THE ICAC RECORDER

International
Cotton
Advisory
Committee

Technical
Information Section

VOL. XVII NO. 4
DECEMBER 1999

- **Update on cotton production research**
- **Nouvelles recherches cotonnières**
- **Actualidad en la investigación de la producción algodonera**

Contents

Introduction

The cotton leaf curl disease, caused by geminviruses, has generated heavy losses in production in India and Pakistan. The disease has been known for many years in Pakistan, but losses became significant for the first time in 1992/93. As expected, the disease moved to India, carried by the whitefly, and it now affects almost the whole northern zone of India. Cotton yields in Punjab, Pakistan, and India's northern zone have decreased significantly. The most noticeable symptom of the disease is vein thickening on the lower surface of affected leaves. As vein thickening becomes pronounced, leaf curling begins, according to the severity of the disease. Ultimately, the plant shows stunted growth, fruit shedding increases, and yield is drastically reduced. The only source of resistance is genetic, but inheritance of resistant genes is not known yet. However, intervarietal resistance differences are very significant. With financial help from the Common Fund for Commodities, ICAC is sponsoring a project to develop genotypes immune to geminiviruses. More details about the leaf curl disease are given in the first article.

Dr. Walter Dirorimwe of the Cotton Research Institute, Kadoma, Zimbabwe, has contributed the second article about the development of resistance to insecticides in Zimbabwe. Other countries' experience show that resistance occurs when insecticides are used to control the whitefly. Insecticides have been used in Zimbabwe to control whitefly, but no studies have been undertaken to find out if the whitefly has already developed resistance to some chemicals. Dr. Dirorimwe reviewed the chronology of insecticide use to control the whitefly in Zimbabwe during the last two decades and strongly recommended initiating a resistance management program before it becomes a problem. This program must involve cotton growers and their associations, while researchers should foster programs to minimize the use of insecticides to control whitefly and assess resistance management strategies in place for possible modification.

The 7th Meeting of the Latin American Association for Cotton Research and Development (ALIDA) was held in Santa Cruz, Bolivia from November 23-26, 1999. The meeting was organized and hosted by the National Association of Cotton Producers. Researchers from Argentina, Brazil, Colombia, Nicaragua, Paraguay, the USA, and many private companies, in addition to representatives of FAO, CIRAD-CA of France and ICAC, attended the meeting. Papers on many aspects of production, including transgenic cottons, high volume instrument testing, ultra narrow row planting, and cotton production research programs in various countries were presented for two days. The meeting discussed the reorganization of ALIDA and agreed on a number of recommendations, which are given in the third article.

A dialog search of various databases on fiber maturity is given at the end of the publication.

The Technical Information Section of the ICAC has updated

The ICAC RECORDER (ISSN 1022-6303) is published four times a year by the Secretariat of the International Cotton Advisory Committee, 1629 K Street, NW, Suite 702, Washington DC. 20006, USA. Editor: M. Rafiq Chaudhry. Subscription rate: $145.00.

its survey on cotton production practices. The database has information from 38 countries and includes varieties planted and their characteristics, rotations, soil types, fertilizer application, insects and control measures, diseases and control methods, and harvesting and ginning of cotton. Detailed information is available on every aspect of production practices. Although the tables are in English only, the text has been translated into French and Spanish. The 109-page report is available in hard copy from the ICAC Secretariat for US$150.00 per copy, or by email or Internet for US$100.00.

The 1999 Technical Seminar on the topic of "Fiber Quality Needs of the Modern Spinning Industry and Advances in Ginning Research" was held at the 58th Plenary Meeting of the ICAC in Charleston, South Carolina, USA from October 25-29, 1999. Nine papers were presented on various aspects of fiber quality, including developments in testing equipment, non-measured fiber qualities of cotton lint, matching fiber qualities with textile products, engineered fiber selection systems, future fiber quality needs of the industry, and recent developments in cotton ginning. All the papers have been put together, and the publication is available from the Secretariat at US$75.00.

Requests for publications can be addressed to fax 202-463-6950, attention Ms. Patricia Buignet, or emailed to publications@icac.org

The ICAC Secretariat is maintaining three electronic lists for discussion and communication among researchers. Subscription to the lists is free. The addresses are

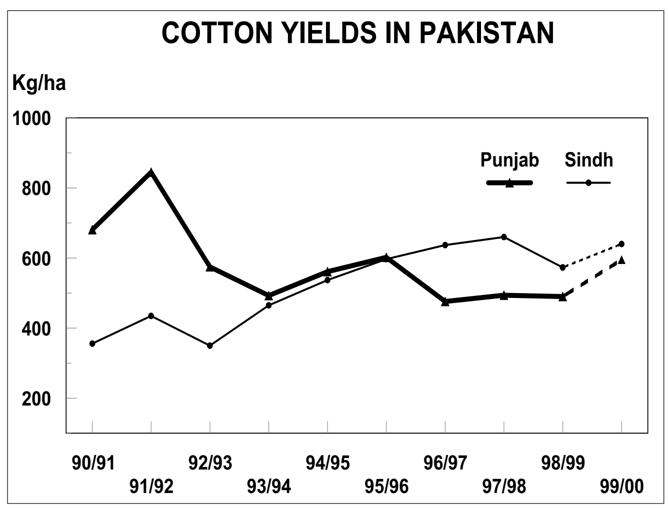
1. Latin American Association for Cotton Research and Development
   alida@liststar.icac.org
2. Cotton Biotechnology
   biotech@liststar.icac.org
3. Asian Cotton Research and Development Network
   asiacottnet@liststar.icac.org

The first list was introduced in July 1996 with the objective of having on-line discussions concerning the boll weevil. Its scope was expanded in December 1999 and the list was named after the Latin American Association for Cotton Research and Development to serve as a forum for the discussion of work on cotton research and development in Latin America. Discussion about boll weevil control will continue to be a part of the list's purpose. It is expected that most messages will be in Spanish.

The other two lists, as evident from their names, also have specific objectives. The Cotton Biotechnology list was started as a service for the Biotechnology Working Group of the Interregional Cooperative Cotton Research Network for the Mediterranean and Middle East Regions, but it is open to all researchers working on cotton biotechnology.

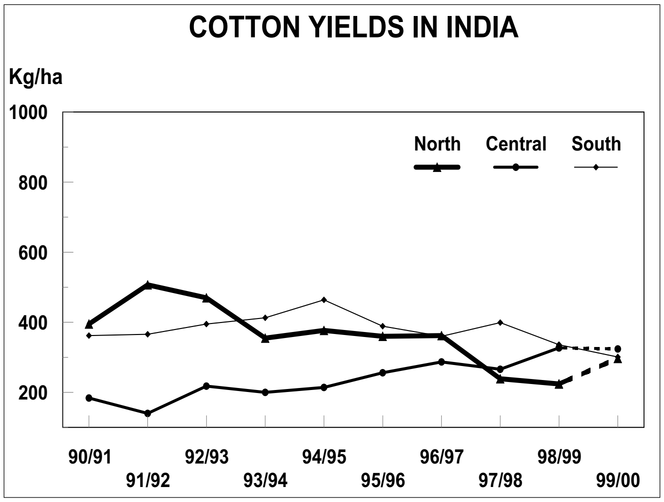
Cotton Leaf Curl Disease: Losses and Remedies

The cotton leaf curl disease affected India and Pakistan causing losses in yields so great that the impact could be felt at the international level. An ICAC analysis suggests that 25% of the increase in the 1993/94 season average of the Cotlook A Index was due to lower production in Pakistan (ICAC, 1994). Cotton yields in Pakistan increased at an annual rate of 13%, or 43 kg/ha, from 1982/83 to 1991/92. Total production in Pakistan during 1991/92 was 2.2 million tons. As a result of effective dissemination of production technology, including adoption of plant protection measures, particularly insecticides, cotton yields continuously increased during the 1980s until 1991/92. Even if the same yield had been sustained, Pakistan now would be producing over 2 million tons of cotton without any increase in area.



Punjab is a major cotton-producing province in Pakistan, accounting for 75-80% of total production in the country. About 20-25% cotton is produced in the province of Sindh and very little in the North West Frontier province. Punjab has been hard hit by the cotton leaf curl disease, which appeared and spread from the central and highest yielding area and has now moved to the bordering areas in Sindh. Cotton yields in Pakistan have been affected only in the province of Punjab. In Sindh, the attack of the disease was not severe and yield losses have been low. Cotton yields in Sindh have increased since 1991/92, indicating that in the absence of the leaf curl virus disease, Punjab could have higher yields than what were realized in 1991/92.

In India, the cotton growing area is divided into three zones, i.e. North, Central and South. In spite of the fact that large areas were devoted to commercial cotton hybrids in the Central and South zones and no hybrids were planted in the northern zone, cotton yields were the highest in the northern zone. The



reasons could be assured irrigation and the level of technology. Cotton growing conditions in the North Zone of India are similar to those in Pakistan's Punjab province. The September 1994 issue of *THE ICAC RECORDER* concluded that the leaf curl disease could move to the northern zone of India. Later, reports confirmed that the leaf curl disease had been detected first in Sri Ganganagar in Rajasthan and then in the state of Punjab, India, in 1994. Now, according to Singh et al (1999), the disease has spread to almost the entire North Zone area.

In India, the Central and South zones are currently free of the leaf curl virus. Though chances are that whitefly, the vector of the virus, may take the inoculum to other regions, it may be many years before it happens under natural movement conditions and because of the non-cotton area between the North and Central zones. However, sorghum is commonly grown as a fodder crop in this belt, which could facilitate the movement of infected whitefly to the Central Zone.

Reports from both countries indicate that the severity of the disease in India has been much lower than in Pakistan, though the inoculum and disease symptoms may be widespread. The cotton yield trend in India is the same as in Pakistan: cotton yields in the North Zone were the highest and still showed an increasing trend in 1991/92; but yields in other regions are higher now than in the North Zone.

Disease Symptoms and Losses

According to Singh et al (1999), the leaf curl disease was first recorded on *G. barbadense* cotton in Nigeria in 1912. In 1926, it was established that the disease was caused by viral infection. In 1930, it was confirmed that the leaf curl-causing virus was transmitted by the whitefly *Bemisia tabaci*. Work in India and Pakistan, since the disease appeared in both countries, has shown that whitefly, if not the only vector, is the major one in the transmission of leaf curl causing geminiviruses. The most pronounced symptoms on affected plants, observed in both countries, are secondary vein thickening and main vein thickening on the lower surface of affected leaves. As the intensity of the disease increases, vein thickening becomes more pronounced and leaf curling starts. Severely affected leaves may also show enations on their lower surface, close to the mid rib nectary. As vein thickening increases, plant growth is affected and ultimately growth is stunted. Fruit shedding, particularly bud shedding, increases, and fewer numbers of white flowers are seen in the field.

Disease symptoms on the plant can be seen from top to bottom, meaning that tender leaves are affected first. But once the leaves are affected, symptoms stay for the rest of the leaves' life. However, affected leaves do not change color until they mature, like normal leaves. Healthy and infected leaves can be seen on the same plant. In the same field, there may be severely infected plants, moderately affected plants, plants with only some leaves affected and healthy normal plants with no disease symptoms. Such a situation can be seen within the same variety but can also be created artificially through a mixture of susceptible and resistant seed varieties.

As the severity of the disease changes within a field, the effect on yield also varies. The loss in yield also depends on the stage of plant development when the crop is infected. If the crop is infected at an early stage and the intensity of the disease is severe, which is quite possible if the inoculum is widespread, losses in yields could be up to 80%, or even higher. During 1992, 1993 and 1994, the severity of the disease in Pakistan was very high in some areas, and many fields had to be discarded and plowed. First, yield was too low and, secondly, the quality of cotton was affected.

According to Singh (1999), the leaf curl disease could reduce the number of bolls from 15% to 87%, and boll weight could be reduced from zero to 39%. He also noted losses in yields of up to 58% and 69% in plants infected only in the upper canopy, or in the upper and lower canopies. According to Singh, the stage of the plant when attacked by the disease is critical.

Disease Spread

Reports from Pakistan indicate that the leaf curl disease was recorded on cotton in Multan, Pakistan, in 1967. Studies were undertaken, and seven to eight years later it was confirmed that the causal organism was transmitted by whitefly. Until then, whitefly was not a major pest on cotton. The status of whitefly among cotton pests in Pakistan changed during the 1980s when intensive breeding efforts were carried out to develop profusely hairy varieties for minimizing early spraying against cotton jassid *Amrasca devantans*, a major sucking pest and always a problem in all fields. Hairy varieties provided favorable conditions for whitefly multiplication.

Earlier reports had shown that the leaf curl virus inoculum existed in Pakistan. Multiplication of the whitefly population and its establishment as a major pest on cotton enhanced the chances of multiplication and spread of the inoculum. Researchers in Pakistan have concluded that the cultivation of specific susceptible varieties of exotic origin was responsible for the spread of the disease, and communications from India are in agreement with this observation.

The following table shows the area in Pakistan that has been affected with the leaf curl disease during different years. Though the level of infestation has varied significantly, from mere traces to over 100% of plants affected, also the affected area varied significantly from year to year. Monthly surveys undertaken from June to October have shown that field infestation peaks by the end of August or at the latest by mid-September, which is the peak boll formation time under Pakistan conditions. In 1999/00, only 17% of total area was affected and the disease intensity was from low to medium, which helped yields to recover.

In Pakistan, the disease spread from a local infection that was suppressed for many years due to various reasons, including the level of whitefly occurrence and varieties grown. It is assumed that the disease inoculum was physically carried to India through the natural movement of whitefly. Reports from India indicate that the disease first appeared close to the border with Pakistan and that it slowly spread to other areas at the rate of about 40 kilometers per year. At that time all commercially grown varieties in Pakistan were susceptible to the disease. Many varieties of Pakistan origin have been found to be cultivated in the North Zone of India on large areas in scattered patches. Therefore, cultivation of susceptible varieties of local and Pakistani origin also helped to spread the disease in India.

Area Affected By Leaf Curl Disease in Pakistan

Year	Total Area (000 ha)	Affected Area (%)
1990/91	2,662	0.03
1991/92	2,836	0.50
1992/93	2,836	48.00
1993/94	2,805	37.00
1994/95	2,653	32.00
1995/96	2,997	30.00
1996/97	3,148	53.00
1997/98	2,959	28.00
1998/99	3,026	19.00
1999/00	2,800	17.00

Area Affected by Leaf Curl Disease in the North Zone, India

Year	Affected Area (ha)
1993/94	Patches
1994/95	1,700
1995/96	500
1996/97	12,000
1997/98	218,610
1998/99	>500,000
1999/00	>500,000

Breeding for Leaf Curl Disease Resistance

Since the widescale appearance of the disease in Pakistan, it has been known that some varieties are more tolerant than others. None of the available commercial varieties was found to be completely immune to the disease. However, the differences among varieties were so significant that sometimes by looking at a field infestation level it could be easily concluded what the variety was. Some varieties were consistent and year after year were affected more than others. It was also observed that varieties of exotic origin were more affected than varieties developed from crossings/selection of 100% local origin. Such a varietal behavior indicated that there was a chance to enhance tolerance to the disease through breeding and selection of resistant genotypes.

India and Pakistan both have very strong breeding programs. Until a resistant variety became available, the Government of Pakistan decided to ban cultivation of highly susceptible varieties. Such varieties were taken off the recommended list, and seeds of tolerant varieties were vigorously multiplied. Breeding is a lengthy process, but breeders did carry tolerant material in breeding lines. Breeders further tightened their screening process and rearranged their priorities for the development of new varieties, and only resistant varieties were approved for cultivation. Consequently, there was a sudden change in varieties grown on a commercial scale. Up until 1990, Pakistan had released on average one new variety every two years. Since the appearance of the disease, the variety development process has been reoriented and the approval process has been accelerated. Since 1992, the following 15 varieties have been approved for general cultivation in Punjab, Pakistan.

Varieties Released in Punjab, Pakistan, since 1992

Release Year	Variety
1992	FH-682, BH-36, MNH-147, NIAB-86 and CIM-240
1995	SLS-1
1996	FH-634, MNH-329, RH-112, NIAB Karishma, CIM-448 and CIM-1100
1998	FVH-53, CIM-443 and CIM-446

The existing varieties that were found to be tolerant to the cotton leaf curl virus (CLCuV) were retained for general cultivation. The two most susceptible varieties, S-12 and CIM-70, with the highest ginning outturn and the most heat tolerance, respectively, among all released varieties in Pakistan so far, were banned for cultivation in 1994. Although NIAB-86 did not occupy a significant area, it was also banned for cultivation in 1994. Realizing the importance of genetic tolerance to the disease, the variety approval process has been four times faster since 1992. The currently available varieties have a high degree of tolerance to the disease. The other major change in the breeding program has been to place less importance to heat tolerance, which had been the number one priority after the release in 1983 of NIAB-78, the first heat tolerant variety.

Disease Standards

After the disease spread to a large area, and it was confirmed that varieties differ in their ability to resist the viruses responsible for the disease, a need arose to categorize varieties in groups. One of the factors limiting the categorization was the difference in disease severity among different fields and during different years. One variety may show disease symptoms at one location and may prove to be tolerant at another location. The same variety may be susceptible this year and tolerant the next. Though such an unreliable response complicated the issue, researchers agreed to establish standards for screening varieties and categorize them in different groups according to their tolerance to the disease. Researchers have agreed on the following standards for screening varieties:

Leaf Curl Disease Standards in Pakistan

Code	Description
0	Complete absence of disease symptoms
1	Thickening of new small scattered veins
2	Thickening of small group of veins
3	Thickening of large group of veins
4	Thickening of all veins
5	Severe vein thickening and leaf curling
6	Severe leaf curling and severe stunting of plants
E	Denotes enation

Genetic Basis for Resistance

Experience in dealing with the CLCuV disease in both countries so far has proved that varietal resistance is the strongest defense among currently available tools. Researchers have tried to establish the genetics of resistance to the disease. In most cases, the crosses made among resistant and susceptible parents have resulted in a resistant F_1 generation. Some of the early work in Sudan (Siddiq 1970) showed that resistance to CLCuV is controlled by a single dominant gene, though minor (modifiers) genes may also be involved. Ali (1999) also made crosses between highly susceptible and resistant parents and came to the conclusion that a single dominant gene is involved in the control of resistance to virus attacks. But Indian researchers have concluded that not one but two dominant genes are involved in the control of resistance to CLCuV. Thus, the genetic control of resistance to the disease is not certain yet.

Control Measures

Work in India and Pakistan has shown that, almost exclusively, whitefly serves as a vector for the virus although other sucking insects like jassid, thrips and aphids also exist on cotton in both countries at the time the disease is transmitted. It has also been observed that many times disease infestation is related to whitefly population in the field. But if the whitefly population, although high, is not infected with the virus, no disease symptoms will be seen in the field regardless of the high whitefly pressure. A number of techniques are available to screen tolerance to the disease but the most appropriate is overnight feeding of whiteflies on infested plants and release of virulent whiteflies on the test variety under cage conditions. It takes about 25 days for infected plants to show disease symptoms. A mini cage technique has also been standardized at Punjab Agricultural University, Ludhiana, India.

In the September 1994 issue of *THE ICAC RECORDER* a number of control measures were discussed. The whitefly population can be depressed to the lowest levels but it requires extensive use of insecticides. No chemical control methods are available for the viruses. Both cultivated diploid species, *G. arboreum* and *G. herbaceum,* are resistant. *G. barbadense* is highly susceptible, more so than *G. hirsutum*. Effective control of the disease has three alternatives:

- Because the disease is transmitted by whitefly, one of the best solutions would be the elimination of whitefly as a pest on cotton. Under normal conditions, the economic threshold for whitefly is 5-6 nymphs per leaf, but only one whitefly per leaf is enough to effectively transmit the disease and cause heavy losses. Thus, for reliable disease control what would be required is the elimination of the vector and not only a reduction in the population.
- Realizing the problems associated with the elimination of a pest like the whitefly from multi-cropping systems like those in India and Pakistan, the second best solution could be the elimination of the causal organism and the infected whitefly population. Such a solution is also as difficult as the elimination of the vector itself.
- If it is not possible to eliminate the vector and the causal organism, the other option lies in the development of varieties that are immune to virus attacks. The vector may be there and the causal organism may also be there, but the viruses may not be able to survive on the target variety or even may not be able to be injected into the target species. Currently, ICAC is sponsoring such a project in Pakistan, UK and the USA with financial assistance from the Common Fund for Commodities.

ICAC/Common Fund for Commodities Project

The project entitled "Genome Characterization of Whitefly-Transmitted Geminiviruses of Cotton and Development of Virus-Resistant Plants through Genetic Engineering and Conventional Breeding" is a collaborative effort among four institutes/organizations in the three countries mentioned above. The project has a duration of five years and started activities in 1996. In addition to the in-kind contributions and co-financing provided by local governments/organizations, the Common Fund for Commodities has provided grant funds for the implementation of the project. The project covers both the fundamental and applied research aspects and will be completed by the end of 2000. The main objectives of the project are as follows:

- Define the host range, symptomatology and transmission characteristics of select virus isolates.
- Clone viral genes of selected isolates from Polymerase Chain Reaction (PCR) amplified regions of the genome to obtain DNA sequences.
- Use clones to make DNA probes for investigating epidemiological parameters.
- Engineer cotton for virus resistance using viral-derived genes that, when expressed in the plant, will confer complete resistance.
- Utilize germplasm resistant to cotton viruses in hybridization to develop commercial varieties resistant to virus attack.

In particular, the project is aimed at understanding the cotton-infecting geminiviruses and utilizing this information for developing virus-resistant genotypes through conventional breeding and genetic engineering. Specifically, biological and genetic characteristics of the economically important whitefly transmitted geminiviruses of cotton are being studied in the project. Attainment of these objectives will enable CLCuV affected cotton-producing countries to enhance productivity without losses from the leaf curl disease.

The National Institute for Biotechnology and Genetic Engineering and the Cotton Research Institute in Pakistan, the John Innes Centre in the UK, and the University of Arizona in Tucson, USA, are working together to achieve the mentioned objectives. The project has already made significant progress and it is expected that leaf curl virus immune genotypes will be available at the end of the project.

In India, the intra-hirsutum hybrid LHH 144, developed at the Punjab Agriculture University, Ludhiana, has shown high resistance to CLCuV. Resistant varieties like RS 875 have been developed at the Cotton Research Station, Sriganganagar. Control strategies in India include elimination of disease-affected plants, use of plant resistant varieties and hybrids, effective control of whitefly and use of host plant resistance.

References

Ali, Mahbub. 1997. Breeding of cotton varieties for resistance to cotton leaf curl virus. *Pakistan Journal of Phytopathology*, Vol. 9 (1), 1-7, 1997.

Ali, Mahbub. 1999. Inheritance of cotton leaf curl virus (CLCuV). *Proceedings of the ICAC-CCRI Regional Consultation on Insecticides Resistance Management in Cotton*, June 28 to July 1, 1999, Multan, Pakistan.

Rahman, Hafeezur. 1997. Breeding approaches to cotton leaf curl resistance. *THE ICAC RECORDER*, International Cotton Advisory Committee, Vol. XV, No. 1, March 1997.

Siddiq, M. A. 1970. Breeding for leaf curl resistance in Sakel cotton. In: *Cotton Growth in Gezira Environment*. Ed. By M. A. Siddiq and L. C. Hughes, Agricultural Research Corporation, Sudan, pp 153-158, 1969.

Singh, Joginder, A. S. Sohi, Dulcha A. Brar, Ian Denholm, Derek Russell and R. Briddon. 1999. Management of cotton leaf curl viral disease in India. *Proceedings of the ICAC-CCRI Regional Consultation on Insecticides Resistance Management in Cotton*, June 28 to July 1, 1999, Multan, Pakistan.

Technical Information Section. 1994. Leaf curl virus in Pakistan, *THE ICAC RECORDER*, International Cotton Advisory Committee, Volume XII, No. 3, September 1994.

Chronology of Use of Whitefly Insecticides on Cotton in Zimbabwe

Walter Dirorimwe, Cotton Research Institute, Zimbabwe

Abstract

The use of insecticides for whitefly on cotton in Zimbabwe has been studied between 1978 and 1999. Insecticides that were registered and recommended for use after several years of field evaluations for whitefly control belong to pyrethroids, organophosphates and a carbamate and, recently, insect growth regulators (IGR), buprofezin, and a thiourea derivative, diafenthiuron. Some of these insecticides are still being used and others have been withdrawn by the manufacturers or suppliers for various reasons. Whitefly has developed resistance to some of these insecticides in some countries. It is against this background that a resistance management strategy has been put in place in Zimbabwe, especially on the new products buprofezin and diafenthiuron, by initially limiting the number of sprays of each of these products to three applications per season. This strategy will be modified and strengthened as new products are introduced, and as whitefly continues to pose a threat to the cotton industry.

Introduction

Whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae) is a severe pest of field and vegetable crops, both in the greenhouse and out of doors (Gerling et al, 1986; Cook, 1986; Osborne et al, 1990). *B. tabaci* has become an economically important pest rather recently in Zimbabwe, becoming a major pest of cotton in the early 1990s, particularly in the Mazowe valley and southeast low-yield areas. The pest has been a potential primary pest of cotton since the 1970s.

B. tabaci is responsible for several types of direct and indirect damage to cotton plants and yields. The most serious economic damage to cotton is caused by the heavy secretion of honeydew on lint, which interferes with the spinning process and reduces the lint quality. Additional reductions in quality are caused by the blacksooty molds that develop on the honeydew and stain the lint.

Past and Present Situation

Insecticides continue to play a prominent role in whitefly control programs in Zimbabwe. As has been observed elsewhere in the world where this pest occurs, resistance has developed rapidly to essentially all groups of registered insecticides used against this pest in Arizona (Dennehy and Williams, 1997). The use of insecticides in the past is blamed for the present pest status of *B. tabaci* in the Sudan (Dittrich, 1987; Dittrich et al, 1985), in California (Prabhaker et al, 1985) and in India (Jayaraj et al, 1986), and resistance is currently a problem in whitefly control (Horowitz et al, 1988, Ahmed et al, 1987, Prabhaker et al, 1988). The status of *B. tabaci* resistance to the insecticides in use in Zimbabwe has not been studied but the threat of resistance to the old and new insecticides in use remains a great worry, if nothing is done to formulate a resistance management program. It is against this background that this paper attempts to look at the past, present and future of whitefly insecticides on Zimbabwean cotton.

Table 1 gives a summary of the chronology of use of various insecticides to control whiteflies on cotton between 1978 and 1999. These insecticides have been field tested for several years and have been registered and recommended for whitefly control on cotton in Zimbabwe. Some of the insecticides have been withdrawn by the manufacturers for various reasons. These can be dealt with in their respective chemical groups.

Pyrethroids

Decamethrin 2.5 EC was registered for whitefly control in 1978 but was withdrawn by the manufacturer in 1979. Cypermethrin 20 EC and deltamethrin 2.5 EC were registered and recommended for whitefly control in 1979 and 1980 respectively as shown in Table 1. The two pyrethroids were also recommended for bollworm control but were not recommended in the early 1980s because trials showed that they promote an increase in red spider mite populations (Cotton Research Institute, Annual Report, 1992/93). The use of these three pyrethroids for whitefly control was minimal, if any was used at all, because of very low whitefly population pressure at that time.

Organophosphates

Organophosphates form the bulk of insecticides registered and recommended for whitefly control in Zimbabwe, These are dimethoate 40 EC, demeton-S-methyl 25 EC, chlorfenvinphos 24 EC, pirimiphos methyl 50 EC and chlorpyriphos 48 EC, as shown in Table 1. Dimethoate 40 EC has been the most widely used insecticide for whitefly control since 1979 because the product is readily available and cheap compared with new products. However, there are reports that dimethoate is not controlling whiteflies effectively, but some farmers are still happy with its efficacy. Demeton-S-methyl is also used by farmers, but not to a large extent, and chlorfenvinphos has not been widely used for whitefly control because of its high mammalian toxicity (toxicity class, WHO, EPA1). It has been restricted to farmers who can afford aircraft spraying. This product should not be applied with knapsacks or hand-held ULV sprayers because of the above reason. Pirimiphos methyl and

Table 1. Chronology of Use of Whitefly Insecticides on Cotton in Zimbabwe

Year	Decamethrin 2.5 EC	Dimethoate 40 EC	Cypermethrin 20 EC	Deltamethrin 2.5 EC	Demeton-S-methyl 25 EC	Chlorfenvinphos 24 EC	Pirimiphos-methyl 50 EC	Chlorpyriphos 48 EC	Butocarboxim 50 EC	Buprofezin 50 WP	Diafenthiuron 50 SC
1978	o										
1979	x	o	o								
1980		o		o							
1981		o			o						
1982		o			o						
1983		o			o						
1984		o			o						
1985		o			o						
1986		o			o	o					
1987		o			o	o					
1988		o			o	o					
1989		o			o	o					
1990		o			o	o	o				
1991		o			o	o	o				
1992		o			o	o	o				
1993		o			o	o	o	o			
1994		o			o	x	x	o	o		
1995		o			o			x	o		
1996		o			o	o	o		x		
1997		o			o	o	o			o	
1998		o			o	o	o			o	
1999		o			o	o	o			o	o

o: in use --- x: withdrawn by manufacturer or supplier --- EC: emulsifiable concentrate --- WP: wettable powder --- SC: suspension concentrate chlorpyriphos have not been used widely because chemical companies who import these products either do not import them any longer or have not brought in enough to control sufficient areas. This is the same story with chlorfenvinphos.

Carbamate

Butocarboxime 50 EC is the only carbamate registered and recommended for whitefly control on cotton in Zimbabwe. Its use has been minimal because of its high cost. Limited quantities were imported by the supplier in 1994 and 1995 (Table 1), but the supply was not used because of a low whitefly population then. The supplier has since stopped importing this product.

Insect Growth Regulator (IGR)

Buprofezin 50 WP was first used for whitefly control in Zimbabwe in 1997, as shown in Table 1. It was granted temporary registration because there was an outcry by farmers that the available insecticides were failing to contain the whitefly population in most parts of the country. Full registration was given in 1998 when all the field trial results consistently showed its effectiveness in controlling whiteflies. This product represents a different chemistry from the traditional compounds for whitefly control. Another IGR (pyriproxyfen 10 EC) is showing promise in controlling whiteflies but it is still under field-testing.

Thiourea Derivative

Diafenthiuron 50 SC is a thiourea derivative that belongs to a new class of insecticides and has a unique mode of action. This product will be commercially used for whitefly control in Zimbabwe in 1999, as shown in Table 1. Field trials have shown that this product achieves the desired effect in controlling whiteflies.

Discussion

Intensive reliance on a limited range of insecticide groups results in a resistance crisis. If insecticide resistance develops to the available whitefly insecticides in Zimbabwe, cotton growers in the affected areas will apply many sprays without achieving effective control. The buyers of cotton in Zimbabwe, which are the Cotton Company of Zimbabwe, Cargill and Cotpro, will discount the prices paid to growers as a result of honeydew contamination, despite insecticide expenditures of many dollars per hectare.

The past decades have shown that nearly all major insects and mites are capable of developing resistance to different classes of insecticides and acaricides. The issue, therefore, is not whether resistance will develop to these whitefly insecticides in Zimbabwe, but when? Waiting until the pest has become resistant before starting resistance management is an ineffective strategy. The key element in any resistance management program is reduced use of pesticides. Resistance management is thus a component of integrated pest management and it ensures the long-term usefulness of a product. In the late 1980s, cotton growers in Israel faced serious whitefly resistance to pyrethroid insecticides (Dennehy and Williams, 1997). To overcome the problem, they formulated a successful resistance management program centered on the strategic use of IGRs. A whitefly resistance crisis climaxed in 1995 in Arizona cotton and this prompted the development of an integrated resistance management strategy adapted from a program implemented in Israel in 1987 (Dennehy and Williams, 1997). Pyrethroids, organophosphates or carbamates failed to control whiteflies throughout much of central Arizona. Resistance is currently a problem in whitefly control worldwide (Horowitz et al, 1988).

A resistance management strategy for whitefly insecticides in Zimbabwe can be developed with the insecticides in use. Pyrethroids are no longer recommended for whitefly control because they can only be used for bollworm control during certain periods of the cotton-growing season. Only one carbamate, butocarboxim, has been recommended for whitefly control, but it is not available in the country. Organophosphates readily available are dimethoate, demeton-S-methyl and chlorfenvinphos. Dimethoate and demeton-S-methyl have been in use for a long time and have been used extensively on other cotton pests. Their use in controlling whiteflies since 1979 and 1981 (Table 1) has been minimal, mainly due to low whitefly population pressure. These organophosphates, together with buprofezin and diafenthiuron, can still be used if there is a need to control whiteflies.

Buprofezin is an IGR that controls whitefly nymphs by the inhibition of the moulting process. It is recommended that this IGR be used with other insecticides, and in this case, it can be used with one of the organophosphates or diafenthiuron. It is essential to limit the number of sprays per season for buprofezin and diafenthiuron as a preventive resistance management strategy to ensure that resistance does not develop against these new insecticides and subsequent products. These sprays should only be applied when necessary, i.e., based on threshold levels for treating whiteflies. Each of the two products should only be applied at a maximum of three spray applications per season. This strategy will prolong the useful life of these new insecticides. The strategy will be improved in future as new insecticides are introduced to control whiteflies. Monitoring of whitefly resistance needs to be carried out in Zimbabwe with the help of international collaboration. This will provide a way of tracking the future success of these efforts and will allow the strategy to be modified quickly, should resistance develop to buprofezin and diafenthiuron as a curative resistance management strategy.

Conclusion

Resistance management in cotton in Zimbabwe requires participation, cooperation and consensus-building by cotton grower associations (Commercial Cotton Growers Association, Zimbabwe Farmers Union), individual growers, cotton extensionists, regulatory authorities and policy makers, local chemical companies and researchers. Research efforts should foster the overall reduction in the use of insecticides in cotton with long-term detection of resistance and assessing the resistance management strategies in place for possible modifications and strengthening.

References

Ahmed, A.H.M., Elhag, E.A. and Bashir, N.H.H. 1987. Insecticide resistance in the cotton whitefly (*Bemisia tabaci* Genn.) in the Sudan Gezira. *Tropical Pest Management,* 33: 62-72.

Cock, M. J.W. (Editor) 1986. *Bemisia tabaci.* A literature survey on the cotton whitefly with an annotated bibliography. C.A.B. International Institute of Biological Control, Great Britain.

Cotton Research Institute, 1992/93. Annual Report, Department of Research and Specialist Services, Zimbabwe, 256 pp.

Dennehy, T.J. and Williams, III, L. 1997. Management of Resistance in *Bemisia* in Arizona cotton. *Pesticide Science,* 51: 398-406.

Dittrich, V., Hassan, S.O. and Ernst, G.H. 1985. Sudanese cotton and the whitefly: A case study of the emergence of a new primary pest. *Crop Protection,* 4: 161-176.

Dittrich, V. 1987. Resistance and hormoligosis as driving forces behind pest outbreaks. In Rational Pesticide Use (Edited by Brent K.Y. and Alein A.K.), Cambridge University Press, 169-181 pp.

Gerling, D., Horowitz, A.R. and Baumgaertner, J. 1986. Autecology of *Bemisia tabaci*. *Agriculture, Ecosystems and Environment,* 17: 5-19.

Horowitz, A.R., Toscano, N.C., Youngman, R.R. and Georghiou, G.P. 1988. Synergism of insecticides with DEF in sweetpotato whitefly (Homoptera: Aleyrodidae). *Journal of Economic Entomology,* 81: 110-114.

Jayaraj, S., Rangarajan, A.V., Murugesan, S., Santharam, G., Vijayaraghavan, S. and Thangaraj, D. 1986. Studies on the outbreak of whitefly *Bemisia tabaci* (Gennadius) on cotton in Tamil Nadu. In Resurgence of Sucking Pests (Edited by Jayaraj S.), Tamil Nadu Agric. University, Coimbatore, India, 103-115 pp.

Osborne, L., Holmes, K. and Gerling, D. 1990. Prospects for biological control of *Bemisia tabaci*. *WPRS Bulletin,* 13 (5): 153-160.

Prabhaker, N., Coudriet, D.L. and Meyerdirk, D.E. 1985. Insecticide resistance in the sweetpotato whitefly *Bemisia tabaci* (Homoptera: Aleyrodidae). *Journal of Economic Entomology,* 78: 748-752.

Prabhaker, N.,Coudriet, D.L. and Toscano, N.C. 1988. Effects of synergists on organophosphate and permethrin resistance in sweetpotato whitefly (Homoptera: Aleyrodidae). *Journal of Economic Entomology,* 81: 34-39.

7th Meeting of the Latin American Association for Cotton Research and Development

The 7th Meeting of the Latin American Association for Cotton Research and Development (ALIDA) was held in Santa Cruz, Bolivia, from November 23-26, 1999. The Association was instituted in 1986 and meetings have held every two years since. The 7th meeting was hosted by the National Association of Cotton Producers (Asociación Nacional de Productores de Algodón – ADEPA) of Bolivia and organized jointly by ADEPA and the Technical Information Section of ICAC. The meeting was sponsored by ICAC, the FAO Regional Office for Latin America and the Caribbean and ADEPA. Researchers from countries in the region, people from the private sectors of the cotton production chain and representatives of FAO, CIRAD-CA of France and ICAC attended the meeting. The list of participants is attached.

Bolivia is not a large producer of cotton but planted cotton on 50,000 hectares in 1995/96, 1996/97 and 1997/98, similar to the 1972-74 period. However, during the 1980s, cotton area in Bolivia never exceeded 14,000 hectares and it came down to almost nothing in 1988/89. During the early 1990s, cotton production in Bolivia expanded significantly. In 1998/99, cotton area decreased to about 35,000 hectares, and in 1999/00, it is expected that only about 10,000 hectares will be planted. The main reason for the decline in area is low prices at the international level, which have serious effects on domestic prices in Bolivia. At the current Cotlook A Index level of U.S. 44 cents per pound of lint (in the first week of January 2000), it is not economical to produce cotton in Bolivia. Once again, Bolivia seems to be heading toward a situation like the one in the late 1980s, when cotton almost disappeared.

ADEPA, based in the main cotton growing area of Bolivia, is a strong and organized association. ADEPA was able to revive cotton production in the 1990s but it has not been able to offset the current low international prices. In addition to low prices and weather calamities, Bolivia now is being threatened by the boll weevil. The Bolivian Committee for the Prevention and Elimination of Boll Weevil, ADEPA, the Chamber of Exporters of Santa Cruz (CADEX) and the National Association of Cotton Ginners reported on June 23, 1999, that the Bolivian Ministry of Agriculture had detected the boll weevil in the area close to the border with Brazil through a monitoring program that has been carried out for many years. The catches in the traps have indicated the presence of boll weevil inside the border of Bolivia. Although the area where the boll weevil has been detected is about 600-700 kilometers away from the actual cotton area, the pest can easily move and settle in the cotton area because a large number of fields are not cleaned after the final picking. Cotton plants remaining in the field coupled with non-harsh weather during winter could help to establish the pest on cotton. Looking at the history of this pest in other countries in the region, it seems that it carries a great threat to cotton production in Bolivia.

The Government of Bolivia, ADEPA, and the Committee for the Prevention and Elimination of Boll Weevil are working together in different phases to anticipate infestation in the field. Apparently, one of the limitations is the inexperience of Bolivian researchers to deal with this pest. The FAO Regional Office for Latin America and the Caribbean has already started a short-term project to help the Government of Bolivia in education programs and in the prevention of the spread of the boll weevil to the cotton area. FAO will provide expert advice through short-term consultancy services and will organize training courses for people directly involved in cotton production and extension activities.

Bolivia has the potential to grow cotton on a much larger area. Some government plans project cotton production to expand to 200,000 hectares. As the area under cotton increased, the ginning industry also expanded, and currently there are 15 gins in Bolivia. An 80% reduction in area in the last two years is a major set back to the ginning industry. If the cotton area is not revived in the next few years, the ginning industry will also shrink. Socioeconomic conditions in Bolivia strongly demand the revival and expansion of cotton production, thus, favorable climatic conditions, reasonable prices and the prevention of the boll weevil are critical.

Soil conditions in Bolivia are fit for cotton production, and large growers produce mostly cotton suitable for mechanical cultivation. However, Bolivia has not been able to start its own variety development program. All the varieties commercially grown have been adopted from other countries, including Argentina and the USA. During 1998/99, three varieties—Stoneville 132, Guazuncho II and Stoneville 373—were planted on more than 90% of the total area, and Stoneville 132 alone was grown on about 60% of the total area. About 75% of seed needs are met through imports from other countries. Cotton is generally planted at 40-inch row spacing. Lately, there has been a trend to adopt zero tillage, and it is estimated that about a 30% of total area during the last year was planted under zero tillage. Only 3-4% of total area is irrigated, and fertilizer is not commonly applied.

Insects are a major problem and require strict vigilance and plant protection measures. A number of sucking insects may require insecticide applications but *Alabama argillacea*, *Spodoptera* spp., *Heliothis* spp., and *Pectinophora gossypiella* are the most important to control. About 15% of total area receives up to four sprays per year. 25% of total area is sprayed up to six times, while about 60% is sprayed more than six times per season. As cotton is grown in large blocks, most of the insecticides are applied through tractor-mounted sprayers and aerial spraying. Diseases are not a problem in Bolivia.

Growth regulators and defoliants are used on about 35-50% of total area. About 85% of total production is hand picked. In Bolivia, cotton yields have varied drastically in different years mainly because of climatic conditions, particularly rains, which may also affect fiber maturity due to high humidity.

Conclusions and Recommendations

Participants included experts of various disciplines who, in order to draw conclusions and formulate recommendations, were divided into four groups: Fiber technology, transgenic cotton, insect pest control and agronomic management of cotton farming. The groups, comprised of 4-5 experts, met simultaneously. Based on the papers presented at the meeting, current trends in production research, and on their expertise, the groups made recommendations in four disciplines. Later, the recommendations were discussed in the general meeting and approved.

On the last day of the meeting, ALIDA's organizational set up was discussed to make it more effective. Again, certain recommendations were made, which are included under "general," in the conclusions and recommendations given below.

Agronomic Management of Cotton Farming

It was recommended that a system that is sustainable, profitable and results in a minimum of environmental disturbance for the production of cotton be found.

In accordance with the goals of the speakers who presented important needs regarding adequate cotton production management, the activities to be carried out that will lead to the next ALIDA meeting comprise the following areas:

- Soil conservation management with the purpose of maintaining and conserving organic matter.
- Identification of cotton varieties in their specific ecosystems.
- Adequate physiological management in order to make agricultural tasks efficient.

Fiber Technology

The importance of equipment such as high volume instruments (HVI) for the classing of cotton, according to measurable objective parameters, is evident.

There must be a transparent and fair system of classification at the Latin American region level for the entire cotton sector: producers, ginners, traders, and the cotton industry.

The use of a classification system similar to or equivalent to others in the rest of the world will directly benefit all members of the cotton sector.

To meet the current requirements of the textile industry, it is important to turn fiber technology into a major concern for producers and ginners as well as for traders.

Recommendations:

Request ALIDA coordinators and the International Cotton Advisory Committee (ICAC) to propose, on a priority basis, a process for the classification of cotton for the entire region (Latin America) in accordance with international standards.

It was also recommended that the starting point of said standardization process be one already known and proven, as is the case with the U.S. Department of Agriculture (USDA).

Plant Protection

It is important for different countries to carefully monitor the acceptance of transgenic varieties and their environmental impact at the international level, and take into account their long-term benefit/cost ratio.

Considering the limitations that have been faced in the application of integrated pest management (IPM) in cotton, it is convenient to adopt wider concepts for the management of agroecosystems, taking into account the generalized acceptance of IPM.

The countries and zones that are free of boll weevil should continue their cooperation in order to slow to the maximum boll weevil expansion in the area.

The small and medium cotton production sectors should set up test plots for the study and demonstration of diversified farming in strips of land under the supervision and validation of research and extension entities.

The Paraguayan program for cotton reactivation is interesting and its results should be kept under observation in the coming years; at the same time, it is necessary to generate and validate a technology for cohabitation with the boll weevil in the sector of small farms.

The tripartite project sponsored by CFC/ICAC is providing important information and should be given full support from member countries and sponsoring institutions. The participation of Bolivia in this project could be considered.

Genetic Selection for Transgenic Cotton

It is recommended:

To carry out comparative tests by regions in groups of countries, e.g., Central America and Andean countries. The results of the tests in each of the regions should be exchanged in future meetings of ALIDA.

Prior to the comparative tests, cotton germplasm and information should be exchanged. For example, Argentina has a database with 600 described entries, Bolivia has 1,200 lines that are not described—said material could serve as a base for the exchange.

ALIDA countries should carry out actions to elaborate an information catalog regarding lines with outstanding characteristics, coming from a program of public improvement.

ALIDA countries realize the significance of Internet use and propose to include an item on "Genetic Improvement" on various web pages. This initiative could be supported by the ICAC.

National institutions in ALIDA member countries should ask their governments to establish regulations or a national legal framework for activities with transgenic plants mainly their introduction into their territories. These regulations should establish parameters and legal techniques that allow the acceptance or rejection of activities based on risk/benefit and cost/benefit.

ALIDA member countries feel the need to participate in courses, workshops and other events regarding biotechnology and transgenic cotton farming, with emphasis on advantages and disadvantages, to educate cotton producers.

ICAC should expand the use of its email list on the cotton boll weevil to serve as an ALIDA forum for the exchange of information on cotton production and research, including biosafety aspects of transgenic cottons.

General

Participants in the meeting reiterated that there are almost no activities of the Association and minimum interaction among researchers during the two years between ALIDA meetings. Participants were informed that ICAC maintains an email list for communication on the boll weevil. The boll weevil electronic list is a free service of the ICAC Secretariat and should be used to enhance communication among researchers in the region. Any researcher having an email address can enroll in this list and send and receive messages. A message sent to the list is relayed to all subscribers from the ICAC server at the same time. ICAC agreed to enhance the scope of the list from a boll weevil information exchange to an ALIDA forum for discussions among researchers in the region.

Participants welcomed ICAC's offer to launch the ALIDA list and committed to participate actively in the list activities.

In order to maintain the communication among countries in the region between meetings, national coordinators were appointed in various countries.

It was observed that there is a need to bring a new generation of young researchers to the next ALIDA forum.

On behalf of the outgoing president of ALIDA, Ing. Juan Poisson of Argentina proposed to hold meetings of ALIDA every three years instead of every two. Participants discussed the advantages and disadvantages of extending the period to three years and deferred the decision until the next meeting, which will be held in two years.

Participants accepted an invitation from the Ministry of Agriculture of Paraguay to hold the next meeting of ALIDA in Paraguay. Representatives of the Paraguayan Ministry of Agriculture invited all countries in the region to the next ALIDA meeting.

The meeting elected Ing. Juan Campero of Bolivia as the new president of ALIDA. His complete address is as follows:

Ing. Juan Campero-Rojas
President of ALIDA
President, Asociación Nacional de Productores de Algodón (ADEPA)
Avenida Cumavi No. 10
Casilla 1125
Santa Cruz, Bolivia
Email: adepa@cotas.com.bo
Phone: 591-3-466264/65   Fax: 591-3-466267

List of Participants

Argentina

Ing. Juan Alberto F: Poisson
Instituto Nacional de Tecnología Agropecuaria - INTA
Casilla de Correo 164
3700 - P. R. Sáenz Peña, Chaco
Phone: 54-3732-421973
Fax: 54-3732-421722
Email: jpoisson@saenzpe.inta.gov.ar

Dr. Teodoro Stadler
Project Director
Proyecto de Manejo Integrado del Picudo del Algodonero
Av. Paseo Colón 367 - 7º Piso
1063 Buenos Aires
Phone: 54-11-49816708
Fax: 54-11-49816708
Email: picudo@redynet2.com.ar

Ing. Pablo de la Fuente
Monsanto Company
Buenos Aires
Phone: 54-11-4316-2425
Email: pablodelafuente@monsanto.com

Bolivia

Ing. Oscar Busch Barbery
Ing. Daniel Duran
danielduran@mail.com
Ing. Francisco Dabdoub L.
Ing. José Luis Bonanquen
Ing. Hugo Moreno Reyes
Ing. Victor Hugo Serrano P.
Ing. Guimerth Sánchez
Ing. Oscar Tapia
Asociación Nacional de Productores de Algodón - ADEPA
Av. Cumavi No. 10
Santa Cruz
Phone: 591-3-466264
Fax: 591-3-466267
Email: adepa@cotasnet.com

Ing. Ron Thorp
AG Specialties S.A.
Santa Cruz
Phone: 591-3-329014
Fax: 591-3-343320
Email: agcot@mailcotas.com.bo

Ing. Sthefan Green
ADEPA -AG Specialties
Santa Cruz
Phone: 591-3-329014
Fax: 591-3-343320
Email: agcot@mailcotas.com.bo

Ing. Alejandro Godefroy
Desmotadora Godefroy
Km 35 a Pto.Pailas
Casilla # 1568
Santa Cruz
Phone: 591-3-429946
Fax: 591-3-429946
Email: godefroy@mail.scbbs.bo.com

Ing. Beatriz Zapata Ferrufino
Ministerio de Desarrollo Sostenible y Planificación
Calle Batallón Colorados
Edif. "El Cóndor" Piso 15. Of. 1504
La Paz
Phone: 591-2-315139
Fax: 591-2-315130
Email: beatriz@latinmail.com

Ing. Luis Enrique Badani
Santa Mónica Cotton
Santa Cruz
Phone: 591-3475545
Fax: 591-3-475535
Email: smcca@mail.cotas.com.bo

Ing. José Lino Roca
Santa Martha
Santa Cruz
Phone: 591-3-432071
Fax: 591-3-432071
Email: desmotadora@mail.zuper.net

Ing. Alfredo Vives Lapoint
Email: pentagro@infonet.com.bo
Ing. Edil Padilla
Email: pentagro@infonet.com.bo
Pentagro
Santa Cruz
Phone: 591-3-431212
Fax: 591-3-431133

Ing. Sergio Gil
Santa Cruz
Phone: 591-3-431212
Fax: 591-3-431133
Email: pentagro@infonet.com.bo

Ing. Armando Gómez
Ing. Manuel Oliva
Semexa
Santa Cruz
Phone: 591-3-882018
Fax: 591-3-882019
Email: info@semexa.com

Ing. Anderson Orsi
Agropecuaria La Prosperidad
Santa Cruz
Phone: 591-3-377225
Fax: 591-3-377225
Email: andersonorsi@cotas.com.bo

Ing. Ingrid Torrez
Hacienda Victoria
Santa Cruz
Phone: 591-3-427587
Fax: 591-3-425283

Ing. Lorgio Paz Gutiérrez
Sta. Mónica Cotton S.A.
Santa Cruz
Phone: 591-3-475545
Fax: 591-3-487989
Email: stamonica@cotasmail.com

Ing. Guillermo Barea
Dow Agro Sciences
Santa Cruz
Phone: 591-3-332024
Fax: 591-3-391985
Email: gbarea@dowagro.scz.com

Ing. Alejandro Larios Larios
Bolsemillas
Santa Cruz
Phone: 591-3-538709
Fax: 591-3-539446
Email: bolsemillas@infonet.com.bo

Ing. José Luis Landivar
Tractores del Aire
Santa Cruz
Phone: 591-3-368076
Fax: 591-3-369375
Email: tractores@mail.infonet.com.bo

Ing. Rene Castedo Pereyra
Monsanto Company
Santa Cruz
Phone: 591-3-372341
Fax: 591-3-372341
Email: reneccastedopereyra@Monsanto.com

Ing. Ciro Simoni
ADEPA -CODEPAG
Santa Cruz
Phone: 591-3-488414

Ing. Carlitos Jacob Klas
Agripac
Santa Cruz
Phone: 591-3-341012
Fax: 591-3-327805

Ing. Ernesto Antelo
Ing. David Soto Cruz
Boltrade Srl
Santa Cruz
Phone: 591-3-463545
Fax: 591-3-463520

Ing. Albert Castillo
Ing. Jaime Chávez Serrano
CIAT-ADEPA
Santa Cruz
Phone: 591-3-370716
Fax: 591-3-342996

Ing. Walter Tarradelles
Comité del Picudo
El Dorado Ltd
Km. 3½ a Pto. Pailas
Casilla #1568
Santa Cruz
Phone: 591-3-426734
Fax: 591-3-426734

Ing. Freddy Paredes Caro
Agro Industrial San Juan
Santa Cruz
Phone: 591-3-882351
Fax: 591-3-882343

Ing. Fernando Viacaba
CEIBO
Santa Cruz
Phone: 591-3-367666
Fax: 591-3-337634

Ing. Jorge Francisco Urioste
CAOL
Santa Cruz
Phone: 591-3-424777
Fax: 591-3-424100

Brazil

Dr. Raymundo Braga Sobrinho
EMBRAPA
Centro Nacional de Pesquisa
de Agroindustria - CNPAT
Av. Dra. Sara Mesquita, 2270
Planalto do Pici
60511-110 Fortaleza, Ceara
Phone: 55-85-2991800, 1840
Fax: 55-85-2991803, 1833
Email: braga@cnpat.embrapa.br

Dr. Juan A. Landivar
Deltapine International
Brazil
Email: Jalcctx@aol.com

Colombia

Dr. Arnulfo Díaz Delgado
Corpoica – Conalgodón
Ibagué, Tolima
Phone: 57-982-889825
Fax: 57-982-889162
Email: corpoica@ibague.cetcol.net.co

Nicaragua

Dr. Mario A. Vaughan
Apartado Postal 5123
Km. 13 Carretera Panamericana Norte
Apartado Postal C116, ZP 13
Managua
Phone: 505-2-762054
Fax: 505-2-760870
Email: mav@tmx.com.ni

Paraguay

Ing. Clotildo Rodas A.
Ministry of Agriculture and Livestock
Pdte Franco 475
Asunción
Phone: 585-21-572256
Fax: 585-21-585210

Ing. Osacar Manesi
Plato Industries Inc.
Paraguay

USA

Ing. Stefano Pallozzi
The Montgomery Company
Miami, FL
Phone: 305-668-6131
Fax: 305-668-9031
Email: spallozz@bellsouth.net

International Organizations

Ing. José Martin
Cotton Program of the CIRAD-CA
Brazil
Phone: 55-61-3646306
Fax: 55-61-3646157
Email: jose.martin@zaz.com.br

Dr. Sebastiao Barbosa
Senior Regional Plant Protection Officer
FAO Regional Office for Latin America
and the Caribbean
Bandera No. 150, 9 Peso
P. O. Box 10095
Santiago, Chile
Phone: 56-2-33772225
Fax: 56-2-3372101
Email: sebastiao.barbosa@fao.org

Ing. José Tubino
FAO Office
La Paz, Bolivia
Phone: 591-2-419551
Fax: 591-2-410518
Email: jtubino@kolla.net

Dr. M. Rafiq Chaudhry
International Cotton Advisory Committee
1629 K Street, Suite 702
Washington, DC, USA
Phone: 202-463-6660
Fax: 202-463-6950
Email: rafiq@icac.org

Short Notes

• Cotton Production in Australia

Cotton is grown in two states in Australia, New South Wales and Queensland, under irrigated and rainfed conditions. About 75% of the area, responsible for over 85% of total production, is irrigated. Cotton yields under irrigated conditions are more than double the yields obtained under rainfed conditions. During 1998/99, cotton yields in Australia were about 300 kg/ha lower than normal, but they were still the third highest in the world after Israel and Syria. While cotton yields in Israel are usually the highest in the world, yields in Syria were unusually high during 1998/99 because of prolonged favorable conditions during boll formation and maturation stages. Cotton yields in Australia during 1998/99 were 1,366 kg/ha of lint, slightly higher than in 1993/94 but one of the lowest since 1990/91. Australia adopted Ingard Bt cotton in 1996/97, and an estimated 80,000 hectares of bollworm-resistant cotton were planted 1998/99. Cotton producing areas in Australia in 1998/99 are given on the next page.

• Cotton Industry Statistics

There were 165,755,000 ring spindles and 7,574,700 open-end rotors in the world at the end of 1998. According to the International Textile Manufacturers Federation (ITMF), 70% of ring spinning installed capacity lies in Asia and Oceania, 14% in Europe, only 4% in Africa, and 6% each in North and South America. However, 49% of open-end rotor installed capacity is in Europe, 28% in Asia and Oceania, 15% in North America, 5% in South America, and only 3% in Africa. Over the last 10 years, from 1988 to 1998, there has been a 6% increase in ring spindles in the world, while rotor capacity increased by 7%. Ring spinning

Cotton Producing Areas in Australia 1998/99

State/District	Irrigated			Rainfed			Total		
	Area (ha)	Yield (kg/ha)	Production (tons)	Area (ha)	Yield (kg/ha)	Production (tons)	Area (ha)	Yield (kg/ha)	Production (tons)
Queensland									
Emerald	21,000	1,635	34,323	6,000	726	4,358	27,000	1,433	38,681
Biloela/Theodore	6,700	1,656	11,103	1,200	726	872	7,900	1,516	11,975
Darling Downs	42,000	1,520	63,878	44,000	863	37,954	86,000	1,184	101,832
St. George	18,500	1,770	32,756	500	273	136	19,000	1,731	32,892
Dirranbandi	15,000	1,748	26,218				15,000	1,748	26,218
Sub-total	**103,200**	**1,630**	**168,278**	**51,700**	**838**	**43,320**	**154,900**	**1,366**	**211,598**
New South Wales									
Macintyre	55,000	1,544	84,898	14,000	795	11,123	69,000	1,392	96,021
Gwydir	90,000	1,544	138,924	25,000	568	14,188	115,000	1,331	153,112
Upper Namoi	22,000	1,498	32,960	18,000	568	10,215	40,000	1,079	43,175
Lower Namoi	60,000	1,589	95,340	20,000	568	11,350	80,000	1,334	106,690
Macquarie	48,000	1,544	74,093	2,400	341	817	50,400	1,486	74,910
Bourke	12,600	1,794	22,596				12,600	1,793	22,596
Tandou	6,500	1,702	11,066				6,500	1,702	11,066
South NSW (Hillston)	7,000	1,725	12,076				7,000	1,725	12,076
Sub-total	**301,100**	**1,568**	**471,953**	**79,400**	**600**	**47,693**	**380,500**	**1,366**	**519,646**
Total/Average	**404,300**	**1,588**	**640,231**	**131,100**	**695**	**91,013**	**535,400**	**1,366**	**731,244**

capacity decreased by 48% in North America and 32% in Europe. Installed ring spinning capacity increased by 30% in Asia and by 10% in South America. In the European continent, open-end rotor spinning capacity decreased by 32% in 10 years; however, in all continents, open-end rotor spinning capacity increased significantly. Spinning capacity in terms of open-end rotors increased by 130% in South America, 117% in Asia, 50% in North America and 40% in Africa.

Out of the total of 671,690 shuttle-less looms in the world, 40% of installed capacity was in Europe in 1998, 38% in Asia and Oceania, 12% in North America, 7% in South America and only 3% in Africa. However, 77% of the total installed capacity of shuttle looms lies in Asia. North and South America share 3% and 9%, respectively. Europe shares about 5% and Africa had about 6% of the 1,553,540 shuttle looms installed in the world in 1998. With the exception of Europe, where it decreased by 7% in the last 10 years, shuttle-less loom capacity increased in all continents. The increase was 161% in South America, 97% in Asia, 22% in Africa and only 2% in North America. At the world level, there was a 27% increase in shuttle-less loom installed capacity in the last 10 years. However, during the same time, shuttle loom capacity decreased by 29%. Shuttle looms decreased everywhere in the world: 70% in Europe, 57% in North America, 38% in Africa, 23% in South America and 20% in Asia.

ICAC estimates suggest that 19 million tons of raw cotton were consumed in the world during 1998/99, against an expected consumption of 19.3 million tons during 1999/00. Because of current lower international prices, consumption is going to increase next year too. According to ITMF, 59% of total world cotton production is used in Asia and Oceania, 17% in North America, 14% in Europe, 6% in South America and only 4% in Africa. In the last 10 years, cotton mill use increased by 14% and 65% in North America and Asia, respectively. Cotton consumption decreased by 5% in Africa and South America and by 48% in the European continent. Asia is the largest consumer of cellulosic and synthetic fibers in the world, accounting for more than two-thirds of world consumption.

(*International Cotton Industry Statistics*, International Textile Manufacturers Federation, Volume 41, 1998, published in October 1999)

• Cotton Contamination in the World

The International Textile Manufacturers Federation (ITMF) undertakes a survey of cotton contamination in the world every two years. The data are collected through a survey mailed to individual mills in many countries. Participating companies are asked to indicate whether or not they have consumed a particular cotton and what the situation is with regard to 16 particular contaminants. The contaminants are categorized as fabric, strings, organic matter (leaves, feather, paper, leather, etc), inorganic matter (sand, rust, metal) and oily substances/chemicals (grease, oil, rubber, stamp color and tar). Respondents are asked to grade the contamination level as non-existent or insignificant, moderately contaminated or seriously contaminated.

The most recent *Cotton Contamination Survey* was published by ITMF in August 1999. In the report, 283 spinning mills in 24 countries evaluated cottons of 87 origins. The data are not based on randomly drawn samples and should not be applied to a country's whole production. However, according to the report, 6% of the total samples evaluated had serious contamination and 15% were moderately contaminated, as against 5% and 13% in 1997, respectively. In 1997, 82% of the total samples tested were contamination free or had only insignificant contamination. But in 1999, such cotton was lower by 3%. Organic matter continues to be the main source of contamination, followed by strings and fabric made of jute/hessian, woven plastic, cotton and plastic film. According to the ITMF, the most contaminated cotton originated in India, Pakistan, Turkey and Turkmenistan. Contamination-free cotton was found to originate in Argentina, Australia, Israel and Zimbabwe.

Respondents were also asked for the level of stickiness. Only 20% of the total samples showed some presence of stickiness, against 23% in 1997 and 27% in 1991. Most of the sticky cotton originated in India, Mexico, Sudan and Tanzania. Israeli Pima, Turkish Izmir, and production from Paraguay, the Rio Grande Valley of the USA and Zambia was found to be free of stickiness.

The incidence of seed coat fragments increased by 6% to 38% in 1999. Seed coat fragments were found to be more common in cotton from India and Turkey. Cotton from Australia, Burkina Faso, Israel, Turkmenistan and the USA had the least seed coat fragments.

Note: A free copy of the 57 page report can be ordered from the International Textile Manufacturers Federation, Postfach CH-8039, Zurich, Switzerland, Fax: 41-1-2017134, Email: secretariat@itmf.org. Orders can also be placed on-line through their web page at http://www.itmf.org. Postage will be paid by the requester.

*****

A DIALOG Search of CAB Abstracts, Biosis, Agricola and AGRIS International Databases

The search was conducted using the key words **cotton** and **fiber maturity**

03608060 CAB Accession Number: 980710402
Mapping variability in cotton fiber maturity.
Bradow, J. M.; Davidonis, G. H.; Bauer, P. J.; Johnson, R. M.
USDA-ARS, New Orleans, Louisiana, USA.
1998 Proceedings Beltwide Cotton Conferences, San Diego, California, USA, 5-9 January 1998. Volume 2.
Conference Title: 1998 Proceedings Beltwide Cotton Conferences, San Diego, California, USA, 5-9 January 1998. Volume 2. p.1463-1465
Publication Year: 1998
Editors: Dugger, P.; Richter, D.
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

03487073 CAB Accession Number: 980701866
The influence of mepiquat chloride (PIX) and nitrogen rate upon the maturity and fiber quality of upland cotton.
Phipps, B. J.; Stevens, W. E.; Ward, J. N.; Scales, T. V.
University of Missouri-Delta Center, Portageville, Missouri, USA.
1997 Proceedings Beltwide Cotton Conferences, New Orleans, LA, USA, January 6-10, 1997: Volume 2.
Conference Title: 1997 Proceedings Beltwide Cotton Conferences, New Orleans, LA, USA, January 6-10, 1997: Volume 2. p.1471-1472
Publication Year: 1997
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

03486440 CAB Accession Number: 980700897
Relationships between maturity and fiber properties for cotton cultivars in Arkansas.
Johnson, J. T.; Bourland, F. M.; Watson, C. E.
Mississippi State University, MS, USA.
1997 Proceedings Beltwide Cotton Conferences, New Orleans, LA, USA, January 6-10, 1997: Volume 1.
Conference Title: 1997 Proceedings Beltwide Cotton Conferences, New Orleans, LA, USA, January 6-10, 1997: Volume 1. p.438
Publication Year: 1997
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

02323754 AGRIS No: 1999-058727
A study of fiber maturity in cotton and its relation to lint and yarn properties
Mohamed, R. M. H.
Ain-Shams Univ., Cairo (Egypt). Faculty of Agriculture
Thesis Degree: Thesis (M.Sc. in Agronomy), 1997, 124 p.
Notes: 3 fig. 23 tables; Bibliography: p. 105-113
Language: English Summary Language: Arabic, English
Availability: Library, Fac. of Agri., Ain-Shams Univ., Egypt
Document Type: Monograph, Summary, Dissertation, Non conventional Literature, Bibliography
Journal Announcement: 2507 Record input by Egypt

3553249 20547013 Holding Library: AGL
Applications of AFIS fineness and maturity module and x-ray fluorescence spectroscopy in fiber maturity evaluation
Bradow, J.M.; Hinojosa, O.; Wartelle, L.H.; Davidonis, G.; Sassenrath-Cole, G.F.; Bauer, P.J.
USDA, ARS, Southern Regional Research Center, New Orleans, LA.
Princeton, N.J. : TRI/Princeton.
Textile Research Journal: publication of Textile Research Institute, Inc. and the Textile Foundation. Sept 1996. V. 66 (9) p. 545-554.
ISSN: 0040-5175 CODEN: TRJOA9
DNAL Call Number: 304.8 T293
Language: English
Includes references
Place of Publication: New Jersey
Subfile: IND; Other US (not exp stn, ext, USDA; Since 12/76); AR-SRRC; AR-MSA; AR-SAA;
Document Type: Article

03374941 CAB Accession Number: 970704758
Environmentally induced variations in cotton fiber maturity and related yarn and dyed knit defects.
Bradow, J. M.; Davidonis, G. H.; Hinojosa, O.; Wartelle, L. H.; Pratt, K. J.; Pusateri, K.; Bauer, P. J.; Fisher, B.; Sassenrath-Cole, G. F.; Dastoor, P. H.; Johnson, A.; Landivar, J. A.; Locke, D.; Moseley, D.
USDA, ARS, Southern Regional Research Center, New Orleans, Louisiana, USA.
1996 Proceedings Beltwide Cotton Conferences, Nashville, TN, USA, January 9-12, 1996: Volume 2.
Conference Title: 1996 Proceedings Beltwide Cotton Conferences, Nashville, TN, USA, January 9-12, 1996: Volume 2. p.1279-1284
Publication Year: 1996
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper
10603621 Biosis No.: 199699224766

A new equation for expressing cotton fiber maturity determined by the Fibrograph model 430 method.
Author: Kondo Julio Isao(a); Sabino Nelson Paulieri(a); Fuzatto Milton Geraldo; Gridi-Papp Imre Lajos; Gondim-Tomaz Rose Marry Araujo(a)
Author Address: (a)Secao Tecnol. Fibras, Inst. Agron., Caixa Postal 28, 13001-970 Campinas, SP, Brazil
Journal: *Bragantia*, 54 (1): p 131-133, 1995
ISSN: 0006-8705
Document Type: Article
Record Type: Abstract
Language: Portuguese; Non-English
Summary Language: Portuguese; English

09820268 Biosis No.: 199598275186
Diallel analysis of yield and other traits in cotton.
Author: Carvalho Luiz Paulo De(a); Cruz Cosme Damiao; Moraes Carlos Floriano De
Author Address: (a) Rua Osvaldo Cruz 1143, Caixa Postal 174, 58107-720 Campina Grande, PB, Brazil
Journal: *Revista Brasileira de Genetica*, 18 (1): p 93-97, 1995
ISSN: 0100-8455
Document Type: Article
Record Type: Abstract
Language: English
Summary Language: English; Portuguese

3530924 20529803 Holding Library: AGL
Effect of salinity on botanical characters and fiber maturity of three Egyptian cotton cultivars
Nawar, M.T.; Zaher, A.M.; El-Sahhar, K.; Abdel-Rahim, S.A.
Cotton Research Institute, Agric. Res. Center, Giza, Egypt.
Memphis, Tenn.: National Cotton Council of America, 1991-
Proceedings / 1995. v. 1, p. 566-569.
ISSN: 1059-2644
DNAL Call Number: SB249.N6
Language: English
Meeting held January 4-7, 1995, San Antonio, Texas.
Includes references
Place of Publication: Tennessee
Subfile: IND; OTHER US (not exp stn, ext, USDA; since 12/76) ;
Document Type: Article

03186197 CAB Accession Number: 960702423
Fiber maturity and yield potential of cotton under drip irrigation in sandy soils of the new land of Egypt.
Nawar, M. T.; Makram, E. A.; El-Ghandour, M. A.
Cotton Research Institute, Agricultural Research Center, Giza, Egypt.
1995 Proceedings Beltwide Cotton Conferences, San Antonio, TX, USA, January 4-7, 1995: Volume 1.
Conference Title: 1995 Proceedings Beltwide Cotton Conferences, San Antonio, TX, USA, January 4-7, 1995: Volume 1, p 569-570
Publication Year: 1995
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

03107474 CAB Accession Number: 950711625
Quantitative cotton fiber maturity measurements by X-ray fluorescence spectroscopy and advanced fiber information system.
Wartelle, L. H.; Bradow, J. M.; Hinojosa, O.; Pepperman, A. B.; Sassenrath-Cole, G.; Dastoor, P.
Southern Regional Research Center, Agricultural Research Service, U.S. Department of Agriculture, 1100 Robert E. Lee Boulevard, New Orleans, Louisiana 70179, USA.
Journal of Agricultural and Food Chemistry, Vol. 43 (5): p.1219-1223
Publication Year: 1995
ISSN: 0021-8561
Language: English
Document Type: Journal article

03021361 CAB Accession Number: 950704171
Fiber monitoring: regulation of cotton fiber maturity with harvest aids.
Lewis, H.
Conference Title: Proceedings of the 1993 cotton research meeting and 1993 summaries of cotton research in progress.
Special Report - Agricultural Experiment Station, Division of Agriculture, University of Arkansas (No. 162): p.39-46
Publication Year: 1994
ISSN: 0571-0189
Editors: Oosterhuis, D. M.
Publisher: University of Arkansas Publications, Fayetteville, USA
Language: English
Document Type: Conference paper; Journal article

01980510 AGRIS No: 96-051651
Quick independent estimates of cotton fiber maturity. 2.- practical unbiased maturity estimate utilizing micronaire reading
Beheary, M.G.I. Alexandria Univ. Egypt. Faculty of Agriculture
Journal: *Alexandria Journal of Agricultural Research*, Dec 1993, V. 38(3) p. 247-256
Notes: 3 tables; 8 ref.
Notes: Issued 1995
Language: English Summary Language: Arabic, English
Place of Publication: Egypt
Availability: Egypt Center
Document Type: Journal Article, Maps Included, Summary
Journal Announcement: 2205 Record input by Egypt

01952854 AGRIS No: 96-012049

Quick independent estimates of cotton fiber maturity -1-cross-sectional characteristics as a parameter of cotton fiber fineness and maturity
Beheary, M.G.I. Alexandria Univ., Egypt. Faculty of Agriculture
Journal: *Alexandria Journal of Agricultural Research*, Dec 1993, V. 38(3) p. 217-230
Notes: 2 fig. 3 tables; 10 ref.
Notes: Issued 1995
Language: English Summary Language: Arabic, English
Place of Publication: Egypt
Availability: Egypt Center
Document Type: Journal Article, Numerical Data, Summary
Journal Announcement: 2201 Record input by Egypt

08387257 Biosis No.: 000043095586
NIR analysis of textiles
Author: Ghosh, S; Rodgers, J.
Author Address: Institute of Textile Technology, Charlottesville, VA.
Journal: *Practical Spectroscopy Series*, Vol. 13. Handbook of Near-Infrared analysis. XVII+681P. Marcel Dekker, Inc.: New York, New York, USA; Basel, Switzerland.
ILLUS. ISBN 0-8247-8657-2. 0 (0). 1992. 495-526.
CODEN: PSPED
Record Type: Citation
Language: English

08332265 Biosis No.: 000094083513
Response of cotton *Gossypium hirsutum* L. to damage by insect pests; in Australian Manual Simulation of Damage
Author: Book, K. D.; Hearn, A. B.; Kelly, C. F.
Author Address: Queensland Dept. of Primary Industries, Meiers Road, Indooroopilly, Queensland 4068, Australia
Journal: J. Econ. Entomolo., 85 (4). 1992. 1368-1377.
Full Journal Name: *Journal of Economic Entomology*
CODEN: JEENA
Record Type: Abstract
Language: English

07954394 Biosis No.: 000093033492
Cotton *Gossypium hirsutum* response to simulated Triclopyr drift
Author: Snipes, C. E.; Street. J. E.; Mueller T. C.
Author Address: Delta Branch Exp. Station., Stoneville, MS 38776.
Journal: *Weed Technology*, 5 (3). 1991. 493-498.
CODEN: WETEE
Record Type: Abstract
Language: English

07396068 Biosis No.: 000091011678
Yield and quality of cotton *Gossypium hirsutum* in a ratoon cropping system
Author: Van Heerden H. G.; Rossouw, J. B.; Welding, M. C.
Author Address: Navorsinginst. Tabak en Katoen, Privaatsak X82075, Rustenburg, 0300 Suid-Afrika.
Journal: Applied Plant Science 4 (2). 1990. 67-69.
Full Journal Name: *Applied Plant Science*
CODEN: APLSE
Record Type: Abstract
Language: AFRIKAANS

07281069 Biosis No.: 000090060956
Reduction yield in quality of cotton damaged by Green Stink bug *Hemiptera pentatomidae*
Author: Barbour, K. S.; Bradley, J. R. Jr; Bacheler, J. S.
Journal: *Journal of Economic Entomology*, 83 (3). 1990. 842-845.
CODEN: JEENA
Record Type: Abstract
Language: English

05546782 Biosis No.: 000083019922
Improvement of yield and quality in upland cotton *Gossypium hirsutum* cultivar Pusa-595B through progeny bulk selection
Author: Singh, M.; Singh, V. P.; Paul, K.
Author Address: Div. Genet., Indian Agric. Res. Inst., New Delhi 110 012.
Journal: *Indian Journal of Agricultural Sciences* 56 (8). 1986. 562-566.
CODEN: IJASA
Record Type: Abstract
Language: English

05149604 Biosis No.: 000081107729
Standard classes for assessing cotton fiber maturity determined by the fibrograph method
Author: Fuzatto, M. G.; Gridi-Papp, I. L.; Sabino, N. P.; Kondo, J. I.; Chiavegato, E. J.
Author Address: Secao de Algodao, Instituto Agronomico-IAC, Caixa Postal, 28 13100-Campinas, SP, Brazil.
Journal: *Bragantia* 44 (1). 1985 (RECD. 1986). 275-282.
CODEN: BRGTA
Record Type: Abstract
Language: Portuguese

01626382 CAB Accession Number: 850527117
Efficacy of new insecticides against the bollworm and their effects on cotton yield, maturity, and fiber properties in West Tennessee.
Lentz, G. L.
Department of Entomology & Plant Pathology, University of Tennessee, West Tennessee Agricultural Experiment Station, Jackson, TN 38301, USA.
Journal of Agricultural Entomology, Vol. 2 (1): p.6-12
Publication Year: 1985
ISSN: 0735-939X

Language: English
Document Type: Journal article

2474563 85048211 Holding Library: AGL
Effects of insect management schemes on cotton yield, maturity, and fiber properties
Lentz, G.L.
Knoxville, Tenn.: The Station Tennessee farm and home science - Tennessee Agricultural Experiment Station. Apr/June 1984. (130) p. 2-5.
ISSN: 0040-3229 CODEN: TFHSA
DNAL Call Number: 100 T25F
Language: English
Includes references.
Subfile: Exp Stn (State Exper. Stn) ;
Document Type: Article

2034189 82074399 Holding Library: AGL
Cotton fiber maturity determined by the 430 Fibrograph.
Maturidade da fibra de algodao determinada pelo fibrografo modelo 430
Sabino, N.P. Gridi-Papp, I.L.; Kondo, J.I.; Buschinelli Carneiro, J.
Campinas, Brazil, Instituto Agronomico do Estado de Sao Paulo.
Bragantia. V. 39 (1), 1980. p. 69-77. ill.
ISSN: 0006-8705
NAL: 102.5 B73TB
Language: Portuguese; English
7 ref.
Subfile: Other Foreign
Document Type: Article

02091135 Biosis No.: 000063006122
Relationship of yield, seed quality and fiber properties in upland cotton
Author: Turner, J. H.; Ramey, H. H. Jr; Worley, S. Jr.
Journal: Crop Sci. 16 (4). 1976 578-580.
Full Journal Name: *Crop Science*
CODEN: CRPSA
Record Type: Abstract

1041715 789000343
Correlacoes entre a maturidade da fibra e outros caracteres economicos do algodoeiro; Simple correlations between fiber maturity and other economic characteristics in cotton
Sabino, N.P.; Gridi-Papp, I.L.; Grossi, J.M.M.
Bragantia 1976, 35 (2): 375-380. Eng. sum.
LC: 102.5 B73TB
Language: Portuguese
Document Type: Article

797149 769042777
Cotton [variety] fiber maturity and testing methods
Kosmidou-Demetropoulou, K.
Geoponika Nov/Dec 1975 (ser. 3) 21(227): 343-353. Eng. sum.
LC: S16.G9G4
Language: Greek
Document Type: Article

00789200 CAB Accession Number: 791674968
Inheritance of fiber maturity in some Egyptian cotton crosses.
El Ghawas, M.I.; Khalil, H.A.; Kamal, M.M.
Fac. Agric., Ain Shams Univ., Cairo, Egypt.
Annals of Agricultural Science, Vol. 20 (2): p.11-19
Publication Year: 1975
Language: English Summary Language: Arabic
Document Type: Journal article
Secondary Journal Source: *Abstracts on Tropical Agriculture* (1978), 4 (7) Abst. 21077.

01377554 Biosis No.: 000057017507
Effect of planting date on the yield and fiber properties of 3 cultivars
Author: Bilbro, J.D.; Ray, L.L.
Journal: Agron. J. 65 (4). 1973 606-609.
Full Journal Name: *Agronomy Journal*
CODEN: AGJOA
Record Type: Citation

01453363 Biosis No.: 000058023340
Studies in the fiber maturity of jute, flax and cotton and other vegetable fibers under different treatments.
Author: Khan, A.H.; Khan, K.A.; Hashmi, P.M.
Journal: Sci. Ind. (Karachi) 9 (1-2). 1972 (Recd 1973) 99-103.
Full Journal Name: *Science and Industry*
CODEN: SINDB
Record Type: Citation

289589 729071537
Determinacao da maturidade da fibra do Algodoeiro pelo fibrografo digital; Determination of the cotton fiber maturity by the digital fibrograph
Paulieri Sabino, N.; Gripi-Papp, I.L; Lazzarini, J.F.
Bragantia, 1971, 30 (1): I-IV. Eng. sum.
LC: 102.5 B73TB
Language: Portuguese
Document Type: Article

2722256 87215973 Holding Library: RQF; AGL
Apparatus for the Causticaire method of measuring cotton-fiber maturity and fineness / by George E. Gaus and Samuel T. Burley
Gaus, George E. 1894-Burley, Samuel T., 1915-Washington, D.C.: U.S. Dept. of Agriculture, Agricultural Marketing Service, Marketing Research Division, 1959. 20 p.: ill.; 27 cm. AMS; 329

DNAL Call Number: A280.39 M34Am no.329
Language: English
Cover title includes bibliographical references.
Place of Publication: District of Columbia
Government Source: Federal
Subfile: UIU; USDA (US Dept. Agr) ;
Document Type: Monograph; Bibliographies

2630642 87202419 Holding Library: RQF; AGL
The Causticaire method for measuring cotton-fiber maturity and fineness improvement and evaluation / by Robert W. Webb and Samuel T. Burley, Jr.
Webb, Robert W. 1895 - Burley, Samuel T., 1915-Washington, D.C.: U.S. Dept. of Agriculture, Agricultural Marketing Service, 1953. IV, 62 p. : ill.; 26 cm.
Marketing Research Report; no. 57
DNAL Call Number: 1 Ag84Mr no.57
Language: English
Cover title: “December 1953”
Bibliography: p. 48-50.
Place of Publication: District of Columbia
Government Source: Federal
Subfile: UIU; USDA (US Dept. Agr);
Document Type: Monograph; Bibliographies; Statistics