at each stage of machine operation was measured using HVI. The percentage of trash content present at each stage of processing was determined using an indigenous trash separator. The performance of a cleaner was assessed by its cleaning efficiency *i.e.* the percentage of trash content removed from the cotton. The trash content present in the machine picked cotton using spindle type picker can be classified into four major groups *i.e.* green and dry leaves, burs, sticks, immature seeds/mote. The analysis of results suggest that the machine picked cotton contains around 19.26 per cent total trash content among which the dry leaves is highly significant (*i.e.* 13.45%) compared to the large

foreign matters (such as sticks and burs). The length and diameter of sticks present in the machine picked cotton varies from 2-40 mm and 1-25 mm, respectively. The overall cleaning efficiencies of pre-cleaner, stick machine and saw band cleaner have been found as 20.45, 41.86 and 23.59 per cent, respectively. The average percentage of trash content present in the machine picked cotton has been brought down to 3.11 per cent using saw cylinder cleaner in combination with the cylinder cleaner and stick machine. The analysis of fibre parameters suggest that the pre-cleaning operations do not make any significant difference in the fibre properties.

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Performance of hybrids produced by different systems for yield and quality in *Gossypium hirsutum* L

S. S. SIWACH AND R.S.SANGWAN

Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar - 125 004
E-mail : profsssiwach@gmail.com

Abstract : Cotton is an important commercial crop of India. *Gossypium hirsutum* is the most commonly grown species among the four cultivated species. Noticeable heterosis has been reported in cotton. Hybrid seed in most of the cases is produced by conventional method. The cost of hybrid seed produced by the conventional method is high because of high labour requirement in the process of emasculation and secondly setting per cent of crossed bolls is also low. Hybrid seed production cost in cotton could be reduced significantly by using the male sterility approach. Performance of cotton hybrids produced by different breeding methods was compared for seed cotton yield, ginning outturn (%), 2.5 per cent span length (mm), fibre strength (g/tex) and micronaire value (ug/in) for three years. Overall mean performance of 191 cytoplasmic genetic male sterility based hybrids; 123 genetic male sterility based hybrids and 155 conventional hybrids revealed that conventional hybrids produced the maximum seed cotton yield (2225 kg/ha) followed by genetic male sterility based hybrids (2157 kg/ha). The cytoplasmic genetic male sterility hybrids performed poorly with mean values of 1406 kg/ha. The ginning out turn, 2.5 per cent span length, fibre strength and micronaire values of all the hybrids produced by different methods were almost similar.

Key words : cytoplasmic genetic male sterility, heterosis, fibre length, micronaire value

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Effect of spinning mechanism on blended fabric

K. KHAMBRA AND CHANCHAL

College of Home Sciences, CCS Haryana Agricultural University, Hisar – 125 004
krishnakhambra@yahoo.com

Abstract : The raw material jute and acrylic were blended in different proportions. Yarns were spun on ring and rotor spinning mechanisms and converted into plain knit fabrics. Pilling resistance was experimented in different blended fabrics and it was found that 100 per cent acrylic had more pilling tendency as compared to jute blends. As the percentage of jute increased in the blend, the number of pills decreased. The yarn made up on ring had lesser diameter and tenacity than yarn spun on OE. The yarn made up on ring spun yarn had more fabric count than of OE yarn thus resulting in less weight, thickness and number of pills. Natural fibre (jute) reduces pilling tendency of blended fabrics to a great extent.

Genetic, biochemical, histological and molecular analysis of thermosensitive genetic male sterility (TGMS) in cotton (*Gossypium arboreum* L)

L.SEKHAR AND B.M.KHADI

Department of Plant Breeding, University of Agricultural Sciences, Dharwad - 580 005

E-mail : sekharqpb@gmail.com

Abstract : The thermo sensitive genetic male sterility is innovative male sterility system, in cotton it is a first kind of report. TGMS 3 x ARBHA 35 F₂ population was scored for male sterility and fertility and subjected to chi-square test. The observed frequencies of the two categories do not significantly differ from the expected frequencies. The observed frequencies have a good fit with the expected 3:1 indicating that the TGMS trait is controlled by single recessive gene. Timing of callase activity plays role in the formation and degradation of cell walls during microsporogenesis. High callase activity is required for the normal release of microspores from tetrads at late tetrad stage, in fertile anthers, the enzyme activity was strong as compared to TGMS line. Hence the release of microspores was not affected in fertile anthers as compared to TGMS lines.

Comparative observations made in fertile anthers revealed that the process of microsporogenesis in male sterile anther paralleled that in the fertile anther until shortly after meiosis of the same TGMS line. Later the microspores were released from the tetrad by dissolution of callose walls in sterile and fertile anthers. The first indication of abnormal pollen development in the sterile anther was early disintegration of tapetum in sterile as compared to fertile anthers. The abnormal pollen development in the sterile anther was the vacuolation of microspore, associated with crushing of chromatin material coupled with shrinkage of microspore cytoplasm. The abnormality associated with the further development of released microspores was most likely due to nutrient deficiencies. Finally, from this investigation NAU 2176 and NAU 2096 markers can be used as linked markers for the TGMS trait in cotton as evident from their differential expression in fertile and sterile anthers of same plant during differential temperature regimes.

Key words : Gentic male sterility, micropores, microsporogenesis, pollen disintegration, thermosenitive

Molecular characterization of genetic male sterile genotypes in diploid cotton (*Gossypium arboreum* L) and development of male sterility specific scar marker

SEKHAR BABU GEDDAM AND B. M. KHADI

Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad - 580 005

E-mail : sekharbabug.iari@gmail.com

ABSTRACT : Genetic male sterility in the *Gossypium arboreum* was found to be under the control of recessive gene. This GMS system has been used for diploid cotton hybrid breeding in India. In the present study RAPD marker system to characterize the Hisar GMS and SRT-1GMS lines which were derived from the repeated back crosses and the male sterility in these genotypes is governed by the single recessive gene *ams₁* was used. From the survey of 60 random decamer primers 34 were found to be polymorphic generating 60.73 per cent polymorphism between male sterile and male fertile plant. Out of the polymorphic primers OPAB3, OPAB4, OPAB5, OPAB19, OPH20, OPI2, OPI3 and OPI7 showed a notable differences in the amplicon profile of male sterile and their fertile counterparts. Dendrogram revealed two distinct clusters in which all the male sterile plants made independent cluster and similarly the fertile plants indicating genetic differences

between them for sterility. The primer OPI3 was found to be male sterile specific in repeated PCR by consistently producing a specific fragment of 486 bp only in the sterile plants which has been later converted into a locus specific sequence Characterized amplified regions (SCAR) marker. The RAPD markers associated with male sterility and putative SCAR marker specific to male sterility may facilitate the utilization of the GMS system in hybrid breeding in the Asiatic cotton.

Key words : Asiatic cotton, genetic male sterility, random amplified polymorphic DNA, sequence characterized amplified regions marker

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Study on the epidemiological aspect of Alternaria leaf spot on Bt cotton

G. N. HOSAGOUDAR AND S. N. CHATTANAVAR

Department of Plant Pathology, University of Agricultural Sciences, Dharwad, 580 007
gnhosagoudar@rediffmail.com

Abstract: Cotton is one of the most ancient and important commercial crops next to food grains and is the principal raw material for a flourishing textile industry. The present investigations were under taken to study the epidemiological aspect of Alternaria leaf spot on Bt cotton caused by *Alternaria* spp during 2010 and 2011 through the aerobiological studies. The spore load in the open air was found maximum during August to October months. Maximum temperature had positive correlation, while remaining weather parameters like minimum temperature, relative humidity (morning and evening), rainfall and rainy day had negative correlation with spore load. Through pooled analysis of *kharif* 2010 and 2011 the multiple linear regression model was obtained as $Y = -28.31 + 1.01X_1 - 1.11X_2 + 0.17X_3 + 0.13X_4 + 0.01X_5 - 0.33X_6$ with R^2 of 0.43. The step down regression equation was fitted as $Y = -9.30 + 0.4 X_1$ with R^2 value of 0.18 including the factor maximum temperature. The aerobiological studies also revealed that, per cent disease index (PDI) was progressing at linear rate throughout the plant growth and it was negatively correlated with minimum temperature and relative humidity (morning and evening). The multiple regression model developed for PDI is $Y = -250.10 + 10.26X_1 - 12.23X_2 + 2.00X_3 + 0.67X_4 + 0.04X_5 - 0.79X_6$ with R^2 value of 0.78. Stepdown regression had modified the equation as $Y = -235.94 + 9.89X_1 - 11.84X_2 + 1.89X_3 + 0.64X_4 - 1.23X_6$ with R^2 value of 0.78 including variables, temperature (maximum and minimum), relative humidity (morning and evening) and rainy day.

Key words : Aerobiological, Alternaria leaf spot, epidemiological, Bt cotton, model.

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Utilization of Sesbania aculeata (Dhaincha) non woven fabric as mulch material

NEETA SINGH AND ANITA RANI

Department of Clothing and Textiles, College of Home Science G. B Pant, University of Agriculture and Technology, Pantnagar- 263 145
E-mail : neetasingh.345neeta@gmail.com

Abstract : The needle punched non woven fabric prepared from processed/treated *Sesbania aculeata* (Dhaincha) fibres was tested for physical properties namely, fabric weight, fabric thickness, abrasion resistance, fabric stiffness, tensile strength and elongation, tearing strength, bursting strength and air permeability. The prepared non woven fabric of *S. aculeata* (Dhaincha) fibres had medium weight, compact structure and high air

permeability. It was judged suitable for different purposes in agriculture sector like in mulching, air layering/ propagation of plant, packaging, filtering, etc. Finally *S. aculeata* (*Dhaincha*) non woven fabric was found suitable as mulch material compared to control and other conventional mulch materials i.e., wheat straw and poly mulch. Therefore *S. aculeata* (*Dhaincha*) non woven fabric can be used as mulch material for increasing the production of cotton according to climate change.

Keywords : Mulch, Needle punching, non woven fabric, Retting, *Sesbania aculeata*

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Response of *Bt* cotton to different methods of fertilizer application under irrigated situation in north eastern dry zone of Karnataka

G. Y. VIDYAVATHI, M.V. RAVI , G.S. YADAHALLI, S. N. UPPERI AND H. S. LATHA
University of Agricultural Sciences, College of Agriculture, Bheemarayanagudi - 585 287
E-mail : vidyasac@rediffmail.com

Abstract : The suitable method of fertilizer application for *Bt* cotton was studied in deep black soils of Shahapur and Shorapur taluks of Yadagir District in north eastern dry zone of Karnataka under Upper Krishna Command Project area during 2010 – 2011 and 2011 – 2012. The results (pooled over two years) indicated that cotton seed and dry matter yield were recorded significantly higher in the STCR approach (29.8 q/ha and 48.8 q/ha, respectively) as compared to all other treatments and was followed by NK + 50 % & P + 25 % (27.9 and 44.8 q/ha respectively). The increase in seed yield was 49 per cent with application of fertilizer by STCR approach followed by NK + 50 per cent and P + 25 per cent (40 %) over other treatments. The discounted net returns and B: C ratio were significantly higher in treatment receiving fertilizer by STCR approach (Rs.166788 and 4.55/ha, respectively). This was followed by soil test based NK ± 50 per cent and P ± 25 per cent (Rs. 155896 and 4.43/ha, respectively). Soil available nutrients were also found significantly higher with STCR approach fertilizer recommendation.

Key words : B:C., discounted net returns, soil test, STCR

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Heritability and genetic advance in Asiatic cotton (*Gossypium arboreum* L) genotypes

RUMESH RANJAN, R. S. SANGWAN, S. S. SIWACH, O. SANGWAN, NANCEE, MITALI SAH AND J. N. SAH
Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar - 125 004
E-mail : rumeshranjan5@gmail.com

Abstract : Sixty *Gossypium arboreum* genotypes were studied to observe genetic variability, heritability and genetic advance for seed cotton yield and its contributing characters. The analysis of variance revealed that the sufficient variability was present in the material for all the characters. The value of phenotypic coefficient of variation (PCV) is greater than genotypic coefficient of variation (GCV); it meant that the apparent variation was not only due to genotypes but also due to influence of environment. Seed cotton yield/plant provided high estimates of genotypic and phenotypic coefficients of variation coupled with high heritability and high expected genetic gain as a per cent of mean, which provided better scope for advancement through direct selection. Similar results were also observed for number of monopods. Hence, improvement in seed cotton yield due weight age should be given on number of monopods.

Key words: genetic advance, *G. arboreum*, heritability, seed cotton yield, Variability

Impact of climate change on cotton and its production in India

R.S. JAGLAN, NAMITA SINGH AND KANU PRIYA

Guru Jambheshwar University of Science and Technology, Hisar - 125 001

Email : namitasingh71@gmail.com, rsjaglan@yahoo.com

Abstract : Cotton (*Gossypium spp.*) is a major cash crop, being the world's leading natural fibre for the manufacture of textiles and edible oil. Climate has changed many times in response to a variety of natural causes but the term climate change usually refers to those changes that have been observed since the early 1900s and includes anthropogenic and natural drivers of climate. Increasing temperature can have both positive and negative effects on cotton growth depending on the location of the region. Higher CO₂ levels in the immediate surroundings of the cotton plant will increase photosynthetic activity. Pests are a threat to the cotton production worldwide. Water availability is another important factor in cotton cultivation. India is the third largest cotton producing and consuming country in the world following USA and China. This review discusses thorough impact of climate change on cotton production and recommendation for minimizing the impact of climate change.

Key words: Climate, cotton, temperature, CO₂, water availability.

Impact of salinity on different cotton genotypes (Desi, American and Bt cotton)

KAVITA, PROMILA KUMARI, RENU MUNJAL. S. K. SHARMA AND S. S. SIWACH

Department of Botany and Plant Physiology, CCS Haryana Agricultural University Hisar- 12 5004

E-mail : kpoonia9@gmail.com

Abstract : A screen house experiment was conducted in pots in the Department of soil science CCS Haryana Agricultural University Hisar to study the impact of salinity on different cotton genotypes. Saline water of different EC *i.e.* 0, 4, 8 and 12dSm⁻¹ was applied for irrigation. In the present investigation six cultivars of cotton namely, HD 123, AAH 1 (*Desi* cultivars), RCH 134, Bio 6488 (*Bt* cultivars), H 1236 and HHH 223 (*American* cultivar) were sown in the month of May. Per cent germination of all the cotton cultivars decreased with increasing levels of salinity. *Bt* cotton cultivars (RCH 134 and Bio 6488) showed maximum germination percentage, while *desi* cultivars (HD 123) and its hybrid (AAH 1) showed minimum seed germination at all the levels of salinity. A significant reduction in chlorophyll content of leaves was found with increasing salinity levels and reduction was found to be maximum in *Desi* cotton cultivars while minimum in *Bt* Both *Bt* hybrid cultivars had more chlorophyll content as compared to *desi* cultivars and *American* cultivars. Photosynthetic rate, transpiration rate and stomatal conductance of all the cotton cultivars decreased with increasing salinity levels. Significantly higher assimilation rate was recorded in both *Bt* cultivars, RCH 134 and Bio 6488 at zero salinity level *i.e.* control. Although the photosynthetic rate decreased with increasing salinity in all the cotton cultivars but *desi* cultivar HD 123 showed a remarkable decrease in photosynthetic rate as compared to its corresponding *desi*, its hybrid and *American* cultivars at 12dSm⁻¹. Maximum stomatal conductance was recorded in *desi* where as minimum stomatal conductance was recorded in *American* and *Bt* cotton cultivar. Different cotton cultivars were identified on the basis of Protein banding pattern.

Key Words : Chlorophyll content, Germination per cent, Photosynthetic rate, Protein banding pattern, transpiration rate, salinity and stomatal conductance

Study of heterosis for fibre quality characters in GMS based diploid cotton hybrids

SEKHAR BABU GEDDAM., B.M. KHADI, RAJESH S. PATIL., L. SEKHAR, NAGAPPA HARIJAN., SUMA C. MOGALI AND I. S. KATAGERI

Department of Genetics and Plant Breeding, University of Agricultural sciences, Dharwad - 580 005
sekharbabug.iari@gmail.com

Abstract : The investigation was carried out during *kharif* 2009-2010 at Main Agricultural Research Station, UAS, Dharwad. A total of nine genetic male sterility based hybrids were tested for heterosis over mid parent, better parent and checks for fibre quality characters. All the parents and hybrids recorded significantly higher fibre length over the hybrid check AAH-1. Six crosses showed positive significant heterosis for fibre length over varietal check GSaV-1056. Except the cross, MSD 7 nkd × Jayadhar, all the entries showed significantly higher fibre strength over the check AAH-1. Two crosses MSD 7 nor × ARBH-35 and MSD 7 nor × DDhc 11 exhibited significant heterosis in desirable direction over mid parent, better parent and both the checks for fibre strength. For fibre fineness all the hybrids recorded significantly lower micronaire values than the hybrid check. All the crosses over GSaV-1056 exhibited significant heterosis for fibre uniformity ratio. The crosses MSD 7 nor × RAhS 14 and MSD 10 × RAhS 14 for fibre length, MSD 7 nor × DDhc 11 and MSD 7 nor × ARBH 35 for fibre strength, fibre fineness and fibre elongation (%), MSD 11 × DLSa 102 and MSD 7 nkd × Jayadhar for uniformity ratio were found superior.

Key words : Diploid cotton, Fibre quality, Genetic male sterility, Heterosis

Investigation of superior parents and hybrid combinations in respect to *kapas* yield and yield attributing characters and forming heterotic boxes for exploitation in cotton (*Gossypium hirsutum* L)

YANAL ALKUDDSI, M.R. GURURAJA RAO AND S.S. PATIL

Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad - 500 005
E-mail : y.alkuddsi@hotmail.com

Abstract: Estimating combining ability are important genetic attributes to cotton breeders in predicting improvement *via* hybridization and selection programmes. The purpose of this study was to determine estimates of the general combining ability of parents and the specific combining ability of hybrids needed to develop high yielding cotton varieties. An investigation was carried out during *kharif* 2008 in cotton (*G. hirsutum* L.) to evaluate *intrahirsutum* hybrids produced through Line x Tester mating design using 6 *hirsutum* non *Bt* lines (RAH 318, RAH 243, RAH 128, RAH 146, RAH 97 and RAH 124) and 8 *hirsutum* non *Bt* testers (SC 14, SC 18, SC 7, SC 68, RGR 32, RGR 24, RGR 58 and RGR 37) to generate information on combining ability effects in respect of *kapas* yield (seed cotton yield) and yield attributing characters and to for heterotic boxes. The 48 F₁ hybrids were sown in a randomized complete block design (RCBD) with two replications at the Agricultural Research Station, Bavikere, UAS, Bangalore. From the estimates of additive and dominance variance, it is observed that dominance variance was predominant for all the characters and was maximum for *kapas* yield per plant followed by plant height and bolls per plant. However, both additive and dominance variance were found to be important in case of ginning/cent, monopodia/plant, mean boll weight, days to 50 per cent flowering, seed index and lint index. Among the lines, the mean sum of squares was significant for all characters except monopodia/plant and mean boll weight. The testers differed significantly for most of the characters except monopodia/plant, mean boll weight and seed index. However, the line x tester interaction was significant for all the characters except monopodia per plant, mean boll weight, seed index and lint

index. Estimation of *gca* effects of lines and testers indicated that, no single line or tester was found to be a good general combiner for all the characters studied. However, the line RAH 146 exhibited significant *gca* effects in the desired direction for 5 characters (plant height, sympodia per plant, bolls per plant, *kapas* yield and ginning per cent) and was considered as best general combiner among lines. Among the testers, the tester RGR 32 was considered as the good general combiners, since it had high significant *gca* effects in the desirable direction for monopodia per plant, bolls per plant, mean boll weight and ginning/cent. The hybrid RAH 128 x RGR 37 exhibited significant specific combining ability for plant height, sympodia per plant and *kapas* yield; RAH 146 x SC14 for monopodia/plant, bolls/plant and *kapas* yield. The estimates of overall *gca* status of parents indicated that, the lines RAH 318, RAH 243 and RAH 124 were good general combiner as evident from its high (H) overall *gca* status. Among testers, testers SC 14, SC 7, SC 68 and RGR 24 were identified as good combiners with high (H) overall *gca* status. It also becomes important to determine whether a cross is a good specific combination across all the traits or not for the same reason, it is evident that 23 out of 48 hybrids had high (H) overall *sca* status, while remaining 25 crosses had low (L) overall *sca* status across all the traits studied.

Key words: General combining ability, *Gossypium hirsutum*, Line x tester analysis, specific combining ability,

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Genetic variance and combining ability estimates in upland cotton for yield and quality characters (*Gossypium hirsutum* L)

O. P. TUTEJA AND D. MONGA

Central Institute for Cotton Research, Regional Station, Sirsa 125 055

E-mail : optuteja2001@yahoo.co.in

Abstract : Cotton is an often cross pollinated crop and possesses a considerable amount of heterosis. 1st conventional hybrid was developed in India but in other countries hybrid seed production by conventional method could not be made possible being labour intensive. Several alternate methods for emasculation are available; however GMS and CMS systems are quite effective, because in rest of the methods there is always a chance of pistil damage and anthers are not completely eliminated. In case of GMS and CMS systems only GMS system may be more effective, because in CMS system there is a deleterious effect of *G. harknessii* cytoplasm, which suppresses the yield. But the success in development of GMS based hybrid largely depends on availability of stable GMS line and the good combiner male parent. The present study was to estimate the *gca* of the parents and *sca* of the hybrids for the development of high yielding and better quality cultivars. Combining ability was studied in a line x tester design involving five GMS lines as female parent and ten germplasm lines as male parent for yield and quality traits. In a line x tester analysis, analysis of variance for combining ability indicated predominance of non-additive variance for all the characters except 2.5 per cent span length. The studies on *gca* of parents revealed that the male parents OK 2885, CSH 2912, CSH 3129, CSH 2907 and female parents GMS 26, GMS 27, GMS 17 for seed cotton yield were found to be good general combiners. Similarly GMS 17 for ginning percentage and CNH 911 for 2.5% span length and 004 NAH, OK 2885, CNH 911, GMS 27 for fiber strength (g/tex) showed significant positive *gca* effects. Among fifty cross combinations, *sca* was significant for fifteen parents in terms of seed cotton yield and GMS 20 x CNH 911, GMS 27 x H-103, GMS 17 x 004 NAH hybrids had the highest *sca*. The crosses showing significant positive *sca* effects were having one of the parents with good general coming ability.

Key words: Combining ability, cotton, genetic male sterility, *Gossypium hirsutum*

Biotech seed genes textural texture taxonomy [BSGT] and biotech research steps, aspect and direction [BRSAD] and methods of extension

PRAVINCHANDRA M. RAKHOLIA
Saga Seeds Company Ahmedbad - 382 210
Email : pravin_rakholia@yahoo.co.in

Performance of introgressed genotypes of *Gossypium arboreum* for fibre quality parameters

V.N.CHINCHANE AND A.H.MADKEMOHEKAR
Cotton Research Station. Marathwada Krishi Vidyapeeth Parbhani 431401

Abstract : Cotton is an inevitable source of natural fibre in the textile industry throughout the world . India is the only country where all the four cultivated species are grown. The two diploid species *G.arboreum* and *G. herbaceum* are characterized by inherent biotic stresses tolerance as compared to their tetraploid counterparts *G.hirsutum* and *G.barbadense*, but tetraploids have high yield potential and superior fibre properties .*G.arboreum* genotypes are grown by marginal farmers . *G.arboreum* varieties fetches low returns to farmers due to its inferior fibre properties and low yield potential especially in these times of open end high speed spinning machines. Therefore efforts were done to introgress desirable traits from a tetraploid genotype of *G.hirsutum* to *G.arboreum*. It was seen that improved genotypes with bigger boll size and yield potential were isolated

Among the fourteen genotypes of *G.arboreum* developed through introgression breeding , the genotype PAIG 326 and PAIG 368 were the best introgressed genotypes for seed cotton yield as well as fibre properties like fibre length, fibre strength, uniformity ratio and ginning outturn.

Key words : Diploid, genotypes, Introgressed, quality parameters, tetraploid

Studies on drip irrigation, fertigation and spacing in *Bt* cotton

R.P.S. CHAUHAN AND B.S. YADAV
Swami Keshwanand Rajasthan Agricultural University, Agricultural Research Station, Sriganaganagar – 335 001
email: drbsyadav@gmail.com

Abstract : Three experiments were conducted to find out suitable crop geometry under drip irrigation, optimum irrigation schedule and optimum fertigation schedule for *Bt* cotton at Agricultural Research Station, Sriganaganagar during kharif 2009 to 2011. Paired row spacing of 60 x 120 cm and single row spacing of 90, 108 and 120 cm gave statistically *at par* seed cotton yield. When the row spacing of cotton was further increased to 135 cm, the yield of cotton was significantly reduced as compared to other closer row spacings tested in the study. The minimum drip cost was observed in paired row of 120 x 60 cm. Thus, 120 x 60 cm paired row spacing was found optimum for *Bt* cotton. The maximum seed cotton yield was recorded when drip irrigation was scheduled at 1.2 ETc, however, it was *at par* with seed cotton yield obtained at 1.0 ETc. Seed cotton yield at 0.8 and 0.6 ETc was significantly less than that of 1.0 per cent 1.2 ETc treatments. Thus, drip irrigation to *Bt*

cotton at 1.0 ETc was found optimum. This treatment gave 31.0 per cent higher seed cotton yield and saved 32.9 per cent of irrigation water over conventional flood irrigation. The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 4.21 kg/ha mm was recorded at 1.0 ETc followed by 3.98 kg/ha mm at 0.8 ETc irrigation treatment with drip system. The maximum seed cotton yield was recorded at 120 per cent RD of fertilizers, however, it was at par with 100 per cent and 80 per cent RD of fertilizer with 2 per cent KNO₃ spray. Thus, 80 per cent RD of NPK+ foliar spray of 2 per cent KNO₃ at 90 and 105 DAS was found optimum for *Bt* cotton. This treatment gave 15.6 per cent higher seed cotton yield over conventional method of fertilizer application and irrigation. The maximum water expense efficiency of 3.95 kg/ha mm was recorded with 120 per cent of RD, followed by 3.87 kg/ha mm with 100% of RD +2% KNO₃ as foliar spray at 90 and 105 DAS and 3.78 kg/ha mm with 80 per cent of RD +2 per cent KNO₃ as foliar spray at 90 and 105 DAS.

Key word : *Bt* cotton, drip irrigation, fertigation, crop geometry, yield, water use efficiency

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Agronomic studies on promising *hirsutum* varieties in relation to spacing and fertilizer levels

P.L.NEHRA AND RAJNI GUMBER

Swami Keshwanand Rajasthan Agricultural University, Agricultural Research Station, Sri ganganagar - 335 001

E-mail: pl.nehra@yahoo.co.in

Abstract : A field experiment was carried out during kharif season at Agricultural Research Station, Sriganganagar on sandy loam soil to see the effect of spacing and fertilizer levels on promising *hirsutum* varieties for improvement in productivity of cotton. Significantly higher seed cotton yield was recorded under LH 2107 (2632 kg/ha) over F 2164 (2192 kg/ha) but it was statistically at par with LH 2108 (2521 kg/ha). The increase in yield under this variety might be due to significant increase in bolls/plant and boll weight over F 2164. As regards spacing both were statistically at par. Increasing dose of fertilizer from 100 % RDF to 125 % RDF could not show its impact on seed cotton yield and application of 100 % RDF (80: 40: 20) seems to be optimum dose of fertilizer. Fibre length, uniformity ratio, micronaire value and strength g/tex, have been recorded but the parameters were not influenced by different treatments.

Key words : *Hirsutum* varieties, seed cotton yield, spacing, productivity

Screening of *Gossypium hirsutum* genotypes for drought tolerance by studying genotypic variability for growth and biophysical parameters

B.C. PATIL, A.G., BABU, K.N. PAWAR AND A.B., SHAHEEN

University of Agricultural Sciences, Agricultural Research Station, Dharwad - 580 007

E-mail : bc_patil@yahoo.com

Abstract : Drought stress is a complex phenomenon affecting the physiology of cotton plant in turn reduces crop growth and yield. An experiment was conducted in two years 2010-2011 and 2011-2012 using twenty *Gossypium hirsutum* genotypes grown in RBD design at Agricultural Research Station, University of Agricultural Sciences, Dharwad to evaluate for genotypic variability for growth, biophysical parameters, yield parameters under irrigated as well as in water deficit rainfed condition. The two years pooled analysis showed that, the genotypes ARBH 2004, ARBH 813, Sahana recorded highest bolls/plant while GSHV 96/612 recorded the least. Maximum boll weight was recorded by AKH-0205 followed by RCR-102 and the least by GSHV-96/612 in irrigated condition. In both irrigated as well as rainfed condition BS-279 and ARBH 2004 recorded the highest water potential while GSHV-96/612 and HBB 101 showed the least. The genotypes BS 279 and ARBH-2004 recorded highest photosynthesis rate and chlorophyll content, while CDP 168, CPD 231 recorded least. The genotypes BS 279, ARBH 2004 and HBB 101 showed higher LAI while GJHV 358 and NH-635 recorded by least. The Biplot of seed cotton yield under irrigated condition *v/s* DSI showed that genotypes BS-279, BS-30 and RCR-102 recorded more cotton yield irrigated condition but high drought susceptibility index. Overall the BS 279, ARBH 813, ARBH 2004 and Sahana proved better as they recorded highest seed cotton yield both in irrigated and also in rainfed condition and least to moderate drought susceptibility indices. This increased yield may be due to higher photosynthesis rate, Water use efficiency and other biophysical and genetic factors. These genotypes can be used as desirable genotypes for drought situations.

Key words: Biplot, Cotton, growth, photosynthesis rate, yield, water deficit, water potential.

Evaluation of integrated weed management practices in rainfed cotton (*Gossypium hirsutum* L) at farmers fields

MOOLCHAND C.V. SINGH, SAIRAM AND S. PRABHUKUMAR

National Bureau of Plant Genetic Resources, New Delhi – 110 012

E-mail : mcsingh@nbpgr.ernet.in

Abstract : An on farm trial was conducted during the *kharif* of 2006 and 2007 at farmers fields in Belgaum district of Karnataka to find out suitable integrated method of weed control for rainfed cotton. Pre and post emergence application of herbicides along with 2 hand-weedings and 2 hoeings at 20 and 40 days after sowing (DAS) gave effective control of weeds. The highest weed control efficiency was recorded by pre emergence application of pendimethalin followed by post emergence application of glyphosate with 2 hand weedings and 2 hoeings at 20 and 40 days. Maximum seed cotton yield (8.54 q/ha) was recorded with 3 hand weedings and 3 hoeings followed by pre- and post emergence application of pendimethalin and glyphosate with 2 hand weedings and 2 hoeings (8.44 q/ha). Maximum benefit:cost ratio (1.34) was recorded with 3 hand weedings and 3 hoeings treatments. Among integrated weed-management treatments, the post emergence application of glyphosate with 2 hand weedings and 2 hoeings recorded more benefit:cost ratio compared to other integrated weed-management treatments.

Key words : Cotton, economics, herbicides, integrated weed management, weed control efficiency

Studies on photosynthetic efficiency in *Gossypium hirsutum* cotton hybrids

R. W. BHARUD, M. R. THOKALE, A. S. MOKATE AND A. R. AHER

All India Co-ordinated Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri- 413 722

E-mail : cotton_mpkv@rediffmail.com

Abstract : A field experiment was carried out to study the photosynthetic efficiency in cotton hybrids (*Gossypium hirsutum* L.) at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in randomized block design (RBD) with three replications and ten hybrids. The physiological basis for differences in seed cotton yield amongst the high and low yielding hybrids was mainly due to the variation in magnitude of the morphological and physiological characters along with yield contributing characters. Higher magnitude of mean values of plant height, leaf area, dry matter production and its partitioning, photosynthetic rate and yield contributing characters are important physiological traits in ideotype for achieving higher productivity in cotton. The cotton hybrids NHH 44, Phule 492, RHH 516, RHH 707 and Ankur 651 were observed to be photosynthetically more efficient thereby resulting in to the higher yield. These hybrids were also found to be superior in respect of photosynthetic rate, stomatal conductance, chlorophyll content, dry matter production and its partitioning.

Key words: Cotton, physiology, photosynthetic efficiency, yield, *Gossypium hirsutum*

Enhancing the productivity of *Bt* cotton (*Gossypium hirsutum* L) through transplanting technique under irrigated conditons

SATYANARAYANA RAO, SHASHIDHAR SAJJAN, B.K. DESAI , S. A. BIRADAR AND SHANTAPPA DUTTARAGANVI

University of Agricultural Sciences, Main Agricultural Research Station, Raichur – 584 102

E-mail : satyanarayanc_kulakarni@rediffmail.com

Abstract : A field experiment was conducted at Main Agricultural Research Station Farm, Raichur, on medium black soil during 2009-2010 and 2010-2011 to evaluate the performance of transplanted *Bt* cotton [*Gossypium hirsutum* L.] under different planting geometry in comparison with normal sown cotton under irrigation. The pooled results indicated that among different transplanting geometry treatments, the highest seed cotton yield of 3164 kg/ha was obtained with 90 x 45 cm spacing and closely followed by 90 x 60 cm spacing (3046 kg/ha). Significantly lowest seed cotton yield was recorded with recommended dibbled practice at 90 x 60 cm spacing (2553 kg/ha). The row spacing of transplanted cotton at 90 x 45 cm resulted in significantly higher net returns (Rs.82, 947/ha) over other row spacings of transplanted and dibbled cotton except the cotton transplanted at 90 x 60 cm spacing (Rs.82, 282/ha). Highest benefit cost ratio was obtained with transplanted cotton of 90 x 60 cm spacing (3.35).

Variations in soil properties and nutrient status as influenced by organic *vis-a-vis* conventional method of cotton cultivation and climatic factors in black cotton soils of Krishna zone

A.LALITA KUMARI AND K.VEERAI AH

Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Guntur

E mail: lalithakumari.atmakuri@gmail.com

Abstract : Cotton is one of the important commercial crops grown in Krishna zone under intensive cultivation. The soil nutrient status is one of the key factors for higher yields. Hence a study was taken up to study the variation due to the effect of organic and conventional method of cultivation on soil properties and nutrient status at monthly intervals in black cotton soils of Regional Agricultural Research Station, Lam during *kharif*, 2011-12. The initial soil sample analysis indicated that the application of fertilizers in conventional method showed reduction in soil pH whereas under organic cultivation, the soil pH values were high. In case of soil EC, the reverse was true. Organic plots showed higher organic carbon than inorganic plots. The available potassium content was high in the inorganic plots compared to organic plots. The trend was same at 0-15 and 15-30 cm depths. When the initial soil samples were compared with the post harvest soils of previous crop, they indicated that there was an increase in the soil pH from March to July during summer in both organic and inorganic plots. There was a decrease in soil EC from March to July in both the treatments which may be due to heavy rainfall received by the end of July month.. There was a decline in the soil organic carbon during summer in both the treatments. In case of soil available K_2O , there was a decline in the organic plots and there was an increase in fertilizer plots during summer. In case of available N there was an increase in both the treatments. At different stages, soil available N, K_2O and EC values were high in conventional plots where as OC content and soil pH values were higher in organic method. At 90 DAS, there was a further decline in OC content, available N, K_2O and EC values while only pH values recorded increase. When the seasonal variations in soil properties were studied and related to climatic conditions, there was an initial increase in soil pH up to July and decreased in September followed by a continuous increase up to 120 DAS. Heavy rain fall during July and September could reduce the soil pH and EC. Sol nutrient contents like OC, available N, P_2O_5 and K_2O also showed a continuous decline with progress of the season. The study indicated that though the soils under organic farming are rich in organic carbon and Available P contents, the low soil available N in this method was resulting in lower yields

Key words : Conventional method, potassium, organic, inorganic, variation

Improving the profitability of rainfed *Bt* hybrid cotton based intercropping systems with changing climate

AMBATI RAVINDER RAJU, SONIYA K. THAKARE AND G. MAJUMDAR

Central Institute for Cotton Research, Nagpur - 440 010

E-mail : bumaraju@gmail.com

Abstract : A field experiment was conducted at Central Institute for Cotton Research, Nagpur for four years during 2008-2012 with five *Bt* hybrid cotton based intercropping systems in *Vertisols*. Two rows of intercrops were accommodated at 45 cm apart by skipping one row of cotton (paired row). Sole *Bt* hybrid cotton (90 x 45 cm) with 2.5 plants/ m² was significantly superior only in a year of 30 per cent less than normal in assured rainfall zone over paired row *Bt* hybrid cotton (90 x 135 x 45 cm) with 1.65 plants/ m², which was profitable only in ¼ years with change in normal rainfall with lowest yields when 30 per cent excess rains were received in few rainy days. *Bt* hybrid cotton + pigeonpea check row stripcropping (8:2) significantly reduced seed cotton yields followed by intercropped castor, however, they were very efficient in utilizing stored soil moisture below 20-40 cm soil depth when rainfall was received from post September rains. Intercropping with soybean, field bean and marigold did not reduce seed cotton yields in excess rains. The most profitable intercropping systems were *Bt* hybrid cotton with ‘African tall’ marigold, Fieldbean, followed by soybean variety ‘JS. 93-05’ with 11.3, 8.7 and 3.5 thousand/ha respectively over sole *Bt* hybrid cotton in assured rainfall areas. Herbicides Pendimethalin 1.0 kg a.i./ha PPI in 2008 and 2010 years; Oxyflurofen 0.10 kg a.i./ha pre emergence (except fieldbean) in 2009, Pyriothiac Na 0.070 kg a.i./ha early post em. over the top and applications in 2011 were followed as herbicides rotation. *Tridax procumbens*, *Cyperus rotundus* were found to be tolerant to Pyriothiac Na herbicide. A multi purpose tool bar was developed which can plant, place fertilizer and conserves soil moisture along with interculture operations for weed control.

Key words : Intercropping, post emergence, preemergence, profitability

Stale seedbed technique - A novel approach for managing weeds in irrigated cotton based intercropping system

P. NALAYINI AND M. SUVEETHA

Central Institute for Cotton Research, Regional station, Coimbatore – 641 003

E-mail : nalayiniganesh@gmail.com

Abstract : Cotton is sensitive to weed competition due to its slow initial growth and wider spacing. In recent years, *Bt* cotton which is high yielding and responsive to higher levels of inputs like fertilizers, irrigation etc., is grown under intensive cropping system, all these factors promote luxurious growth of weeds which grow more quickly than cotton and compete strongly for soil moisture, nutrients, light and space. Hybrid cotton is normally grown in ridges and furrow methods and sowing is done only on one side of the ridge and the other side is kept vacant. A new method of introducing short duration intercrops which would complete the life cycle within 45-60 DAS was standardized and the short duration intercrop, coriander has been introduced on the other side of the ridge without sacrificing the main crop population of cotton grown under normal recommended spacing. Weed control under intercropping system is very difficult and the removal of weeds by manual method is tedious as it is very difficult to differentiate the young weed

seedlings and germinating intercrops. Hence, a novel approach of exhausting weed seed bank before the crop emergence by stale seed bed approach was standardized for *Bt* cotton based intercropping system during 2010-2011 and 2011-2012 cropping season at Regional station of Central Institute for Cotton Research, Coimbatore. Among the treatments, Stale Seed Bed Technique (SSBT) using a mixture of pendimethalin 1.0 kg + glyphosate 1.0 kg one week after irrigation (one week before sowing) recorded the highest weed control efficiency of 85.2% on 35- 45 DAS. Adopting this new method of planting, *Bt* cotton RCH 20 *Bt* with coriander as intercrop under SSBT of managing weeds with pendimethalin 1.0 kg + glyphosate 1.0 kg recorded the highest seed cotton yield (3261 kg/ha), seed cotton equivalent yield (4686 kg/ha ₹ 1,80921/ha).

Key words : Net return, seed cotton equivalent yield, seed cotton yield, stale seed bed technique, weed control efficiency

Symposium papers “Global Cotton Production Technologies *vis-a-vis* Climate Change” 305-309

Effect of weather variables on productivity of American cotton (*Gossypium hirsutum* L) under field conditions

DEVRAJ, PARVENDER SHEORAN, V. S. MOR, R. S. ANTIL AND S. S. SIWACH
Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004
E-mail: devraj_chauhan @rediffmail.com

Abstract: Climatic conditions in the coming years are expected to be different from that of today. Boll maturation period, which determines the productivity, is a critical stage in the life cycle of cotton. During this period the boll grows, fibre develops and seed matures. Great attention is being paid to the factors affecting this period. In the field, weather conditions are different and complicated. Thus only the field studies can provide realistic assessment of what will happen to the crop growing under field conditions due to change in weather. Keeping this in mind, the seed cotton yield of a long term permanent experiment which were concluded earlier were examined to find out the relationship of weather varieties of boll maturation period to seed cotton yield. From the correlation study it was found that night temperature and vapor pressure of morning during the boll maturation period significantly influenced the seed cotton yield and higher seed cotton yields were obtained when night temperature was lower than normal value of location. The night temperature and vapor pressure of morning were identified as most critical weather variable influencing seed cotton yield and some management practices such as sowing date; irrigation etc. must be taken care of to mitigate the adverse effect of weather variables to improve the production and productivity of cotton on sustainable basis. The other weather variables not much influenced the seed cotton yield.

Key words: American cotton, boll maturation, weather variables, seed cotton yield

Synergistic effect of cry toxins on tobacco caterpillar, *Spodoptera litura* (Fabricius)

V. PALLAVI, T. RAMAN GOUD AND T.V.K. SINGH

Department of Entomology , N.G. Ranga Agricultural university, College of Agriculture, Hyderabad - 500 034

Abstract : A laboratory study was conducted during 2005-2006 to investigate the individual and cumulative toxic effects of purified Cry toxins on tobacco caterpillar *Spodoptera litura* (Fab.) larvae by leaf surface coating method. The effect of individual toxins viz., Cry1 F, Cry1 Ea and Cry1 C was less when compared to their combined effect with Cry1 Ac on *S.litura* larvae. On the other hand there was low mortality recorded when a combination of Cry 1 Da+ Cry 1 Ac was fed to *S.litura* than single Cry1 Da proving its antagonistic effect.

Keywords : *Spodoptera litura*, Cry toxins, Synergistic effect.

Field efficacy of new insecticide combination Ampligo 150 ZC (chlorantraniliprole 9.3% +Lambda cyhalothrin 4.6% ZC) against bollworm complex in cotton

D. R. BAJYA, H. S. BAHETI, A. S. TOMAR AND S. K. RAZA

Division of Bioscience, Institute of Pesticides Formulation Technology, Gurgaon - 122 016

Email: deva.bajya@gmail.com

Abstract : Field studies were carried out to evaluate the bioefficacy of new insecticide combination (chlorantraniliprole 9.3% + Lambda cyhalothrin 4.6% ZC) at four doses viz 30, 37.5, 45 and 60 g a.i./ha. against bollworm complex in cotton crop. The field experiment was conducted during May 2011- Nov 2011 at research farm of Institute of Pesticide Formulation Technology, Gurgaon. Chlorantraniliprole 9.3% +Lambda cyhalothrin 4.6% ZC @ 37.5, 45 and 60 g a.i./ha. recorded significant reduction in per cent damage on squares, bolls and loculi as compare to untreated control and standard treatments (quinalphos 25 EC @ 500g a.i./ha, Lambda cyhalothrin 4.9% CS @25 g a.i./ha, deltamethrin 2.8 EC @ 12.5 g a.i./ha and chlorantraniliprole 18.5% SC). There was no significant difference in population of natural enemies (chrysoperla and spider) among the combined insecticide (chlorantraniliprole 9.3% +Lambda cyhalothrin 4.6% ZC) standard insecticides and untreated control. Combination insecticides (chorantraniliprole 9.3% + Lambda cyhalothrin 4.6% ZC) 60 g a.i./ha recorded the lowest square (14.33%) and boll (15.97%) damage at 14 DAS. Similarly, the lowest (16.63%) locule damage at harvest was recorded in combination insecticide (Chorantraniliprole 9.3% + Lambda cyhalothrin 4.6% ZC) 60 g a.i./ha. It was however, at par with its lower doses @ 37.5 g a.i. and 45g a.i./ha.

Key words : Bollworms, chlorantraniliprole (9.3%) + Lambda cyhalothrin (4.6%), Cotton, field efficacy

Toxicity studies of insecticides against leafhopper, *Amrasca biguttula biguttula*(Ishida) on *Bt* cotton under laboratory conditions

G.N.SHREEVANI, A.G.SREENIVAS, M.BHEEMANNA, A.C.HOSAMANI AND S.G.HANCHINAL
Department of Agricultural Entomology, University of Agricultural Sciences, Raichur-584 102
Email: shreevanign@gmail.com

Abstract : Studies on toxicity of insecticides *viz.*, thiamethoxam (25 per cent WDG), acetamiprid (20 per cent SP), pyriproxyfen (10 per cent EC), acephate (75 per cent SP), clothianidin (50 % WDG), oxydemeton methyl (25 % EC), dimethoate (30 % EC), lambda cyhalothrin (5 % EC) and imidacloprid 17.8 % SL against the third instar nymphs of *Amrasca biguttula biguttula* (Ishida) on *Bt* cotton were tested under laboratory conditions in Department of Agricultural Entomology, College of Agriculture, Raichur. The per cent mortality of leafhopper nymphs was more in thiamethoxam (50.67 %) followed by imidacloprid 17.8 % SL (46.67 %) and clothianidin (37.33 %). These three chemicals were *on par* with each other but differed significantly with other insecticides. Further, these superior molecules were bioassayed using Potter’s tower to find out LC50 values. Accordingly, the insecticides *viz.*, thiamethoxam (25 % WDG), imidacloprid (17.8 % SL) and clothianidin (50 % WDG) had 0.001, 0.007 and 0.041 LC50 values.

Key words : *Amrasca* , *Biguttula biguttula*, bioassay, *Bt* cotton, toxicity

Pollinators diversity and their role in pollination in cotton

SUNITA YADAV AND H. D. KAUSHIK
Project Coordinating Unit, AICRP on Honey Bees and Pollinators, CCS Haryana Agricultural University, Hisar - 125 004
E-mail : sunitayadav10@rediffmail.com

Evaluation of popular *Bt* and non *Bt* transgenic cotton hybrids against major pests

A.V. KOLHE, U.P. BARKHADE, P.N. ZADE AND B.R. PATIL
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104
E-mail : avkolhe@gmail.com

Abstract : Popular *Bt* transgenic hybrids (RCH 2 BGI , Bunny BGI and KDCH 9632 BG I) along with their non *Bt* counterpart, conventional hybrid (PKV Hy-2) and variety (PKV Rajat), as a local check were evaluated against major pests under unprotected and rainfed condition for 3 consecutive years (2008-2009 to 2010-2011) at All India Coordinated Cotton Improvement Project, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola M.S., Akola. The results revealed that there were no significant differences amongst *Bt* transgenic hybrids and its non *Bt* counterpart as regards major sucking pests and predators (Leadly bird beetle adult & grubs, chrysopa larvae, spiders and syrphid fly larvae). Lowest leaf hoppers population was recorded in PKV Hy-2 and PKV- Rajat as compared to rest of the

hybrids tested indicating tolerant reaction to leaf hoppers. Highest population of leaf hoppers and lowest count of thrips and white flies was recorded in RCH-2 *Bt* and non *Bt*. Loculi damage due to bollworm complex at harvest in *Bt* cotton hybrids was significantly lower (1.46 to 2.32 %) than non *Bt* hybrids tested (5.68 to 12.66 %).

As regards yield parameters, plant stand was uniform. Sympodial branches and height of plants was statistically equal in all the hybrids tested, except, RCH 2 *Bt* and non *Bt*. Highest bolls/plant was noticed in PKV Hy-2 followed by PKV Rajat , Bunny *Bt* and non *Bt*. Highest seed cotton yield was obtained from PKV Hy-2 and being equal to Bunny *Bt* and its non *Bt*. Under unprotected condition, there is increase of 33.85, 11.47 and 7.04 per cent seed cotton yield in *Bt* transgenic hybrids *viz.*, RCH 2, KDCH 9632 and Bunny over their non *Bt* counterpart, respectively

Key words : Bollworms, *Bt* Cotton, Sucking pests

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Insecticidal toxin genes from bacteria *Paenibacillus* sp potent against insect pests potential under climate change

NANDINI GOKTE-NARKHEDKAR, KANCHAN BHANARE, PRACHI NAWKARKAR, S.KRANTHI AND K.R.KRANTHI

Division of Crop Protection, Central Institute for Cotton Research, Nagpur - 444 104

E-mail : nnarkhedkar@rediffmail.com

With the threat of global warming looming large, altered climate conditions have the potential to intensify pest and disease problems in agricultural crops. It is speculated that under climate change hitherto minor pests and diseases are likely to become dominant in pest spectrum while present day dominant pests may be relegated to minor status. The possible enhanced pest and disease infestations may bring about need for greater use of chemical pesticides to control them necessitating further development and refinement of biological control based management techniques. With the advent of *Bt* cotton developed for protection against cotton bollworms, sucking insect pests now account for major chunk of insecticides used in cotton. Entomopathogenic nematodes (EPN) and their bacterial symbiont have been recognized as a potent management tool against insects pests of cotton. At central Institute for Cotton Research, Nagpur an heat tolerant isolate of EPN *Heterorhabditis indica* has been selected and developed which was capable of infecting insect larvae at temperatures as high as 40°C. A bacterial isolate associated with this EPN isolate was found to be effective against sucking pests as mealybug and white flies. Therefore, this bacteria was characterized based on biochemical and molecular parameters and work was initiated to clone insecticidal toxin genes from this bacteria as it has potential for use against sucking pests which are fast emerging as major insect pests of crops under climate change.

Key words : Catalase, gelatinase, heterorhabditis, insecticidal toxin

Trends and instability in area, production and yield of cotton in northern India

SUKHPAL SINGH, MANJEET KAUR AND H. S. KINGRA

Department of Economics and Sociology, Punjab Agricultural University, Ludhiana-141 004

E-mail : sukhpalpau@yahoo.com

Structural changes in cost of cultivation of cotton in Gujarat after the introduction of *Bt* cotton

A. R. REDDY, SACHITA M YELEKAR, ISABELLA AGARWAL

Central Institute for Cotton Research, Nagpur - 444 104

Email: ar.reddy@gmail.com

Abstract : This study examines the changes in costs and returns in cotton cultivation during pre *Bt* period and post *Bt* period in Gujarat. The cost of cultivation data obtained from Commission for Agricultural Costs and Prices was analyzed using simple tabular analysis. The analysis revealed that total cost of cultivation increased by 134 per cent during post *Bt* period when compared with pre *Bt* period. Major contribution to this increase was made by the increase in human labour and rental value of owned land. Cost of all items showed an increase during post *Bt* period. Quantities of human labour and fertilizers used in cotton cultivation showed an increase while quantities of bullock labour, seed, insecticides and manures recorded a decrease. Seed cotton yield/ha recorded a threefold increase making the cotton cultivation more profitable during post *Bt* period.

Socio economic assessment of cotton growers’ awareness about climatic change and adaptation strategies – An empirical analysis

S. USHA RANI, M. V. VENUGOPALAN, A.H. PRAKASH AND S.M. WASNIK

Central Institute for Cotton Research Regional Station, Coimbatore - 641 003

E-mail : ushajoshua@rediffmail.com

Abstract : One among the many challenges faced by cotton, the most important commercial crop of India is aftermath of climate change. Cotton production is both a contributor and victim to climate change. As a contributor, it contributes between 0.3 and 1.0 per cent to total global gas emissions (ITC, 2011) As a victim, the consequences of climate change *viz.*, higher temperature and higher climate variability may severely affect the cotton production in near future. Anticipating the vulnerability of the crop to climate change, the researchers and policy makers propose many adaptation strategies to cope up with the problem. But the reach of this knowledge to the end users at bottom level is always not measured. Simultaneously the perspectives of cotton growers with regard to climate change and the coping strategies adopted by them are not properly documented for researchable proposals. Viewing this, a survey with a well structured interview schedules was conducted among 200 randomly selected cotton growers in Tamil Nadu for assessing their awareness about climate change and adaptation strategies. The average age of the cotton growers interviewed was 49 years and more than 50 per cent of them had high school level education. The study revealed that more than 60 per cent of them felt that the onset of monsoon was delayed and distribution of rain was more erratic, which delayed the sowing of monsoon crop. More than three fourth of them felt that the frequency and duration of dry spells were increased and *vice versa*. More than of half of them perceived that there were changes in the duration and severity of winter and summer seasons. Around sixty percent of them perceived that there were crop failures due to climatic change. Deposit of salts, formation of crusts and water logging were the major physical signature of climate change on soil as perceived by the respondents. Coping strategies *viz.*, changing the crops, varieties, season, date of sowing and quantity of inputs were adopted by majority of the respondents to mitigate the impact of climate change. Thus, documenting cotton growers’ experiences and perspectives about climate change will be useful to recommend appropriate policy initiatives to sustain cotton production in near future in midst of disasters.

Drudgery reduction of women using cot bag in cotton picking

SUDESH GANDHI, M. DILBAGHI, BIMLA AND NIRMAL YADAV

Department of Family Resource Management, CCS Haryana Agricultural University, Hisar - 125 004

E-mail: sggandhi3@gmail.com, hod_frm@hau.ernet.in

Abstract : Cotton picking, one of the agricultural activities, is mainly done by woman in Haryana. She spends nearly 6 hr/day picking 24.5 kg of cotton in 4-5 cycles of cotton picking activity. She uses her head cloth tied in the form of a bag to collect cotton balls which leads to various musculo-skeletal disorders. To facilitate cotton picking activity, a cot bag had been designed and tested on 30 women respondents for 60 min of cotton picking activity studying time and activity profile, physiological stress as well as biomechanical stress. Mean age of woman was 32.7 years having height and weight as 152.2 cm and 49.9 kg, respectively. Cot bag resulted in 20.3 per cent more cotton picked. Hence, production/min was more with cot bag (80 g) than existing bag (66.5 g). Cot bag reduced the physiological stress as heart rate recorded was lesser by 3.1 per cent than the existing bag, consequently, resulting in decrease in energy expenditure (6.5 %) and TCCW (14.8 %) and PCW (15.1%). Cot bag showed significant reduction in musculo-skeletal disorder, specifically in upper back and shoulder joint (47.9% each), thighs (47.9%) and mid back (44.4%). Hence, cot bag has been found as a user friendly bag as it reduces the drudgery of women in picking cotton and increases her work efficiency.

Key words : Cot bag, cotton picking, grip fatigue, musculo skeletal disorders

Evaluation of energy consumption and interventions to improve energy efficiency of cotton bale presses in ginneries

V. G. ARUDE, S. K. SHUKLA, JYOTI M. NATH

Central Institute for Research on Cotton Technology, Mumbai - 400 019

Email: arudev@gmail.com

Abstract : Bale packaging is the final step in processing cotton at cotton ginneries. The fully automatic down and up packing presses that are commonly used in modernized ginneries were evaluated for power requirement, energy consumption, and capacity utilization and to suggest the interventions to improve energy efficiency. The energy consumption for different unit operation such as pressing, tramping, tying, cooling etc. were measured. The actual pressing capacity was found to be 14 bales/hr. The total power requirement was found to be 78 and 71 hp for down packing and up packing presses respectively. The energy consumption for hydraulic ram for pressing operation was found to be 1.10 and 0.62 units /bale, for tramping operation 0.450 and 0.255 units/bale for down packing and up packing presses respectively. The total energy consumption per bale was found to be 1.750 and 1.025 units/bale for down and up packing presses respectively. The power requirement and energy consumption was found to be comparatively less for up packing than down packing press. The energy consumption was found to be influenced by time required and mode of operation of the electric motors employed for each unit operations. The idle and tying time was found to vary between 23 to 30 per cent of the total time/bale. The operational interventions were for improving the energy efficiency and would be useful to cotton ginners.

Key words : Efficiency, energy consumption, ginneries, interventions

Utilization and production of cotton linters: A byproduct of cotton processing industry

JYOTI M. NATH, P. G. PATIL AND S. K. SHUKLA

Central Institute for Research on Cotton Technology, Nagpur - 440 023

E-mail : jyotimnath@gmail.com

Abstract : Cotton has been basically grown for its fibres now find application for every byproduct the crop yields. Linter is the fuzz on cotton seeds, the short fibres still attached to the seed after the long fibre has been combed out in ginning process. It comprises 8 per cent of the cotton seed byproduct and would go waste if not recovered. More than 95 per cent of the ginned seeds are directly crushed for oil resulting in loss of precious by-products like linters, seed hulls etc. Linters are produced from cotton seeds expelling industries, and from solvent or oil extractions plant using gin stands (Delinters), similar to those in saw gins. Delinting is the process of removal of short fibre from the cotton seeds before sent for oil extraction. Delinters can remove the fuzz in a single passage or in two or three passages. The first passage linters are known as 1st cut linters usually 6 to 12 mm fibre length and the second passage linters are known as 2nd cut linters, usually having fibre length less than 5 to 6 mms. Sometimes the seeds are subjected to third passage and are known as 3rd cut linters having fibre length ranging between 2 to 3 1/2 mm. First cut linters are linters of the highest grade with more resilience and length, and are used in manufacturing non-chemical products, for stuffing mattresses, padding furniture and automobile cushions, twine, and candle wicks, surgical cotton, mixing with wool for felt, and high grade paper stock. 2nd cut cotton linters short fibre is a very good raw material rich in alpha cellulose (99%).

Key words : Acetate, byproduct, cellulose, ethereal cellulose, nitrocellulose