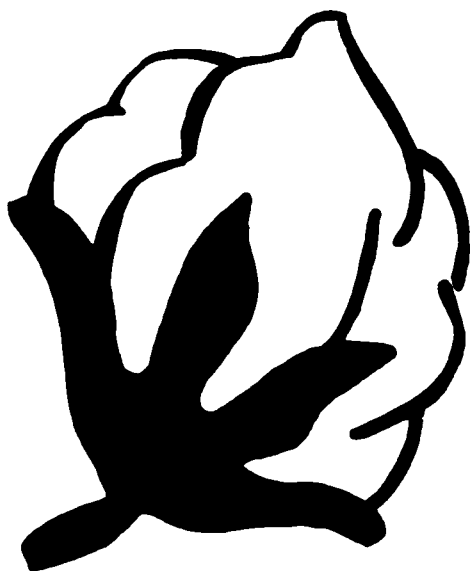




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- **Update on cotton production research**
- **Nouvelles recherches cotonnières**
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Introduction

Fiber length is one of the primary characters affecting yarn quality and is probably the quality characteristic most measured in cotton. Breeders have striven successfully to bring improvements in conformance with spinning industry requirements. However, improvements in fiber length are limited genetically in each species. Emphasis has shifted from increasing fiber length to improving length uniformity and accurately measuring short fiber content. Fiber length is defined in many ways and can be measured on a variety of machines. Details and factors affecting fiber length, its effect on yarn quality and current international issues are given in the first article.

Dr. Robert Kofi Mensah of Australia has contributed the second article in this issue of *THE ICAC RECORDER*. The report, "Conservation and Utilization of Beneficial Insects for Pest Management Programs in Cotton Systems in Australia," discusses intercropping of lucerne as a refuge and food for predators, planting cotton in stubble, and utilization of a food attractant that has been developed after eight years of research in Narrabri, as choices used to preserve insects beneficial against bollworms, particularly *Helicoverpa* spp. The application of beneficial insect food attractants on commercial cotton crops changed the predator-to-pest ratio by attraction and arrestment of predatory insects, increased the searching activity and consumption rate of predators, and decreased the oviposition activity of *Helicoverpa* spp.

The third article is a brief note on gossypol content in cotton. Gossypols are helpful for host plant resistance against bollworms, particularly pink bollworm and tobacco budworm. But gossypols in cotton seed are harmful to livestock (raw seed) and humans (oil). The most desirable situation would be to have a high gossypol content in plants but no gossypols in seed. Natural sources of such a combination existed in uncultivated diploid species, and a team of researchers in Belgium has developed genotypes through trispecies hybridization that have gossypol in plant parts but reduced levels of gossypols in the seed.

The Inter-regional Cooperative Research Network on Cotton for the Mediterranean and Middle East Regions will have its joint meeting in Adana, Turkey, from September 20-24, 2000. More details of the meeting and a registration form are given on page 17.

Also, a Dialog search of the CAB Abstracts database was conducted on gossypol in cotton. The reported work includes development of gossypol free varieties, registration of low gossypol varieties, insect reactions to gossypols, gossypol content in disease-affected plants and roots, effect of fertilizers and growth regulators on gossypol content, and tissue residue levels of high gossypol cotton seed fed to animals.

Fiber Length: Achievements and New Challenges

Fiber formation initiates on the day of anthesis, and fiber length is determined in the next 15 to 25 days by genetic factors and growing conditions. Among tetraploid cottons, fibers start to appear even before anthesis in *G. barbadense*, while the process of fiber formation in *G. hirsutum* may start shortly after anthesis has taken place. Though there are species-to-species differences in the beginning time of fiber formation, it is common in all species that fibers start appearing first on the chalazal region. Initiation of fibers on the micropylar end could start one to two days later. This is the first wave of fibers and forms the lint. The second wave of fibers, which is equally dense and starts after anthesis, may continue to grow up to ten days after anthesis and forms the bulk of linters or fuzz on the seed.

Length Formation

Cotton fiber is a unicellar outgrowth from the epidermis of the cotton seed, in the case of a fertilized ovule, and from a mote when fertilization does not take place. The fiber formation process can be divided into three stages. First, although many factors will have effects, on average for the first 24-48 hours fiber growth is non-polar or isodiametric, meaning that length is still not a criterion for fiber growth. Therefore, for about 48 hours, fibers grow on the surface of the ovule (fertilized or not fertilized) in the form of a balloon like protrusion. Fiber diameter is established within 24-48 hours after anthesis and long before fiber length. As soon as the diameter of the fiber is reached, its intrinsic fineness (fiber perimeter), which remains constant, is also established.

The second stage begins when each fiber starts to grow in length. Fiber elongation can start a few hours earlier, but in most cases polar elongation or fiber tip growth starts on the third day after anthesis. Non-polar fiber growth is more a genetic character, while fiber elongation is greatly influenced by growing conditions in addition to species and variety characteristics. Fiber continues to grow in length for 15 to 25 days. The duration of fiber length growth depends on genotype and environmental factors. At the end of the second stage, when fiber ceases to grow, fiber length and length distribution are finally established. The second stage results in the formation of a primary cell wall, which is flexible enough to accommodate a large quantity of cellulose.

The third stage begins with the deposition of cellulose within the primary wall. Literature shows that the formation of primary and secondary walls overlaps for a considerable period of time extending up to 10 days. However, chances are that the overlapping of two stages (second and third), calculated on the basis of mean fiber length and dry weight for a boll, could be due to variation among seeds or among fibers. The secondary wall comprises cellulose deposited in the form of tiny threads called "fibrils" placed side by side to form a ring shaped lamellae. The fibrils follow a helical course making an angle known

as the spiral angle that varies from variety to variety and is also subject to environmental effects. In general, longer fibers have a steeper spiral giving them more strength compared to shorter fibers. The fibrils of different lamella may have different spiral angles and may also adopt a reversal spiral path. The places in the fibrils in the lamellae where spirals change their directions usually form the weakest parts of the fiber and make them more prone to breaking during processing. The frequency of reversals is variety-dependent but may be affected by other factors, although very little is known about the influence of other factors on frequency reversals. The secondary wall forms more than 90% of fiber weight and practically determines most fiber properties.

Fiber Length Variation

Fiber length is not the same on all seeds within a boll; thus no boll has a uniform fiber length. But fiber length variation within a boll is less than the variation in fiber length among bolls on the same plant. The position of bolls on the plant has a significant effect on fiber length. A large number of squares are formed but the cotton plant cannot afford to retain and convert all into bolls. Fruit abscission occurs due to physiological, environmental and entomological reasons. Some abscission is necessary for the remaining fruit on the plant, and there is a lot that simply cannot be avoided. Particularly, the available photo-assimilates become limiting close to the end of the season, which is the main reason for the shedding of flower buds and even small bolls. Whatever the reason for the shedding of fruit forms, the distribution of bolls on the plant is not uniform. Plant type has a lot to do with the distribution of bolls. In a sympodial type, early-maturing variety, about three-quarters of the produce come from the central part of the plant. The early-formed bolls usually have shorter staple length compared to mid and late season bolls. As in the case of bolls positioned at the bottom, middle or top portion of the plant, the uniform location of bolls on the sympodial branches, i.e. first position or second position, also produces more uniform fibers compared with other locations. Fibers on a single seed measure longer on the chalazal or blunt end compared to the micropylar end.

Fiber length is usually measured after ginning. The lint sample used in the estimation of fiber length is comprised of fibers taken from not only the various ends of the seed but also from various seed positions within a locule, various boll positions on the plant, various plants within a field and various fields on the farm. Variation in length among fibers harvested from the same field is more related to position of bolls on the plant.

Breeders have made enormous efforts over decades, to satisfy the fiber length requirements of the spinning industry. There have been changes in spinning machinery to faster speeds, but research efforts have met the requirements of the spinning industry. Length is no longer a spinners' number one priority in

high-speed open-end spinning. Rather, spinners now require finer and stronger lint. It shows that breeders' efforts have been successful. In the USA, average staple length has increased at the rate of 1/32nd of an inch every ten years since 1975. The fiber length uniformity index has also increased steadily but at a slower rate. Similar statistics may not be available from other cotton producing countries, but the basis for the increase in fiber length and uniformity index—cultivation of longer uniform fiber-producing varieties—shows that the same could be happening in other countries. Upward revisions in the staple length quote of the cotton referred to by the New York futures and the Cotlook A Index is another indication that the average fiber length of world cotton production has increased.

Factors Affecting Fiber Length

Today's cotton plant has been evolved in the hotter and dryer parts of the world and still retains a high degree of tolerance to drought and a need for sufficient light. Independent of the water situation and other factors affecting growth in the field, 32°C is the most suitable temperature for plant growth in *hirsutum*. Though there may be a difference of opinion about the most suitable temperature within *hirsutum* genotypes, as they can be modified for new conditions, the most suitable temperature for plant growth is also the most suitable temperature for fiber growth. If there were no variation in maximum and minimum temperatures, the variation in fiber length produced on the same plant would be significantly reduced. Cotton grown under high temperatures produce comparatively shorter fibers while low temperatures below optimum may not only prolong the formation of proper length but may also help to form a longer fiber. Extremely low temperatures affect fiber maturity and could also be detrimental to fiber length.

No universal conclusions can be drawn to say that an increase in temperature could improve fiber length or could have a negative effect, because not only growing conditions could be different but varietal response to growing conditions could also be different. Maximum temperatures over 32°C, and minimum temperatures below 15°C will have a negative effect on fiber elongation. Similarly, the formation of the secondary wall could also be affected by variations in temperatures.

Water stress can negatively affect fiber length in many ways. Though developed bolls have a higher tolerance to water stress than green leaves on the plant, water stress for small bolls, particularly those less than ten days old, means abscission. Seeds within growing bolls are more affected than bolls. Water stress can lower the seed index and thus affect a seed's ability to properly feed fibers. Water stress conditions in general produce shorter fiber length.

The effect of fertilizer on fiber length is determined by the excess or deficiency of the water supply. In particular, a shortage of nitrogen could have a serious effect on fiber length. An adequate supply of nitrogen may not increase the number of fibers per seed but would certainly help to get the best interac-

tion out of genetic ability and growing conditions for fiber length. If the soil were deficient in potassium, the addition of potassium fertilizer would not only increase fiber length but would also improve length uniformity. Potassium has a significant effect on seed maturity, and if the supply is not enough, the addition of potassium would increase seed weight. So, the effect on length and uniformity could be a secondary effect of the increase in the seed index. Literature also shows that, if not required, the addition of some micronutrients like manganese, zinc and boron decreases fiber length.

Fiber length formation is also dependent on many other factors, including humidity, sunlight and insect pressure, but genotypic influence remains the primary determining factor. Length formation can also affect other quality characters like strength, fineness and maturity.

Fiber Length vs. Yarn Quality

Fiber length is the most important fiber character affecting yarn quality. Length and length uniformity have a direct influence on yarn strength, elongation, evenness, hand, structure, and hairiness, as well as on yarn twist performance. Though literature shows that longer fibers may be weaker and shorter fibers stronger, in general, longer fibers are stronger than shorter fibers under the same growing conditions, and if genotypic differences are not great.

Fiber length has a variable degree of influence on various yarn parameters. Yarn evenness or irregularity could be affected by the number of fibers per cross section or length uniformity. The relationship between length uniformity and yarn evenness is linear, provided short fiber content is low and remains constant for given samples. The direct effect of length uniformity could occur at the nip of the feed roller. There will be a more irregular release of fibers and, consequently, yarn evenness will go down if the variation in fiber length is greater. The uneven release of fibers will produce a yarn quality inclined toward ring-spun yarn. Another effect could come from the drawing process, where fibers are straightened for even formation of yarn. But, if the floating fibers are high, it leads to uneven distribution of fibers in the sliver, ultimately affecting yarn evenness. A high percentage of uncontrolled fibers or floating fibers can increase the drawing waste significantly, another direct loss. The leveled-out card sliver has the potential to reduce drawing waste, but it is difficult to eliminate the effect of differences in fiber length on the ultimate quality of yarn. Lower uniformity index for fiber length, lower upper half-mean length and mean length enhance the coefficient of variation in yarn irregularity. Yarn strength and yarn elongation could be negatively affected by shorter span length. Yarn irregularity can increase yarn strength variability.

Fiber Length Definitions

Fiber length can be measured by different methods. However, the fiber length measurement methods also have an effect on

length measurement expression. According to Behery (1993), the following fiber length definitions are used in the trading and processing of cotton fiber.

Staple Length

Staple length can be called the classer's estimate of fiber length and is the oldest method used to estimate the fiber length of cotton. Length is still measured on a hand-prepared staple like a tuft wherever hand classing is in practice. Staple length is a personal judgment of the length appearance of the sample prepared from a given cotton bale or lot. Preparation of the sample has a lot to do with the staple length estimation. This is one of the reasons why there could be differences in judgment by different individuals of as high as three millimeters, even if a ruler is used in length measurement.

Modal Length

The length in a fiber sample length distribution frequency diagram, which lists the highest frequency of occurrence.

Mean Length

An arithmetic mean of all the fibers in the test specimen based on weight-length data.

2.5% Span Length

Currently, the most commonly used measure of fiber length adopted in most countries where HVI use is still not popular. 2.5% span length is the length that is exceeded by only 2.5% of the beard fibers scanned by the Fibrograph.

Effective Length

The effective length value is the upper quartile of a numerical length distribution from which some of the short fibers have been eliminated in the process of preparing the specimen. This is a length measurement that is closer to the staple length value.

Upper Quartile Length

The fiber length that is exceeded by 25% of the fibers by weight in the test specimen when tested by the Array method.

Upper-half Mean Length

The mean length of fibers longer than 50% of the fibers by weight as tested by the HVI.

Length Uniformity Index

The ratio between the mean length and upper-half mean length expressed as a percentage of the upper-half mean length.

Length Uniformity Ratio

A ratio between two span lengths expressed as a percentage of the longer length. The 2.5% and 50% span longer lengths and the 50/2.5 uniformity ratio are usually used.

Span Length

A distance scanned by a specific percentage of fibers in a test

beard when tested by the Fibrograph, taking the amount reading at the starting point of scanning as 100%.

Short Fiber Content

Short fibers are fibers measuring less than 12.7 mm (half an inch).

Floating Fiber Index

The floating fiber index (FFI) relates to those fibers that are not clamped by either of the pairs of rollers of a drafting system.

ITMF Working on Fiber Length

The International Textile Manufacturers Federation has a technical committee commonly known as the ITMF International Committee on Cotton Testing Methods. Formed in 1980, the ITMF International Committee on Cotton Testing Methods conducts its work through five working groups dealing with maturity, stickiness, dust/trash, fiber length and high volume instrument (HVI) testing. Each working group has its own membership but all the working groups meet together every two years. The main function of the committee, and thus of the Working Group on Fiber Length, is to consider various testing methods/machines or reference methods for testing a particular fiber characteristic and approve them as recommended. The committee is not an authority to approve or reject testing methods, rather it is a discussion group with the mandate to analyze new developments in fiber testing equipment. The committee and the Working Group on Fiber Length meet every two years before the International Cotton Conference in Bremen, Germany. The last meeting of the Working Group on Fiber Length was held from February 29 to March 1, 2000. The Group reviewed the state of fiber length measurement in the world and considered some new machines for measuring length parameters. The meeting is summarized here.

- The Bremen Fiber Institute undertakes round tests on different parameters of fiber length. According to the Bremen Round Tests, fiber length measurements at the long end of the distribution are consistent with acceptable levels of variation among laboratories.
- The ITMF International Committee on Cotton Testing Methods recommends that only HVI Calibration Cotton Standards be used for HVI calibration. However, about 50% of the Bremen Round Tests participants still use International Calibration Cotton Standards (ICCS).
- 2.5% span length results and upper-half mean length results have the same values with low variations among laboratories. The same conclusions can be made for the between-laboratory variations of the Uniformity Ratio and Uniformity Index values.
- Short Fiber Content (SFC) measurements by means of the Almeter, the Advanced Fiber Information System (AFIS) and HVI lines are unsatisfactory in the Bremen Round Tests. The

implementation of the Short Fiber Index (SFI) measurement in HVI lines did not improve the results in the Bremen Round Tests. Currently, AFIS seems to be better than other machines for measuring SFC, but there is a strong need for a better machine to measure SFC.

- A report from Zellweger Uster Inc. on the analysis of the Bremen Round Tests SFC data showed that there are considerable differences in inter-laboratory variation for each cotton type, depending on the origin of the cotton.
- Work done in Poland showed that fiber length values in AFIS are influenced not only by different software but also by the machine hardware.
- Lenzing Technik of Austria presented a new machine (FILE) for measuring fiber length with a focus on short fiber content. The instrument has the ability to measure fiber length at a speed equivalent to AFIS but still more data is required to judge the repeatability of the data among labs and machines. The machine is being developed with the objective of improving repeatability, reliability, speed and comparability of data with other machines.
- The Working Group decided to organize special round tests on AFIS for measuring length and length distribution because of the high variation in the Bremen Round Tests.
- The issue of redefining the SFC definition was raised. The current definition of less than 12.7 mm, or half an inch is not a fair criterion for diploid cottons. It was stated that SFC should be a function of fiber length; however, nothing was decided. The issue of redefining SFC will be discussed at the next meeting in March 2002.

Methods to Measure Fiber Length

A number of methods and machines are available to measure fiber length and some are more objective than others. The oldest method used is the combing and tuft method of measuring staple length. Fiber length can also be measured while fibers are still on the seed by straightening them. The tuft method is the most common method used by professional classers, among the old methods.

The Array method physically separates fibers of various lengths and measures weight-length data, upper quartile length, mean length and coefficient of length variation. In a sample of 75 gms, fibers are straightened and aligned with the help of two banks of parallel combs. The fibers are pulled in such a way that one end of each fiber is aligned at the base of one comb. Similarly, the process is repeated to align the other end of the fibers. The fibers are placed on a velvet-covered board and pulls are measured. This method is not a precise measurement of fiber length, so it is not used in commercial transactions.

HVI testing has gone through extensive changes since two different companies introduced the system during the 1980s. In the latest HVI machines, like Model 900 of Zellweger Uster Inc., the test specimen is held in a clamp in such a way that

fibers in the bundle are contained in a random position. Light is sent through the sample and the beard is scanned photoelectronically from the base to the top. The amount of light passing through the beard is used as a measure of the number of fibers that extend various distances from the comb. It is the same principle used in the Fibrograph. HVI data may also provide information on the 50% span length and uniformity ratio in addition to the 2.5% span length. HVI is the fastest way of measuring fiber length.

HVI use is expanding because of its efficiency and ability to produce reliable results, but the Fibrograph is still the most commonly used method of estimating fiber length where HVI has not been adopted. Fibrograph data is based on the assumption that fibers are caught in the comb in proportion to their length and the point of catch is random at its length. The Fibrograph may not necessarily produce results in close agreement with other systems; however, the inter-laboratory Fibrograph readings normally have a high degree of confidence and repeatability.

The methodology applied in the Advanced Fiber Information System, AFIS-L&D, is different from the other methods mentioned above. AFIS-L&D gives detailed single fiber information on length by weight and length by number. AFIS-L&D can measure upper quartile length, fiber histogram, staple length diagram, and fiber length at various span lengths in addition to short fiber content. AFIS-L&D has a sample preparation facility wherein all the fibers are individualized. Individual fibers are transported in an air stream through a sensor that has a camera which registers the length of each fiber even in curled condition. Because AFIS – L&D provides the measurement of individual fibers, it constitutes a way of measuring SFC.

Routinely Used Length Grades		
Length		Classification
(mm)	(inches)	
< 12.7	< ½ inch	Short fiber content
12.8 to 25.4	½ to 1 inch	Medium staple
25.5 to 27.9	1 ¹ / ₃₂ to 1 ³ / ₃₂	Medium long staple
28.0 to 33.5	1 ¹ / ₈ to 1 ⁵ / ₁₆	Long staple
> 33.6	> 1 ³ / ₈	Extra long staple

Short Fiber Content

Zero short fiber content would be an ideal situation but it is not possible. Cotton naturally has some percentage of SFC, which can be called inherent or genotypic dependent SFC. However, most of the short fibers originate during ginning. Ginning not only reduces fiber length but also increases SFC many times. As cotton has to be ginned, the increase in SFC cannot be avoided, but it seems that by making the process gentler the amount of SFC can be reduced. Varieties with less SFC can also be developed. There are no universally accepted classifications for SFC. However, the lower the SFC the better. Some

indications of short fibers in a sample of cotton are given below.

Short Fiber Content	
%	Classification
< 6	Very low
6.1 to 9.9	Low
10.0 to 13.9	Medium
14.0 to 16.9	High
> 17	Very high

The spinning industry is becoming more conscious of SFC as it represents a direct as well as an indirect loss to spinners, and yet there is no incentive to lower SFC. In general, cotton with a low SFC does not receive any premium

and cotton with an extremely high SCF is not punished. The lack of reliable testing methods could be a reason for the non-observance of SFC standards. So far, all fibers less than 12.7 mm are said to be SFC, but how much shorter the fibers can be and still be spinnable with a minimum effect on yarn quality is not understood.

Short fibers can be measured by weight or by percent, and the uniformity index also indicates the quantity of SFC. In general, a high uniformity index means a low quantity of SFC, but the uniformity index cannot be used as a measure of short fibers in a given sample. There is recognition of the fact that SFC should be measured irrespective of other length readings. The message from the spinning industry's point of view is to reduce SFC and also find suitable, efficient and reliable testing methods for SFC.

Fiber-to-Seed Attachment Force

Fibers are pulled away from the seed coat during the process of ginning. The action could be just pulling in the case of roller ginning or pulling plus beating in the case of saw ginning. Whether it is roller ginning or saw ginning, fibers undergo a physical stretch that can cause breakage. This is the reason that fiber length is reduced during ginning and SFC is increased.

Verschraege and Kiekens (1987) undertook interesting studies on the fiber-to-seed attachment force at different positions on the seed. They reported that there is a drastic variation among species. The attachment force varied from 20 to 80 cN.cm/mg in *hirsutum* genotypes. In many uncultivated species, fibers were more strongly attached to the seed coat and the value ranged from 200-700 cN.cm/mg. On the other hand, *G. barbadense* varieties have an attachment value of as low as 8 cN.cm/mg. The study does not report on the diploid cultivated species, but it is assumed that their attachment force is higher than *hirsutum*. If fibers are more firmly attached to the seed coat, more force will be required to remove them. Higher force consequently means higher chances of fiber breakage (or length reduction) thus creating more short fibers.

Strong fibers have a higher probability of resisting stretching forces. But interspecies and intraspecies differences in the attachment force suggest that varieties with a lower attachment force can be developed, and physical pressure on the fiber during the harshest processing can be reduced. Though Verschraege

and Kiekens also observed that the fiber-to-seed attachment force is not related to tensile strength, fiber perimeter and maturity, it does seem that immature fibers are weakly attached to the seed. Inexpensive equipment is available to estimate the attachment force, but it is customary not to test varieties for this character.

Issues for Consideration

The significance of fiber length was recognized over 300 years ago when mechanical spinning was introduced on a commercial scale. Length has been measured for a long period of time and probably is one of the most researched fiber quality characters. However, there is a cap in the improvement of fiber length, beyond which improvement is not possible within groups. Thus, it would be realistic to assume that arboreum varieties with the same fiber length as *hirsutum* varieties cannot be developed, or that *hirsutum* varieties with fibers as long as *barbadense* varieties cannot be developed. And, the reverse is also true: *barbadense* varieties with fiber lengths as short as *arboreum* cannot be developed. It is concluded that the improvement in length within species is subject to certain limits.

Fiber length is a quantitatively controlled genetic character. To transfer together an accumulation of desirable genes and alleles in one genotype to another genotype is out of the control of breeders. Thus, now the textile industry could benefit more by concentrating breeding efforts on improving other qualities related to fiber length or other fiber parameters, rather than length.

Length uniformity is an important character in fiber length which would require more attention than it has received in the past. The intervarietal differences in length uniformity provide a strong hope and a challenge for researchers to develop varieties, if not without variation, at least with a minimum variation in length among fibers on the same plant. Since insufficient work has been undertaken on this aspect, it still needs to be determined how much conventional breeding can contribute to bring improvements in fiber length uniformity.

The first phase in the application of genetic engineering to cotton was focused around agronomic traits. However, since biotechnology became an applied technology, it has been anticipated that genetic engineering technologies could be applied to bring improvements to other characters. No such genotypes are available yet, but improvement in fiber quality including length is among the targets. It is not sure if it will be through manipulation of mRNA (Messenger Ribose Nucleic Acid) or of hormone levels in developing fibers, or through the synthesis of new biomaterials in fibers, or even through an unknown approach at this time that could be followed to obtain more control on length formation. If researchers were successful in obtaining such a control, the level of control would determine the success in producing all fibers of equal length on the same plant. Uniform fibers is certainly an area of great interest to biotechnologists.

Short fiber content has two challenges: to reduce the quantity

of short fibers, and to measure SFC with a higher degree of confidence. Current efforts of machinery manufacturers indicate that the accurate measurement of SFC, where data could be repeated in laboratories, is not far away. However, minimizing SFC by, say 50% or even lower, will be a challenge for a long time.

The fiber-to-seed attachment force and its contribution in minimizing SFC is another area of research which could be studied in more detail and could be utilized.

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Conservation and Utilization of Beneficial Insects for Pest Management Programs in Cotton Systems in Australia

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Abstract

Many predatory insects such as predatory beetles, bugs, lacewings and spiders have been recorded in cotton systems in Australia and other parts of the world, but their potential value has not been widely exploited in cotton pest management due to lack of techniques to conserve and maximize both their abundance and effectiveness. Adoption of within-field monocultures in cotton production systems is known to discriminate against and reduce the activity of predatory insects because they lack ecological diversity. The major focus of the Australian cotton industry is to reduce its dependence on synthetic insecticides for the control of major pests in cotton, particularly *Helicoverpa* spp. This can be achieved through the development of alternative pest control strategies, which place much more emphasis on the role of beneficial insects. Studies have been conducted since 1992 using strip intercropping, beneficial insect food attractants and planting cotton in wheat stubble to conserve and utilize beneficial insects for pest management programs in cotton. In addition, a predator-to-pest ratio has been developed as a threshold to incorporate the activity of predators into pest management decisions to control *Helicoverpa* spp. in cotton. The application of beneficial insect food attractants on commercial cotton crops can mediate changes in the predator-to-pest ratio by attraction and arrestment of predatory insects fol-

lowing food attractant spray, increased searching activity induced by contact with and feeding upon the food attractant, increased consumption rate of predators, and decreased oviposition activity of *Helicoverpa* spp. due to the presence of the food attractant, especially Envirofeast®. The decision to control *Helicoverpa* spp. should be based on a predator-to-pest ratio of 0.5 or lower in the cotton crop as indicated by scouting/bug checking counts. For food attractant sprays to work effectively, there need to be a source within or close to the cotton farm where the insects can be attracted. Interplanting a lucerne crop in cotton fields as strips can conserve and increase the densities of predatory insects of *Helicoverpa* spp. in cotton. The interplanted lucerne crop acted as a refugia and a source of the predators to the cotton crop. Also, planting cotton in wheat stubble can conserve some beneficial insects in cotton.

Introduction

The role of generalist beneficial insects in regulating pests in agroecosystems, especially the cotton system, is becoming increasingly important (Clark *et al.* 1994). Though these beneficial insects, particularly generalist predators, do not show tightly coupled dynamics with their prey, they most often provide effective control, particularly in non-chemical insecticide regimes, because their population dynamics are not solely dependent on

target pests (Wratten, 1987; Murdoch *et al.*, 1985). Many beneficial insects have been recorded in cotton worldwide, which include generalist predators and specialist parasitoids. The potential value of these beneficial insects has not been widely exploited in cotton pest management due to a lack of understanding of its efficacy, lack of techniques to maximize their abundance and effectiveness, and the indiscriminate use of broad-spectrum insecticides. The adoption of within-field monocultures in cotton production systems worldwide also discriminate against and reduce the activity of beneficial insects because they lack ecological diversity (Hagen and Hale, 1974).

In Australia, cotton fields are monoculture, which militates against the activities of beneficial insects. In such agroecosystems, pest populations increase, minor pests become major pests and non-pests become pests. This is because the food, hosts, prey, and hibernating or overwintering sites of natural enemies are reduced, thus affecting biological control (DeLoach 1971; Mensah, 1997, 1999). Natural enemies of cotton pests usually have different food requirements in the larval and adult stages to develop and survive through the season. In contrast, adult pests particularly *Helicoverpa* spp. can normally lay their eggs without any feeding, relying only on food reserves transferred from their larval stage (Beirne, 1967). *Helicoverpa* spp. are highly migratory and can rapidly infest cotton crops and lay their eggs. Unless natural enemies are present and well established in high numbers before pests arrive, they cannot respond rapidly enough to control them (Fitt, 1989; Mensah, 1997, 1999).

The development of a strategy that may conserve and maximize the abundance and effectiveness of natural enemies of pests in cotton fields will be crucial to enhance biological control. In agroecosystems, manipulating the habitat has shown to enhance biological control of crop pests (Alderweireldt, 1994; Mensah, 1999). In Australia, techniques such as strip intercropping cotton with lucerne, provision of supplementary food, and the use of a predator-to-pest ratio as a threshold to incorporate activities of beneficial insects in pest management decisions have shown to conserve and maximize the abundance and effectiveness of beneficial insects in cotton systems.

Provision of Supplementary Food

The most important predators of *Helicoverpa* spp. in Australia are given in Table 1. The application of supplementary food products, such as artificial honeydews, to crops has been reported to attract and concentrate predatory insects and enhance biological control (Neuenschwander and Hagen, 1980; Hagen, 1986).

In Australia, a beneficial insect food attractant called Envirofeast® (NSW Agriculture product and commercialized by Rhone-Poulenc Rural Australia Pty Ltd) has been developed. The product, when applied to cotton, attracts, arrests and conserves predatory insects (Figure 1). The food product has been used on commercial cotton to manipulate populations of

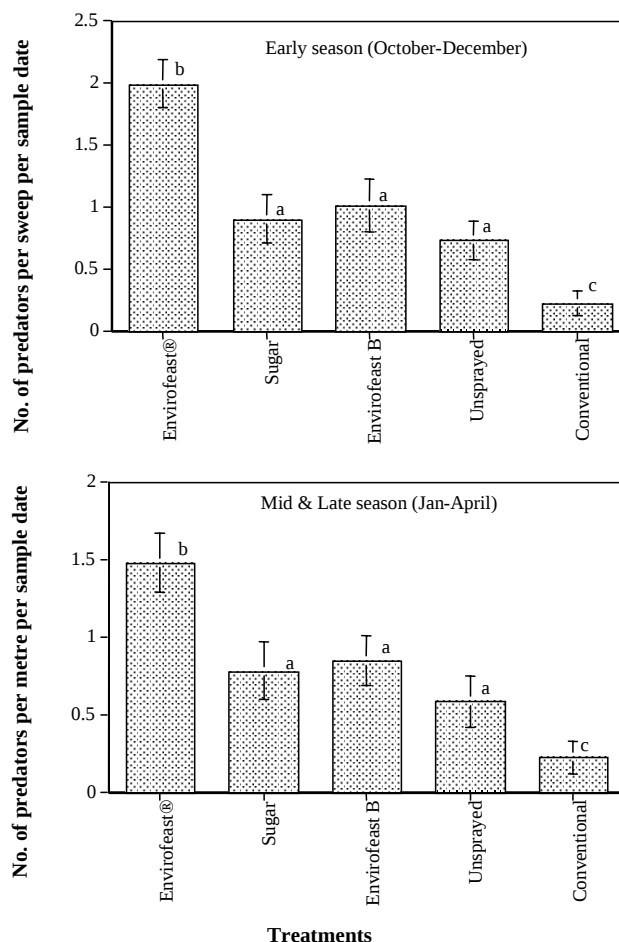


Figure 1: Effect of food sprays on numbers of predatory insects on commercial cotton during the early, middle and late cotton season in Auscott at Narrabri, NSW, 1992-93. Means between treatments followed by same letter are not significantly different ($P > 0.05$). Error bars represent standard errors.

predatory insects and utilize them in pest control programs. The strength of such manipulation may be dependent in part on the type of food supplement or protein supplement in the food product. The use of supplementary food to attract, arrest and conserve predatory insects in cotton fields, especially early in the season is important for the management of *Helicoverpa* spp. in cotton.

For food sprays to attract predators effectively into cotton farms, it is crucial to have a haven within or close to the cotton farm from where insects can be attracted. A refugia for the beneficial insects can be set up in the form of alternative crops interplanted as strips in a commercial cotton farm or as borders to cotton fields, or in a centrally-located field in the cotton farm.

Apart from food sprays attracting and arresting predatory insects when applied to cotton crops, food spray products can increase the consumption rate of some predators particularly ladybird beetles (Figure 2), increase their searching ability and suppress oviposition of *Helicoverpa* spp. females (Mensah, 1996). Studies show that the number of *Helicoverpa* spp. eggs

Table 1: Major Predators of Cotton Pests in Australia

Order	Family	Species	Group
Coleoptera	Coccinellidae	<i>Coccinella transversalis</i> (Fabricius)	Predatory beetles
		<i>Adalia bipunctata</i> (Linnaeus)	
Hemiptera	Melyridae	<i>Dicranolauis bellulus</i> (Guerin-Meneville)	Predatory bugs
	Nabidae	<i>Nabis capsiformis</i> (Germar)	
	Lygaeidae	<i>Geocoris lubra</i> (Kirkaldy)	
	Pentatomidae	<i>Cermatulus nasalis</i> (Westwood)	
		<i>Ochelia schellenbergii</i> (Guerin-Meneville)	
Neuroptera	Reduviidae	<i>Coranus triabeatus</i> (Horvath)	Predatory lacewings
	Chrysopidae	<i>Chrysopa</i> spp.	
	Hemerobiidae	<i>Micromus tasmaniae</i> (Walker)	
Araneida	Lycosidae	<i>Lycosa</i> spp.	Spiders
	Oxyopidae	<i>Oxyopes</i> spp.	
	Salticidae	<i>Salticidae</i> spp.	
	Araneidae	<i>Araneus</i> spp.	

consumed by transverse ladybird beetle is significantly higher on cotton leaves treated with Envirofeast® than on leaves treated with a sugar solution or water (Figure 2).

Guidelines for Use of Food Sprays in Cotton Systems

The pest management system whether organic or IPM which incorporates food sprays essentially focuses on the manage-

ment of insect pests by manipulating predatory insect populations. For the success of this type of pest management strategy, it is important to select a field or whole farm far away from insecticide drift or not to be surrounded by conventional insecticide-managed farms. It is also very important for the grower or consultant or the pest manager to carry out visual checks (i.e. bug checking or scouting) of pests particularly *Helicoverpa* spp. or bollworm eggs, very small (VS), small (S), medium (M) and large (L) larvae, and all beneficial insects at least two times every week or as required by the grower for the particular farm. Both pests and beneficial insects should be recorded as numbers per meter. This is to allow a predator-to-prey or a pest ratio to be determined and used as a protocol to make pest management decisions on a particular farm.

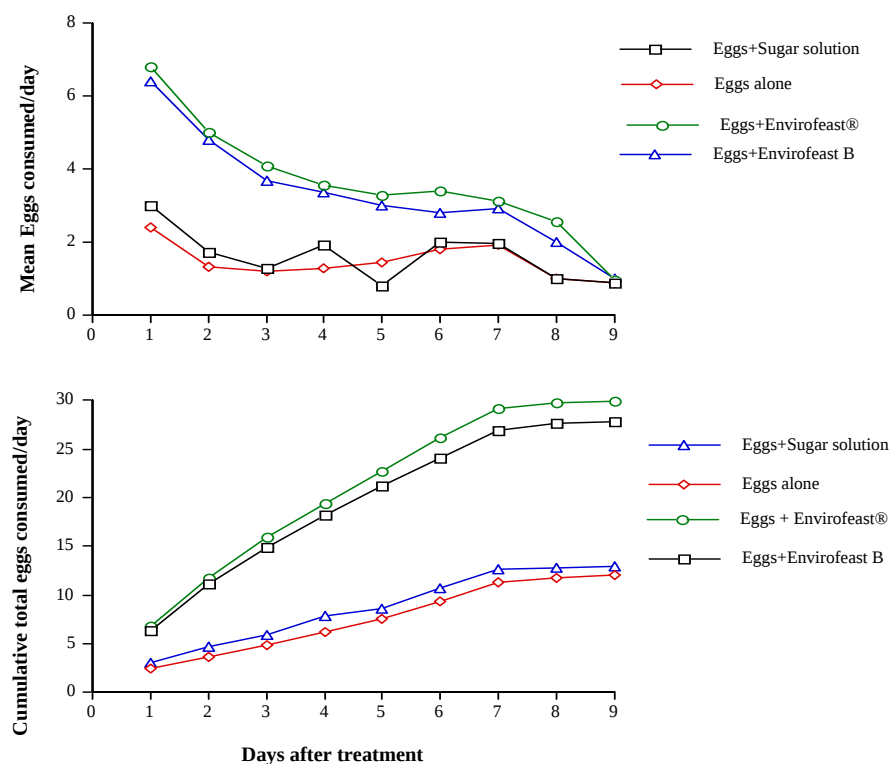


Figure 2: Effect of food sprays on the number of *Helicoverpa* spp. eggs consumed by *C. transversalis* in the laboratory at ACRI in Narrabri, 1997-98.

Recommended Application of Food Sprays

Food sprays can be applied as band

or skip row in early season or over the entire field in mid and late season using a groundrig, knapsack or an aircraft. Application volume when using a knapsack or groundrig will vary according to the stage of the cotton crop. Application to run off is recommended to ensure good coverage.

Use of Predator-to-Pest Ratio

Since beneficial insects, particularly predators, form a major component in pest management programs, it is very important to incorporate their activity into pest management decisions. This can be achieved through the use of a predator-to-pest (*Helicoverpa* spp.) ratio. The application of insect food attractants on commercial cotton crops can mediate changes in the predator-to-pest ratio by

- (1) attraction of predatory insects to the area by volatile compounds emitted by the food attractant;
- (2) arrestment of predatory insects in the area following contact and subsequent feeding on the food attractant;
- (3) increased searching activity induced by contact with and feeding upon the food attractant;
- (4) increased consumption rate of predators; and

(5) decreased oviposition activity of *Helicoverpa* spp. due to the presence of a food attractant like Envirofeast® (Mensah, 1996; 97; Mensah *et al.*, 2000; Mensah and Singleton, 1999). The decision to control *Helicoverpa* spp. should be based on the ratio of predators to pests in the cotton crop as indicated by scouting/bug checking counts. A predator-to-pest ratio of 0.5 or higher can reduce the survival of very small and small larvae to medium and large larvae (Figure 3). However, a ratio lower than 0.5 resulted in higher survival of *Helicoverpa* larvae (Figure 3).

Decision Making Protocol

The accepted predator-to-pest threshold is 0.5 or higher.

- When the predator to pest ratio falls below 0.5 but is higher than 0.4 and *Helicoverpa* population is mostly eggs, a food supplement can be applied to attract more predators to feed on the eggs and improve the ratio.

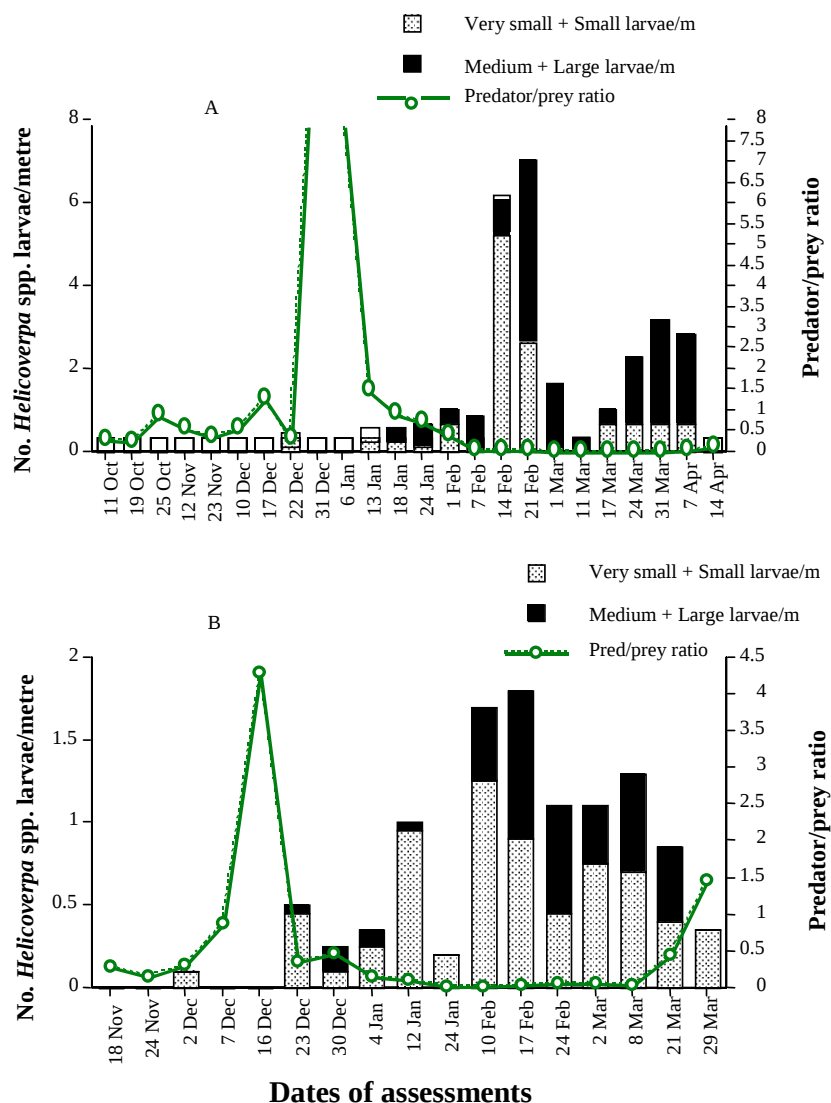


Figure 3: Comparisons of predator-to-prey ratio on numbers of *Helicoverpa* spp. larvae in cotton farms at (A) Norwood, 1993-94 and (B) Bellevue, 1994-95 seasons.

- However, when the *Helicoverpa* population falls below 0.5 but is higher than 0.4 and the bug check consists predominantly of neonates (rather than eggs), a food spray and a biological pesticide should be applied to restore the ratio to 0.5 or higher.
- If the predator-to-pest ratio is 0.4 or lower following the application of a biological insecticide and the *Helicoverpa* population is predominantly larvae, a selective insecticide should be used to control the larvae before they develop to mediums. Three days after applying a selective insecticide, re-apply a beneficial insect food attractant to restore the system.

Interplanting Alternative Crops in Commercial Cotton

Strip intercropping can be used to diversify the habitat in agroecosystems for the benefit of insect predators (Mensah, 1999). Interplanting alternative crops in cotton can serve as a refuge or source of beneficial insects to the cotton crop. However, an intercrop system in some cases may act as a sink for predators by being more attractive than the primary crop itself (Mensah, 1999) and unless predators are attracted or forced out of the intercrop system, the use of an intercrop strategy to maximize the abundance of beneficial insects in the primary crop may be counter productive to the enhancement of biological control.

Studies have been conducted in Australia to determine the utility of alternate crops as refugia for predatory insects of *Helicoverpa* spp. when they were interplanted as strips in cotton fields in Australia (Mensah, 1999) (see Figure 4 and 5). The study showed that interplanting lucerne as strips in cotton fields can conserve and increase the densities of predatory insects of *Helicoverpa* spp. in cotton (Figure 4 and 5). The interplanted lucerne crop acted as a refugia and a source of the predators to the cotton crop (Figure 5). The refugia or source function of the lucerne strips may be attributed to the abundance of floral nectar and alternate prey, shelter, mating and oviposition sites, etc., labored in the lucerne crop (Bugg *et al.*, 1987), compared with the monoculture cotton. Thus, given the abundance of food resources within the lucerne strips, high numbers of predators may not be inclined to move from the strips to forage the adjacent cotton crop.

The movement of predators can be improved by either applying food spray to attract them, especially predatory beetles, bugs and lacewings onto the cotton crop (Mensah, 1997), or by using smaller lucerne strips less than 12 meters wide, or slashing all the lucerne strips or allowing the lucerne crop to hay off (Mensah and Harris, 1995). The last three options may also force *Creontiades dilutus* (green mirids), another pest of cotton that is found mostly in the lucerne strips, to move from lucerne to cause damage in cotton (Mensah and Khan, 1997; Mensah, 1999).

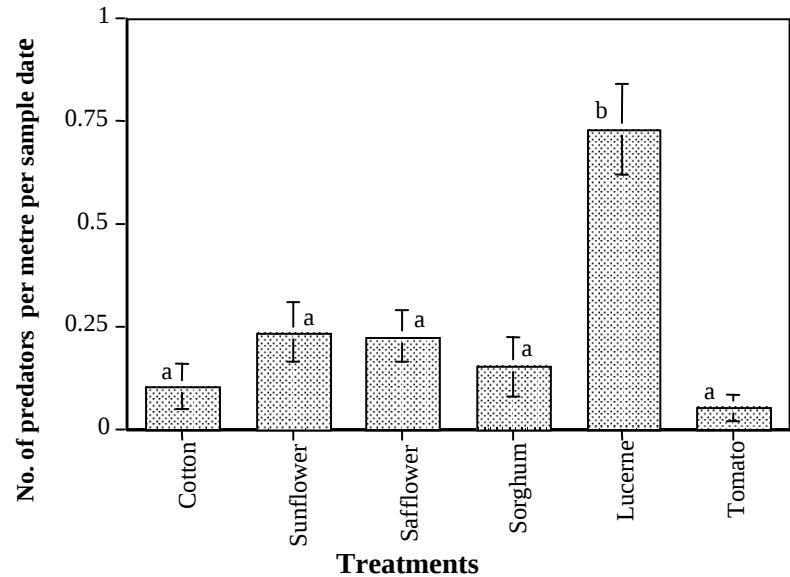


Figure 4: Responses of predatory insects to alternative crops interplanted in commercial cotton in the Australian Cotton Research Institute farm at Narrabri, NSW, 1993-94 (Means of treatments followed by the same letter are not significantly different ($P > 0.05$)(Tukey-Kramer Multiple Comparisons Test). Error bars represent standard errors.

Guidelines for Establishment and Management of Lucerne Strips

Interplanting of lucerne crops as strips in commercial cotton provide a refuge for beneficial insects and spiders on the farm. Many of these beneficial insects can then be encouraged into cotton with the strategic use of food sprays to help manage *Helicoverpa*. Lucerne is also preferred over cotton by the green

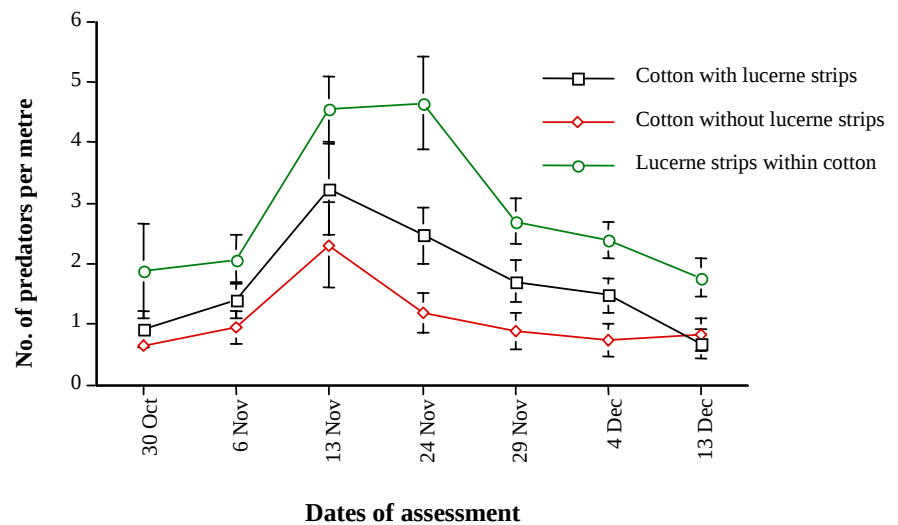


Figure 5: Comparisons of predatory insects in lucerne strips, cotton with and without lucerne strips at Norwood near Moree, NSW, 1995. Error bars represent standard errors.

mirid (*Creontiades dilutus*) and therefore can be used as a trap crop to manage this insect.

Size and Placement of Lucerne Strips

Lucerne strips can be used:

- Within the cotton field with a maximum width of 8 or 12 rows per 300 rows of cotton (between 3% and 4% of total area).
- As a field border; a lucerne crop can be placed on both sides of the field. In this case, a minimum area of 5% of the whole field should be planted to lucerne (e.g. 24 rows each side of a 1,000-row field).
- As a block; a lucerne crop can also be planted in a centrally-located block on the farm. The last two options may be slightly less effective than strips grown within the field particularly for green mirid control. In all cases, the lucerne should be green and not allowed to hay off.

Establishment of Lucerne

It is most important to have the lucerne strips established before cotton planting. Seeding rates of around 5 kg/ha should be used in dryland situations and 10 to 15 kg/ha for irrigated crops. Good seedbed preparation is required to achieve good establishment.

Irrigation Management

A 20-day cycle from September to December and a 10-day cycle from December onwards are the recommendations for maximum production of lucerne in Northern NSW of Australia. Since cotton growers are not striving for maximum production, a first lucerne watering should be done when the cotton starts to square, all other lucerne irrigations can be applied as the cotton requires.

Management of Lucerne within the Strips

The lucerne strips should be kept attractive through the cotton-growing season especially during the early squaring and flowering period of the cotton crop. Once lucerne begins to flower, vegetative growth is limited and it is less attractive to insects that may serve as food for the beneficial insects, hence as a refuge or trap crop. The attractiveness of the lucerne strips can be maintained or achieved by slashing or mowing half of each lucerne strip every four weeks to maintain new regrowth. The presence of new regrowth will enhance continuous infestation of insects such as aphids and thrips, jassids that serve as food for the beneficial insects.

Planting Cotton into Wheat Stubble

Wheat is one of the rotation crops used in Australia, and wheat stubble is known to provide a

high surface soil cover which can reduce soil erosion by 70% (Walters *et al.*, 1999). Planting cotton in wheat stubble can conserve some beneficial insects in cotton by providing shelter for these insects. Studies conducted in Australia showed that densities of predators such as red and blue beetles and also soil predators such as earwigs, carabid beetles, ants, etc., increased in cotton planted in wheat stubble (Figure 6). However, densities of transverse ladybird beetle, two spotted ladybird beetle, big-eyed bug, lacewings and spiders were unaffected by the wheat stubble.

Conclusion

The use of beneficial insect food attractants in pest management is not new. Food sprays like Envirofeast® have been used in organic cotton systems in Australia and also integrated with other tools in IPM programs to manage cotton pests especially *Helicoverpa* spp. effectively. The performance of beneficial insect food attractants is enhanced by the presence of a refugia system such as lucerne strips where insects can be attracted. An IPM program based on food sprays and beneficial insects has been developed in Australia. The program, which involves the use of lucerne strips, food attractants, a predator-to-pest ratio,

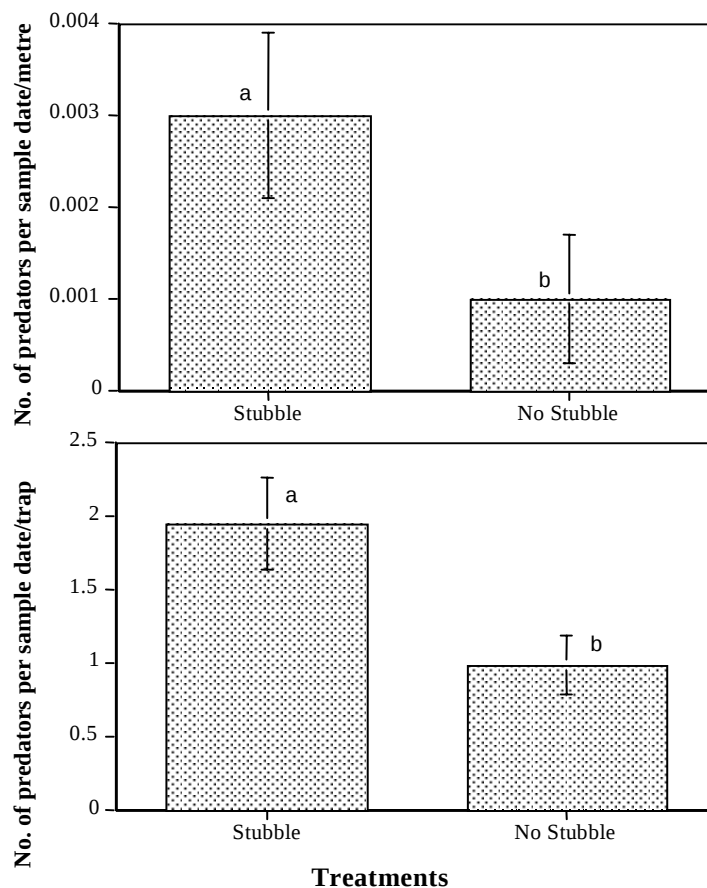


Figure 6. Effect of wheat stubble on densities of (a) red and blue beetles and (b) soil insects. Error bars represent standard error of the mean.

and integrated with pesticides, has been used to manage cotton pests effectively to reduce insecticide use by 40-50% and achieve yields similar to conventional insecticide-managed cotton.

Acknowledgements

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High-gossypol Cotton Plants with Low-gossypol Seed

It has long been known that gossypols in cotton are desirable for some reasons and undesirable for others. High gossypol content varieties offer host plant resistance to bollworms and budworms, particularly to pink bollworm and tobacco budworm and plant bugs. Boll weevil, leaf perforators, leafhoppers and sucking insects are not affected by gossypols in the plant. However, the undesirable aspect of gossypols in cotton is more important than the positive aspect because of their effect on

byproducts consumed by humans. Gossypols, if taken in excessive quantities, are toxic to non-ruminant animals, including humans, which limits its use. However, according to the most recent work done by Y. L. Yuan and his colleagues and published in *Plant Breeding*, vol. 119 (1): p.59-64, 2000 of the Nanjing Agricultural University, Nanjing 210095, Jiangsu, China, and many other researchers before, the presence or absence of gossypols does not have an apparent association with

most agronomic and fiber quality characteristics. Similar conclusions are available showing no effect on yields. Due to gossypols' complex impact, it has been difficult to decide whether to develop gossypol-free varieties or to try to enhance the gossypol content to improve the plant's natural resistance to insects.

All cotton species are characterized by the presence of lysigenous glands in the plant's aerial parts that contain a variety of terpenoid aldehydes, among which gossypol is the best known. Gossypols are phenol compounds that were isolated in cotton over one hundred years ago. Gossypols are intra-glandular pigments and form about 35-50% of the total intra-glandular pigments on the plant. However, gossypols constitute almost 100% of the terpenoid aldehydes found in the seed while other related substances (helicoides, hemigossypol, etc.) form mixtures produced in the chlorophyll organs of the plant. During the process of oil extraction, terpenoid aldehydes which render oil and protein meals toxic for non-ruminants, are released. Animals that chew their cud are affected only by high gossypol level. Some information was published in the last issue of *THE ICAC RECORDER* on methods to get rid of gossypols in oil, the most important use of cotton seed by humans. But, eliminating gossypols from oil has its own limitations.

Some early work showed that gossypol content is not a varietal character, while other work proved that it is a genetic character controlled by two recessive genes. Data also showed that growing conditions have a significant effect on gossypol quantity. Gossypol content ranged from less than 1.0% to over 1.5% in the same variety grown at different locations. Year-to-year differences are also reported in the literature. Work done in India has shown that nitrogen and phosphate applications significantly decreased gossypol content. Literature also shows that oil content in cotton seed was inversely and significantly related to gossypol content. As there has been no improvement in seed oil percentage over centuries, there has been no success in reducing gossypol content. Varieties without gossypols can be developed, but host plant resistance to boll/budworms has to be sacrificed.

The most desirable situation would be to produce cotton seed without gossypols, or glandless, and retain gossypols on the above-ground parts of the cotton plant. Lately, there has been some success in developing such genotypes. A team of cotton researchers at the Department of Tropical Crop Husbandry, Gembloux Agricultural University, Gembloux, Belgium, is working on the same lines using some exotic germplasm. According to a paper published in *Theoretical and Applied Genetics* (1999) 99:1233-1244, Dr. I. Vroh Bi, Dr. Guy Mergeai, and their colleagues, crossed two Australian wild diploid *Gossypium* species belonging to the *Sturtia* and *Hibiscoidea* sections with a *G. hirsutum* variety. Both *Sturtia* and *Hibiscoidea* produce gossypol-free seeds while the above-ground parts contain protective pigment glands. In order to

develop upland cotton plants with low-gossypol seeds and high-gossypol aerial parts, a three-species hybrid was produced using the Australian species *G. sturtianum* Willis as a donor parent, and the wild American diploid cotton *G. raimondii* Ulbrich as a bridge species. This trispecies hybrid designated by the HRS (*hirsutum*, *raimondii* and *sturtianum*) initials was backcrossed with different *G. hirsutum* varieties originating from Central and West Africa to produce BC₁, BC₂, self-BC₂ and BC₃ seeds. Growth regulators were applied at flowering, a mature seed embryo was cultured in vitro, and perturbed hybrids were grafted on vigorous *G. hirsutum* seedlings to obtain a large number of viable hybrid materials.

At least 66% of the seeds of each backcross generation expressed a reduction in gossypol gland density while the aerial parts of the resulting hybrid plants were normally glanded. The segregation pattern observed in the backcross progeny indicated that at least two independent dominant genes control the seed gossypol synthesis repressive mechanism. This hypothesis has still to be confirmed on larger populations of self-introgressed materials.

About 10% (2 seeds out of 20) of the seeds produced by the best self-BC₂ material (BC₂S₁) had less than 500 mg gossypol per kg. According to the Protein Advisory Group of the Food and Agriculture Organization of the United Nations and the World Health Organization, the free gossypol content of edible cotton seed products should not exceed 600 mg per kg for human consumption. The selected plants thus constitute an interesting genetic stock for developing commercial cotton varieties with glanded plant parts and low gossypol seeds.

The research group in Belgium used RAPD and AFLP markers to assess the genetic similarity among the germplasm and RFLP probes to tag introgression of specific chromosome segments from parental species. Both RAPD and AFLP primers generated a high number of DNA fragments, among which about 90% were polymorphic. The genetic similarity between the upland cotton and the wild species ranged from 29.5% to 43.2%, while similarity reached 80% between upland cotton and BC₃ plants. Introgression of species-specific RAPDs and AFLPs was evident from all the parental species and confirmed the hybrid origin of all the analyzed progenies. Southern-blot analysis

Gossypol Content in Parents and Trispecies Hybrids

Genotypes	Gossypol Content (mg per kg)		
	Maximum	Minimum	Average
Parents			
<i>G. hirsutum</i>	11,400	6,700	9,700
<i>G. raimondii</i>	26,900	19,100	23,200
<i>G. sturtianum</i>	27	0	10
Allohexaploid			
(<i>G. hirsutum</i> X <i>G. sturtianum</i>) ²	500	400	400
HRS hybrid back crossed progeny			
BC ₂ S ₁	8,730	480	3,300
BC ₃	6,000	1,500	4,500

based on 49 RFLP probes allowed to trace the introgression of parental DNA segments in the trispecies hybrids and in the three backcross generations. Introgression was evident from 11 and 8 linkage groups of *G. sturtianum* and *G. raimondii* respectively. The ability to trace DNA segments of known chromosomal locations from the donor *G. sturtianum* through segregating generations is a starting point to map the “low-gossypol seed and high-gossypol plant” trait.

Cotton is the fifth largest oil-producing crop in the world. Currently, almost all the commercially grown cotton varieties in the world have some level of gossypol content in the seed. Gossypols may be found in the free (toxic) or protein-bound (less-toxic) forms. Almost all gossypols in the seed are found in the free form. Pima cotton has more of the gossypol free form—the biologically more active form—than upland varieties. Toxicity from gossypols will mainly depend on the quan-

tity of seed or oil consumed within a certain time. If livestock is fed regularly with high doses of gossypol-containing seed, animals may show poisoning symptoms in the form of breathing difficulty, violent labored respiration, acute weakness, heart damage and in severe cases even death. Some other indications are decreased milk production and stomach upset. The suggested maximum level of feeding for cattle less than one year of age is 0.05% to 0.1% of free gossypol. Adult cattle should have less than 0.1% to 0.2% of free gossypol in the total ration. This amounts to about 3-4 kilograms of upland cotton seed and 2-3 kilograms of barbadense varieties seed per day. Bulls are said to be more sensitive than cows and it has been observed that certain breeds of cows are more sensitive than others. Bulls may show fertility problems because of a temporary reduction in sperm cell formation. It is not recommended that calves be fed with cotton seed before they have a well developed rumen.

Correction:

In the March 2000 issue of *THE ICAC RECORDER* the table on cotton seed production yields, included in the first article, was presented in kgs/2 tons of seed. The correct table is as follows:

Cotton Seed Products Yields		
Product	Kg/ton of Seed	%
Crude oil	160	16
Hulls	270	27
Meal	460	46
Linters	80	8
Waste	30	3

The 59th Plenary Meeting of the International Cotton Advisory Committee will be held in Cairns, Queensland, Australia, November 5-10, 2000

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 Telephone (202) 463 66 60
 Email cairns-info@icac.org

For additional information, please visit:

<<http://www.icac.org>> and follow the links to *meetings*

Inter-regional Cooperative Research Network on Cotton for the Mediterranean and Middle East Regions

A Joint Workshop and Meeting of All Working Groups, Adana, Turkey, September 20-24, 2000

The Inter-Regional Cooperative Research Network on Cotton for the Mediterranean and Middle East Regions will hold a joint workshop and meeting of all working groups with the objective of exchanging information on subjects related to cotton within and among the working groups, and to plan future activities. The meeting will start with registration on Tuesday, September 19, 2000. Three days, September 20-22, will be devoted to full sessions and parallel group discussions.

The meeting will be held at the University of Çukurova, Adana, Turkey. Adana has a population of 1.5 million people, and in September the weather is likely to be hot (30-32°C) rarely with showers. English will be the official language of the meeting. A two-day trip to cotton fields and sightseeing is also planned for September 23 and 24.

Members of the Network as well as all who are interested in cotton breeding, variety trials, growth regulators, cotton nutrition, weeds control, water management, integrated pest control, fiber testing, biotechnology, plant modeling and growing cotton in marginal conditions are welcome to participate. Papers are welcome from cotton researchers and extension experts working in the private sector. However, the meeting cannot be used as a forum to promote commercial products.

A number of choices are available for accommodation in Adana and also in Kazkalesi/Mersin, where the paper presentation sessions will be held. Hotel reservations can be made through the Organizing Committee in Turkey. The Turkish Embassy in your country should be contacted for visa regulations. However, the Organizing Committee is ready to send you a personalized invitation letter to facilitate your visa formalities. There will be a registration fee of US\$300 per person for representatives of private companies.

For more information, please contact the following people:

Prof. Dr. Oktay Gençer (Chairman, Organizing Committee)
University of Çukurova
Cotton Research and Application Center
01330 Adana, Turkey
Tel: 90-322-3386797
Fax: 90-322-3386797, 3386381
E-mails: <oktaygencer@usa.net>, <ogencer99@hotmail.com>, <ogencer@cu.edu.tr>

Dr. Urania Kechagia (Coordinator)
NAGREF
Cotton and Industrial Plants Institute
57400 Sindos Thessaloniki, Greece
Tel: 30-31-799444, 796512
Fax: 30-31-796513
E-mail: <ok31944@compulink.gr>

Registration Form

(Arrival & Accommodation)

Please fill in using capital letters:

Name: _____
(Title: Dr., Mr., Ms., Mrs.) (First)

(Middle) (Last)

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Address: _____

City: _____

Country: _____

Telephone: _____

Fax: _____

E-mail: _____

Hotel (Single/Double): _____

Airline and Flight no.: _____

Arrival Date: _____

Arrival Time (hr): _____

Date of Dept: _____

Time of Dept: _____

Date ____/____/2000 _____

Signature

Please return the form to

Prof. Dr. Oktay Gençer (Chairman, Organizing Committee)
University of Çukurova
Cotton Research and Application Center
01330 Adana, Turkey
Tel: 90-322-3386797
Fax : 90-322-3386797, 3386381
E-mails: <oktaygencer@usa.net>, <ogencer99@hotmail.com>, <ogencer@cu.edu.tr>

A DIALOG Search of CAB Abstracts

The search was conducted using the key words **cotton** and **gossypol** for work published since 1995.

03890454 CAB Accession Number: 20001610200
Effects of the dominant glandless gene Gl2e on agronomic and fibre characters of upland cotton.
Yuan, Y. L., Chen, Y. H., Tang, C. M., Jing, S. R., Liu, S. L., Pan, J. J., Kohel, R. J. and Zhang, T. Z.
Key Laboratory of Crop Germplasm and Breeding, Ministry of Agriculture and Department of Agronomy, Nanjing Agricultural University, Nanjing 210095, Jiangsu, China.
Plant Breeding, vol. 119 (1): p.59-64
Publication Year: 2000
ISSN: 0179-9541
Language: English
Document Type: Journal article

03875604 CAB Accession Number: 20001005252
Biochemical changes in cotton infected with *Verticillium dahliae*.
Xia, Z. and Achar, P. N.
Department of Microbiology, University of Durban-Westville, Durban, 4000, South Africa.
African Plant Protection, vol. 5 (1): p.59-63
Publication Year: 1999
Language: English
Document Type: Journal article

03848687 CAB Accession Number: 20001606286
Breeding for «low-gossypol seed and high-gossypol plants» in upland cotton. Analysis of tri-species hybrids and backcross progenies using AFLPs and mapped RFLPs.
Vroh Bi, I., Maquet, A., Baudoin, J. P., Jardin, P. du, Jacquemin, J. M. and Mergeai, G.
Unite de Phytotechnie des Regions Intertropicales, Faculte Universitaire des Sciences Agronomiques, 2 Passage des deportes, B-5030 Gembloux, Belgium.
Theoretical and Applied Genetics, vol. 99 (7/8): p.1233-1244
Publication Year: 1999
ISSN: 0040-5752
Language: English
Document Type: Journal article

03844047 CAB Accession Number: 20000705232
Purification and characterization of S-adenosyl-L-methionine: desoxyhemigossypol-6-O-methyltransferase from cotton plants. An enzyme capable of methylating the defense terpenoids of cotton.
Liu JingGao, Benedict, C. R., Stipanovic, R. D. and Bell, A. A.
Department of Biochemistry and Biophysics, Texas A&M University, College Station, Texas 77843-2128, USA.
Plant Physiology, vol. 121 (3): p.1017-1024

Publication Year: 1999
ISSN: 0032-0889
Language: English
Document Type: Journal article

03759560 CAB Accession Number: 991608362
Development of high-gossypol cotton plants with low-gossypol seeds using trispecies bridge crosses and in vitro culture of seed embryos.
Bi, I. V., Baudoin, J. P., Hau, B. and Mergeai, G.
Unite de Phytotechnie des Regions Intertropicales, Faculte Universitaire des Sciences Agronomiques, 2 Passage des Deportes, B-5030 Gembloux, Belgium.
Euphytica, vol. 106 (3): p.243-251
Publication Year: 1999
ISSN: 0014-2336
Language: English
Document Type: Journal article

03728772 CAB Accession Number: 991605088
Evaluation of the *Gossypium* gene pool for foliar terpenoid aldehydes.
Khan, M. A., Stewart, J. M. and Murphy, J. B.
Agronomy Department, University of Arkansas, Fayetteville, AR 72701, USA.
Crop Science, vol. 39 (1): p.253-258
Publication Year: 1999
ISSN: 0011-183X
Language: English
Document Type: Journal article

03707708 CAB Accession Number: 990703356
Coordinated accumulation of (+)-delta-cadinene synthase mRNAs and gossypol in developing seeds of *Gossypium hirsutum* and a new member of the cad1 family from *G. arboreum*.
Meng YuLing, Jia JunWei, Liu ChangJun, Liang WanQi, Heinsteins, P. and Chen XiaoYa
National Laboratory of Plant Molecular Genetics, Shanghai Institute of Plant Physiology, Chinese Academy of Sciences, Shanghai 200032, China.
Journal of Natural Products, vol. 62 (2): p.248-252
Publication Year: 1999
ISSN: 0163-3864
Language: English
Document Type: Journal article

03665198 CAB Accession Number: 991100188
Evaluation of resistance of cotton strains to *Heliothis virescens* (F.) (Lepidoptera: Noctuidae) under laboratory

conditions.

Aslam, M., Chalfant, R. B. and Herzog, G. A.
Department of Entomology, University of Arid Agriculture,
Rawalpindi, Pakistan.

Sarhad Journal of Agriculture, vol. 14 (5): p.471-474

Publication Year: 1998

ISSN: 1016-4383

Language: English

Document Type: Journal article

03609569 CAB Accession Number: 981007604

Effect of herbicides on *Verticillium* wilt of cotton and
induction of phytoalexin gossypol production by host cells.
Canihos, Y.

University of Cukurova, Faculty of Agriculture, Department
of Plant Protection, 01330 Adana, Turkey.

Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz, vol.
104 (5): p.516-522

Publication Year: 1997

ISSN: 0340-8159

Language: English Summary Language: German

Document Type: Journal article

03607383 CAB Accession Number: 980709725

Effect of nitrogen and phosphorus levels on gossypol and oil
content of cotton genotypes (*Gossypium hirsutum* L.).

Patil, D. B., Naphade, K. T., Wankhade, S. G., Wanjari, S. S.
and Potdukhe, N. R.

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444 104,
Maharashtra, India.

Agricultural Science Digest (Karnal), vol. 16 (3): p.163-166

Publication Year: 1996

ISSN: 0253-150X

Language: English

Document Type: Journal article

03597326 CAB Accession Number: 981611446

Cytogenetics of the 'glandless-seed and glanded-plant' trait
from *Gossypium sturtianum* Willis introgressed into upland
cotton (*Gossypium hirsutum* L.).

Bi, I. V., Baudoin, J. P. and Mergeai, G.

Unite de Phytotechnie des Regions Intertropicales, Faculte
Universitaire des Sciences Agronomiques, 2 Passage des
Deportes, B-5030 Gembloux, Belgium.

Plant Breeding, vol. 117 (3): p.235-241

Publication Year: 1998

ISSN: 0179-9541

Language: English

Document Type: Journal article

03579294 CAB Accession Number: 981107807

Thrips (Thysanoptera: Thripidae) tolerance in cotton: sources
and heritability.

Bowman, D. T. and McCarty, J. C., Jr.

Dept. of Crop Science, Box 8604, North Carolina State

University, Raleigh, NC 27695-8604, USA.

Journal of Entomological Science, vol. 32 (4): p.460-471

Publication Year: 1997

ISSN: 0749-8004

Language: English

Document Type: Journal article

03560666 CAB Accession Number: 981005266

The enzymatic cyclization of nerolidyl diphosphate by delta -
cadinene synthase from cotton stele tissue infected with
Verticillium dahliae.

Alchanati, I., Patel, J. A. A., Liu JingGao, Benedict, C. R.,
Stipanovic, R. D., Bell, A. A., Cui YunXing and Magill, C.
W.

Department of Biochemistry and Biophysics, Texas A & M
University, College Station, Texas 77843, USA.

Phytochemistry, vol. 47 (6): p.961-967

Publication Year: 1998

ISSN: 0031-9422

Language: English

Document Type: Journal article

03547088 CAB Accession Number: 981606345

Survey of cotton germplasm for terpenoid aldehydes impor-
tant in host plant resistance.

Altaf, M. K., Stewart, J. M. and Murphy, J. B.

Department of Agronomy, University of Arkansas,
Fayetteville, Arkansas 72701, USA.

Special Report - Agricultural Experiment Station, Division of
Agriculture, University of Arkansas (No. 183): p.153-155

Publication Year: 1997

ISSN: 0571-0189

Language: English

Document Type: Journal article

03542560 CAB Accession Number: 981104710

Systemic induction of allelochemicals in glanded and
glandless isogenic cotton by *Spodoptera exigua* feeding.

McAuslane, H. J. and Alborn, H. T.

Department of Entomology & Nematology, University of
Florida, PO Box 110620, Gainesville, Florida 32611-0620,
USA.

Journal of Chemical Ecology, vol. 24 (2): p.399-416

Publication Year: 1998

ISSN: 0098-0331

Language: English

Document Type: Journal article

03487207 CAB Accession Number: 980702000

Caloric analyses of the distribution of energy in ripened
cotton (*Gossypium hirsutum* L.).

Hedin, P. A., McCarty, J. C., Jr. and Jenkins, J. N.

Crop Science Research Laboratory, Agricultural Research
Service, U.S. Department of Agriculture, P.O. Box 5367,
Mississippi State, MS 39762, USA.

Journal of Agricultural and Food Chemistry, vol. 45 (8):
p.3258-3261

Publication Year: 1997

ISSN: 0021-8561

Language: English

Document Type: Journal article

03487050 CAB Accession Number: 980701843

Caloric analysis of the distribution of energy in ripened cotton.

Hedin, P. A., McCarty, J. C., Jr. and Jenkins, J. N.

USDA, ARS, Mississippi State, Mississippi, USA.

Proceedings of the Beltwide Cotton Conferences, New

Orleans, LA, USA, January 6-10, 1997: Volume 2.

Conference Title: 997 Proceedings Beltwide Cotton

Conferences, New Orleans, LA, USA, January 6-10, 1997:

Volume 2. p.1436-1437

Publication Year: 1997

Publisher: National Cotton Council, Memphis, USA

Language: English

Document Type: Conference paper

03486761 CAB Accession Number: 980701554

Biosynthesis of gossypol: purification and properties of desoxyhemigossypol 6-O-methyltransferase.

Liu, J., Stipanovic, R. D., Benedict, C. R. and Alchanati, I.

USDA, ARS, Southern Crops Research Laboratory, College Station, Texas, USA.

Proceedings of the 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.1374

Publication Year: 1997

Publisher: National Cotton Council, Memphis, USA

Language: English

Document Type: Conference paper

03463685 CAB Accession Number: 971612403

Registration of 'H1244' cotton.

Calhoun, D. S., Jones, J. E., Dickson, J. I., Caldwell, W. D.,

Burris, E., Leonard, B. R., Moore, S. H. and Aguillard, W.

Delta Research and Extension Center, Stoneville, MS 38776, USA.

Crop Science, vol. 37 (3): p.1014-1015

Publication Year: 1997

ISSN: 0011-183X

Language: English

Document Type: Journal article

03463684 CAB Accession Number: 971612402

Registration of 'H1220' cotton.

Calhoun, D. S., Jones, J. E., Dickson, J. I., Caldwell, W. D.,

Burris, E., Leonard, B. R., Moore, S. H. and Aguillard, W.

Delta Research and Extension Center, Stoneville, MS 38776,

USA.

Crop Science, vol. 37 (3): p.1013-1014

Publication Year: 1997

ISSN: 0011-183X

Language: English

Document Type: Journal article

03463683 CAB Accession Number: 971612401

Registration of 'H1215' cotton.

Calhoun, D. S., Jones, J. E., Dickson, J. I., Caldwell, W. D.,

Burris, E., Leonard, B. R., Moore, S. H. and Aguillard, W.

Delta Research and Extension Center, Stoneville, MS 38776, USA.

Cop Science, vol. 37 (3): p.1013

Publication Year: 1997

ISSN: 0011-183X

Language: English

Document Type: Journal article

03463252 CAB Accession Number: 971611970

Inheritance of high glanding, an insect resistance trait in cotton.

Calhoun, D. S.

Delta Research and Extension Center, P.O. Box 197, Stoneville, MS 38776, USA.

Crop Science, vol. 37 (4): p.1181-1186

Publication Year: 1997

ISSN: 0011-183X

Language: English

Document Type: Journal article

03430463 CAB Accession Number: 971107819

Effects of gossypol on growth of the cotton bollworm and development of its parasitoid *Campoletis chloridae*.

Wang ChenZhu, Yang QiHua and Zhou MingZang

Institute of Zoology, Academia Sinica, Beijing 100080, China.

Entomologia Cínica, vol. 4 (2): p.182-188

Publication Year: 1997

ISSN: 1005-295X

Language: English Summary Language: Chinese

Document Type: Journal article

03404733 CAB Accession Number: 971608301

Gossypol glands in relation to resistance to bollworm (*Helicoverpa armigera*) in upland cotton (*Gossypium hirsutum*).

Rajarajeswari, V. and Subbarao, I. V.

Regional Agricultural Research Station, Andhra Pradesh Agricultural University, Lam 522 034, India.

Indian Journal of Agricultural Sciences, vol. 67 (7): p.293-295

Publication Year: 1997

ISSN: 0019-5022

Language: English

Document Type: Journal article

03363741 CAB Accession Number: 971003318

Aspergillus flavus infection of developing cotton bolls: interactions among isolates and influence of gossypol on sclerotial morphogenesis and aflatoxin biosynthesis.

Garber, R. K. and Cotty, P. J.

USDA, ARS, Southern Regional Research Center, New Orleans, LA, USA.

Proceedings of the 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.221

Publication Year: 1995

Publisher: National Cotton Council, Memphis, USA

Language: English

Document Type: Conference paper

03349856 CAB Accession Number: 970703125

Gossypol biosynthesis IV. The amino acid similarity of terpenoid cyclases.

Magill, C., Bianchini, G. and Benedict, C. R.

Texas A&M University, College Station, Texas, USA.

Proceedings of the 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.1184-1186

Publication Year: 1996

Publisher: National Cotton Council, Memphis, USA

Language: English

Document Type: Conference paper

03341472 CAB Accession Number: 971603089

Glyphosate-tolerant cotton: the composition of the cottonseed is equivalent to that of conventional cottonseed. Nida, D. L., Patzer, S., Harvey, P., Stipanovic, R., Wood, R. and Fuchs, R. L.

Ceregen, Monsanto Company, 700 Chesterfield Parkway North, St. Louis, Missouri 63198, USA.

Journal of Agricultural and Food Chemistry, vol. 44 (7): p.1967-1974

Publication Year: 1996

ISSN: 0021-8561

Language: English

Document Type: Journal article

03328733 CAB Accession Number: 971601639

Occurrence of terpenoid aldehydes and lysigenous cavities in the 'glandless' seeds of Australian *Gossypium* species.

Brubaker, C. L., Benson, C. G., Miller, C. and Leach, D. N.

Centre for Plant Biodiversity Research, CSIRO Division of Plant Industry, GPO Box 1600, Canberra, ACT 2601, Australia.

Australian Journal of Botany, vol. 44 (5): p.601-612

Publication Year: 1996

ISSN: 0067-1924

Language: English

Document Type: Journal article

03318106 CAB Accession Number: 971600735

An allele for high glanding at the GL3 locus?

Calhoun, D. S. and Barfield, M. E.

MAFES Delta Research and Extension Center, Stoneville, MS, USA.

Proceedings of the Beltwide Cotton Conferences, Nashville, TN, USA, January 9-12, 1996: Volume 1.

Conference Title: 1996 Proceedings Beltwide Cotton Conferences, Nashville, TN, USA, January 9-12, 1996: Volume 1. p.615-618

Publication Year: 1996

Publisher: National Cotton Council, Memphis, USA

Language: English

Document Type: Conference paper

03265080 CAB Accession Number: 961107210

Feeding preference of *Heliothis* larvae in relation to glanded strains of upland cotton.

Punit Mohan, Shed Raj and Kathane, T. V.

Central Institute for Cotton Research, P.B. No. 225, G.P.O., Nagpur, Maharashtra 440 001, India.

Insect Environment, vol. 2 (1): p.16-17

Publication Year: 1996

Language: English

Document Type: Journal article

03255880 CAB Accession Number: 961608236

Heterosis for oil and gossypol content in hybrids of Upland cotton (*Gossypium hirsutum*).

Varghese, S., Patel, K. V., Vashi, R. G., Patel, P. G., Patel, J. C. and Patel, U. G.

Main Cotton Research Station, Gujarat Agricultural University, Surat 395 007, India.

Indian Journal of Agricultural Sciences, vol. 65 (10): p.760-762

Publication Year: 1995

ISSN: 0019-5022

Language: English

Document Type: Journal article

03255081 CAB Accession Number: 961607437

Cotton *Gossypium* spp. plant gossypol contents of selected GL2 and GL3 alleles.

McCarty, J. C., Jr., Hedin, P. A. and Stipanovic, R. D.

Crop Science Research Lab, USDA-ARS, MS 39762, USA.

Journal of Agricultural and Food Chemistry, vol. 44 (2): p.613-616

Publication Year: 1996

ISSN: 0021-8561

Language: English
Document Type: Journal article

03232543 CAB Accession Number: 962207713
Accumulation of gossypol enantiomers in ovine tissues.
Kim, H. L., Calhoun, M. C. and Stipanovic, R. D.
Department of Veterinary Physiology and Pharmacology,
Texas A&M University College Station, TX 77843, USA.
*Comparative Biochemistry and Physiology. B, Biochemistry
& Molecular Biology*, vol. 13 (2): p.417-420
Publication Year: 1996
ISSN: 0305-0491
Language: English
Document Type: Journal article

03228090 CAB Accession Number: 961105194
Low sugar and gossypol in anthers of cotton *Gossypium
hirsutum* L. lines deterrent to boll weevil *Anthonomus
grandis* Boh. oviposition.
Hedin, P. A. and McCarty, J. C., Jr.
USDA, ARS, Mississippi State, USA.
Proceedings of the Beltwide Cotton Conferences, San
Antonio, TX, USA, January 4-7, 1995: Volume 2.
Conference Title: 1995 Proceedings Beltwide Cotton
Conferences, San Antonio, TX, USA, January 4-7, 1995:
Volume 2. p.1021-1024
Publication Year: 1995
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

03192789 CAB Accession Number: 961603089
Seed gossypol variation within *Gossypium barbadense* L.
cotton.
Percy, R. G., Calhoun, M. C. and Kim, H. L.
USDA-ARS, Maricopa Agricultural Center, 37860 W. Smith-
Enke Road, Maricopa, AZ 85239, USA.
Crop Science, vol. 36 (1): p.193-197
Publication Year: 1996
ISSN: 0011-183X
Language: English
Document Type: Journal article

03189627 CAB Accession Number: 961101980
Boll weevil *Anthonomus grandis* Boh. oviposition is
decreased in cotton *Gossypium hirsutum* L. lines lower in
anther monosaccharides and gossypol.
Hedin, P. A. and McCarty, J. C., Jr.
Crop Science Research Laboratory, Agricultural Research
Service, U.S. Department of Agriculture, Mississippi State,
Mississippi 39762, USA.
Journal of Agricultural and Food Chemistry, vol. 43 (10):
p.2735-2739
Publication Year: 1995
ISSN: 0021-8561

Language: English
Document Type: Journal article

03133569 CAB Accession Number: 951613227
Progress in breeding for insect resistance utilizing the high
glanding trait.
Calhoun, D. S. and Jones, J. E.
Delta Research and Extension Center, Stoneville, MS, USA.
Proceedings of the Beltwide Cotton Conferences, January 5-
8, San Diego, CA, USA.
Conference Title: 1994 Proceedings Beltwide Cotton
Conferences, January 5-8, San Diego, CA, USA. p.655-657
Publication Year: 1994
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

03092837 CAB Accession Number: 951610492
Representations on Pre-Columbian spindle whorls of the
floral and fruit structure of economic plants.
McMeekin, D.
Department of Botany and Plant Pathology, Michigan State
University, E. Lansing, MI 48824, USA.
Economic Botany, vol. 46 (2): p.171-180
Publication Year: 1992
ISSN: 0013-0001
Language: English Summary Language: Spanish
Document Type: Journal article

03038871 CAB Accession Number: 950707036
Effects of natural bioregulators on cotton production.
Hedin, P. A. and McCarty, J. C., Jr.
USDA, ARS, Mississippi State, MS 39762, USA.
Proceedings of the Beltwide Cotton Conferences, January 5-
8, San Diego, California, USA.
Conference Title: 1994 Proceedings Beltwide Cotton
Conferences, January 5-8, San Diego, California, USA.
p.1345-1347
Publication Year: 1994
Publisher: National Cotton Council, Memphis, USA
Language: English
Document Type: Conference paper

03038688 CAB Accession Number: 950706833
Biological activity of gossypol and its derivatives.
Baram, N. I. and Ismailov, A. I.
A. S. Sadykov Institute of Bioorganic Chemistry of the
Academy of Sciences of the Uzbekistan Republic, Tashkent,
Uzbekistan.
Chemistry of Natural Compounds, vol. 29 (3): p.275-287
Publication Year: 1993
ISSN: 0009-3130
Translated from *Khimiya Prirodnykh Soedinenii* (1993) No.
3, 334-349
Language: English

Document Type: Journal article

03011009 CAB Accession Number: 951605717

Gossypol-gland density and free gossypol content in seed and cotyledonary leaf of upland cotton (*Gossypium hirsutum*).

Punit Mohan, Phundan Singh, Dongre, A. B. and Narayanan, S. S.

Central Institute for Cotton Research, Nagpur, Maharashtra 440 001, India.

Indian Journal of Agricultural Sciences, vol. 65 (1): p.66-68

Publication Year: 1995

ISSN: 0019-5022

Language: English

Document Type: Journal article

03010119 CAB Accession Number: 951604775

Relation of gossypol-gland density with bollworm incidence and yield in tree cotton (*Gossypium arboreum*).

Punit Mohan, Phundan Singh, Narayanan, S. S. and Ram Ratan

Central Institute for Cotton Research, Nagpur, Maharashtra 440 001, India.

Indian Journal of Agricultural Sciences, vol. 64 (10): p.691-696

Publication Year: 1994

ISSN: 0019-5022

Language: English

Document Type: Journal article

02987308 CAB Accession Number: 950703874

Multiyear study of the effects of kinetin and other plant growth hormones on yield, agronomic traits, and allelochemicals of cotton.

Hedin, P. A. and McCarty, J. C., Jr.

Crop Science Research Laboratory, Agricultural Research Service, US Department of Agriculture, Mississippi State, MS 39762-5367, USA.

Journal of Agricultural and Food Chemistry, vol. 42 (10): p.2305-2307

Publication Year: 1994

ISSN: 0021-8561

Language: English

Document Type: Journal article

02987307 CAB Accession Number: 950703873

Effects of 1,1-dimethylpiperidinium chloride on the yields, agronomic traits, and allelochemicals of cotton (*Gossypium hirsutum* L.), a nine year study.

McCarty, J. C., Jr. and Hedin, P. A.

Crop Science Research Laboratory, Agricultural Research Service, US Department of Agriculture, Mississippi State, MS 39762-5367, USA.

Journal of Agricultural and Food Chemistry, vol. 42 (10): p.2302-2304

Publication Year: 1994

ISSN: 0021-8561

Language: English

Document Type: Journal article

02985844 CAB Accession Number: 950702410

Effects of several commercial plant growth regulator formulations on yield and allelochemicals of cotton (*Gossypium hirsutum* L.).

Hedin, P. A. and McCarty, J. C., Jr.

Crop Science Research Laboratory, Agricultural Research Service, US Department of Agriculture, Mississippi State, MS 39762, USA.

Journal of Agricultural and Food Chemistry, vol. 42 (6): p.1355-1357

Publication Year: 1994

ISSN: 0021-8561

Language: English

Document Type: Journal article

INTERNATIONAL COTTON ADVISORY COMMITTEE

The International Cotton Advisory Committee is an association of governments having an interest in the production, export, import and consumption of cotton. It is an organization designed to promote cooperation in the solution of cotton problems, particularly those of international scope and significance.

The functions of the International Cotton Advisory Committee, as defined in the Rules and Regulations are

- To observe and keep in close touch with developments affecting the world cotton situation
- To collect and disseminate complete, authentic and timely statistics on world cotton production, trade, consumption, stocks and prices
- To suggest, as and when advisable, to the governments represented, any measures the Advisory Committee considers suitable and practicable for the furtherance of international collaboration directed towards developing and maintaining a sound world cotton economy
- To be the forum for international discussions on matters related to cotton prices

Membership of the Committee, which represents the bulk of the world's production, trade and consumption of cotton, now comprises the following forty-three governments:

Argentina	Egypt	Mali	Switzerland
Australia	Finland	Netherlands	Syria
Belgium	France	Nigeria	Tanzania
Bolivia	Germany	Pakistan	Togo
Brazil	Greece	Paraguay	Turkey
Burkina Faso	India	Philippines	Uganda
Cameroon	Iran	Poland	United Kingdom
Chad	Israel	Russia	United States
China (Taiwan)	Italy	South Africa	of America
Colombia	Japan	Spain	Uzbekistan
Côte d'Ivoire	Korea, Rep. of	Sudan	Zimbabwe

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ICAC PUBLICATIONS CONTENTS

COTTON TODAY!

Current Estimates of World Cotton Supply and Distribution. (Updated **daily**, Internet only, US\$1,500 per year)

COTTON THIS MONTH

This 8-to-10 page report, sent at the beginning of each month, provides information on the latest events affecting the world cotton market and presents up-to-date supply, demand and price projections. (In English, French or Spanish; **Monthly**, by fax US\$250 per year; Internet, US\$200 per year)

COTTON: Review of the World Situation

Detailed examination of the world cotton market. Provides projections of world supply and demand by country and international cotton prices. Includes review articles on different producing and consuming countries and topics related to the world cotton industry. Projections for 1999 and 2000. (In English, French, or Spanish, **bi-monthly**, hard copy, US\$150 per year; Internet, US\$125 per year)

THE ICAC RECORDER

Latest scientific and technological developments in cotton production. Easy-to-read articles and analysis about cotton technology. Bibliographies of published reports of research on cotton. (In English, French and Spanish, **quarterly**, hard copy, US\$145 per year; Internet, US\$100 per year)

COTTON: WORLD STATISTICS

World cotton supply/demand statistics since 1940/41 and by country since 1980/81. Includes production, area, yield, consumption, imports, exports and stocks. Projections for 1999/00 through 2002/03. Monthly and season average prices of cotton and polyester in North Europe; comparisons of ICAC forecasts since 1988 with actual results. (Hard copy in **October**, US\$125; Internet, tables updated only in **October** and **April**, US\$125)

WORLD TEXTILE DEMAND

Comprehensive analyses and projections of world end-use consumption of textiles, mill use and production of cotton and chemical yarn and fabric for over 100 countries. Provides analysis of the events that have an impact on world textile demand and cotton's share of textile market. World textile end-use demand projections for 1998 and 1999 as well as projections to 2005. Yarn and fabric projections for 1999 and 2000. (**Hard copy** in **October**, US\$250; **Internet**, tables updated only in **October** and **April**, US\$225)

WORLD COTTON TRADE

Trade developments in raw cotton since 1980. Analysis of world trade by region. Import/export projections by country. Matrices of trade flows. Seasonal estimates of export commitments to date. (**Hard copy** in **October**, US\$150; **Internet**, tables updated only in **October** and **April**, US\$125)

THE OUTLOOK FOR COTTON SUPPLY

Provides an overview of factors affecting world cotton prices, including the outlook for production and consumption in major countries, changes in world stocks and government policies affecting trade in cotton and textiles. The publication provides statistics on aggregate world cotton supply and use, with forecasts of average prices for 1999/00. The publication also provides separate estimates of supply and use for each of the six major types of cotton and notes the likely quantity of each type available for export. (**Hard copy** in **October**, US\$100)

ICAC documents on CD-ROM

Includes all issues of *Cotton: Review of the World Situation* in English, French and Spanish (up to March 2000), *THE ICAC RECORDER* (March 1989 to March 2000, English; March 1994 to March 2000, French and Spanish) and all statistics appearing in *COTTON: WORLD STATISTICS* (1924 to present), *WORLD TEXTILE DEMAND* (1970 to present), *WORLD COTTON TRADE* (1970 to present). Includes proceedings (English, French and Spanish), Country Statements and Technical Seminars (English) from the Plenary Meetings from 1989 to 1999. Also includes three databases (one covers research projects and the other two are related to production practices), two 1995 surveys: *The Bale Survey* and *Agrochemicals Used on Cotton* and a report: *Growing Organic Cotton*, a compilation of articles from 1993 to 1996 in English, French and Spanish. (**annual**, Vol. 7 June 2000, US\$395)

AGROCHEMICALS USED ON COTTON

The Technical Information Section undertook a detailed survey on the use of fertilizers, insecticides, herbicides and growth regulators on cotton. In addition to the use of these chemicals per hectare and area, changes in the insect pattern, insecticide resistance and expected trends in the use of these chemicals are given in the report. Farmers' understanding of agrochemical application, particularly application of insecticides, is also covered. (28 pages, hard copy, October 1995, US\$25)

BALE SURVEY

The current report includes data on bale size, shape, weight, wrapping specifications, information given on the bale, sampling procedures, and impediments and suggestions for improving the standardization of bales. Information on 42 countries is available in the report. (23 pages, hard copy, October 1995, US\$25)

CLASSING AND GRADING OF COTTON

Classing and grading systems in various countries are reviewed in this report. Local seedcotton and lint standards have been compared to universal standards. HVI use and futures plans are also included. (38 pages, hard copy, October 1998, US\$50; Internet, US\$25)

CURRENT RESEARCH PROJECTS IN COTTON

Contains detailed information on the structure of research, institutions involved in cotton research, their contact persons and addresses and the source of funding for cotton research in each country. The publication includes detailed descriptions of current projects by discipline of research (agronomy, breeding, biotechnology, etc.) and the researchers responsible for these projects. (October 2000, hard copy, US\$150; Email, US\$100)

GROWING ORGANIC COTTON

Since 1993, the ICAC Secretariat has published a number of reports on organic cotton in addition to papers presented at international meetings. All these articles have been compiled and published in English, French and Spanish. (81 pages, October 1996, hard copy, US\$50; Internet, US\$25)

INSECTICIDE RESISTANCE AND ITS MANAGEMENT IN COTTON INSECTS

ICAC Review article on Cotton Production Research No. 5. (55 pages, hard copy, March 1999, US\$75)

Summaries of the WCRC—2 and Cotton Contamination

Technical Seminar at the 57th Plenary Meeting. Papers by international experts on the Summaries of the WCRC—2 and Cotton Contamination. (36 Pages, October 1998, hard copy, US\$75; Internet, US\$50)

SURVEY OF THE COST OF PRODUCTION OF RAW COTTON

The current report has data on 29 countries for the 1997/98 season. Many countries have reported data by region or type of cotton. The total number of entries by country and region is 55. The costs of all field operations starting from pre-sowing to harvesting and ginning and economic and fixed costs have been determined and computed to determine the cost of production of cotton per hectare and per kilogram. (109 pages, October 1998, US\$150)

SURVEY OF COTTON PRODUCTION PRACTICES

Cotton growing conditions vary from country to country and sometimes even from region to region within a country.

The report contains data on climatic conditions, area under each variety and their fiber characteristics, insects, diseases, weeds and the methods used to control them, use of fertilizers, farm size, rotations and ginning methods. (October 1999, hard copy, US\$150, Internet, US\$100)

THE WORLD COTTON MARKET: PROJECTION TO 2005

Results of a joint ICAC-FAO econometric study to forecast developments in cotton supply and demand to 2005. Includes projections by country of cotton production, mill consumption of cotton, final end-use of cotton, cotton market share, end use of all textile fibers, cotton exports and imports and net imports of cotton manufactures. (62 pages, September 1999, hard copy or Internet, US\$75)

Proceedings

Summaries of all deliberations of the ICAC Plenary Meetings. (In English, French and Spanish, **October**, hard copy, US\$50; Internet, US\$25)

Statements

Statements of the Plenary Meeting during the plenary sessions. Also contain official statements of most of ICAC member countries regarding the domestic cotton and textile situation. (Hard copy, **October**, US\$150; Internet, US\$100)

Note: Publication prices will go up on September 1, 2000.

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