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Introduction

No biological control agent can be utilized successfully unless it has the ability to search for the target insect and unless less expensive and efficient *in vitro* methods of parasite multiplication are available. For these reasons, many known parasites of the boll weevil, *Anthonomus grandis*, cannot be utilized for control on a commercial scale. A boll weevil wasp *Catolaccus grandis* was introduced into the USA during the 1970s but did not reach farmers' fields because production of the wasp at a reasonable cost was not possible. Studies confirmed that *C. grandis* females reach their host in 30-120 minutes, either by directly flying to the host or flying in the vicinity and then moving to the host. *C. grandis* also searches for 3rd instar larvae in boll weevil infested buds. The ability of *C. grandis* to search and locate boll weevil larvae at a distance up to 120 meters, its high rate of multiplication, development synchrony with the host and effective parasitization gave the wasp a competitive advantage over all other parasites. Work done in the last four years has shown that *C. grandis* can be reared artificially at a reasonable cost, but the technology needs to be perfected. Boll weevil infested buds with eggs in them are shed to the ground where the

eggs hatch and produce larvae. The boll weevil wasp released in the affected field can locate and parasitize the boll weevil larvae on the ground. Thus, integrating parasite release with other agronomic practices like inter-culturing operations and pesticide applications is also important. Primarily, the goal is to attack the 1st and 2nd generations of over-wintering boll weevil to reduce the population of the 3rd and 4th generations which actually coincide with the boll formation stage. The ability of *C. grandis* to search for the host, artificial rearing facilities and augmentative releases in accordance with the agronomic operations in the field are reviewed in the first article.

In the second article, the use of growth regulators in the cotton production system is discussed. Growth regulators are used to control excessive growth and to maintain a balance between vegetative mass and reproductive development. Old varieties were usually tall-growing and the addition of excessive nitrogenous fertilizers either delayed formation of fruiting forms or easily disturbed the balance, resulting in a nonproductive use of inputs. The application of growth regulators on tall-growing varieties not only checked plant height but sometimes resulted in increased yield and early maturity. Now the varieties grown in the world have changed. Short

stature and early maturing varieties have become more popular and widely adopted. Whether the growth rate still needs to be checked is controversial. In the last two to three years, the Working Group on Plant Growth Regulators of the Interregional Cooperative Research Network for the Mediterranean and Middle East Region also conducted coordinated trials on growth regulators in various countries. The benefits of growth regulators, particularly for yield improvement, could not be confirmed.

A DIALOG search from the Agricola Database on a selected subject is published every year in the June and December issue of *THE ICAC RECORDER*. The current issue includes a DIALOG search on the use of pheromones to control insects. The key words used are Cotton and Pheromones. 72 references for the period from 1980 to date are given at the end of the publication.

The 54th Plenary Meeting of the ICAC will be held in Manila, Philippines, from October 22-27, 1995. During the Plenary Meeting, the Committee on Cotton Production Research will have its meeting and Technical Seminar on October 26. The seminar will be held on the topic "New Sources of Genetic Resistance to Cotton Pests." The overall status of the plant's built-in

system to resist insects and diseases will be reviewed by experts in different fields. In addition to the morphological characteristics of the cotton plant, non-species gene induction will also be discussed. Full papers will be published after the Plenary Meeting in a separate publication. The Technical Information Section is currently working on the following three reports which will be presented to the 54th Plenary Meeting:

- Survey of the Cost of Production of Raw Cotton - 1994/95
- Pesticide Use on Cotton - 1994/95
- Bale Survey

The reports will be available in October 1995.

More information on the Fifth Meeting of the Latin American Association for Cotton Research and Development (ALIDA) is now available. The meeting will be held from November 13-18, 1995, with the theme "Management of Varieties with Emphasis on Fiber Quality." Persons interested in presenting a paper at the conference should send a summary of the paper, of not more than 250 words, to the coordinator of the meeting by September 15, 1995, at the following address:

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The conference will be held at Las Mercedes Hotel across from the airport. Accommodations have also been booked at two other hotels, Camino Real and Las Cabañitas. Papers will be presented and discussions on common interests in cotton production research will be held for four days. One day has been devoted to a field trip. The Ministry of Agriculture and Farming, Nicaraguan Institute of Agro-Farming Technology, School of Agricultural Engineers of Nicaragua and the National Development Bank of Nicaragua are also sponsoring the conference. Participants are advised to register as soon as possible using the form provided at the end of this publication.

Catolaccus grandis: A Wasp for Boll Weevil Control

Despite the strict plant protection measures adopted by cotton growers year after year, insects are responsible for heavy losses in yield. It is estimated that in the USA an average 7% of yield is lost due to insect attack, and over 25% of the total actual loss is usually due to the boll weevil alone. Boll weevil, *Anthonomus grandis*, is a very destructive cotton pest only in the Americas. As for all other insects, chemical control is the number one choice of farmers for quick, effective control. For any control in general and for chemical control in particular, it is important that a minimum population emerges from over-wintering; for minimum emergence, it is important that the lowest number of insects go into diapause at the end of the cotton season. Research has proved that late-season suppression of the diapausing population is a very effective method to check the multiplication of the boll weevil. Any method to extend the host-free period results in suicidal emergence of the insect which contributes to minimizing the attack during early flowering.

There are many native parasites of boll weevil in the USA, including *Solenopsis invicta*, *Bracon mellitor*, *Bracon compressitarsus* and *C. grandis*. Until 1990, the key boll weevil predator was considered to be the red fire ant, *Solenopsis invicta*. The inaction levels, i.e., no pesticide application, were established based on a density of 0.4 ants per plant. As long as the ant population is above the level of 0.4 ants per plant, there is no need to spray the crop. However, artificial rearing remained a problem. The parasite *Bracon mellitor* causes high mortality at times but is not considered an effective means of boll weevil control. *Bracon compressitarsus* has also been tried but over-wintering was a problem in the USA. Moreover, the parasites, being polyphagous, did not search for boll weevil and the control was poor. Such conditions presented a challenge for researchers to find new and more suitable parasites for local conditions.

C. grandis wasps are black in color and tiny in size, but they could prove to be an answer to a big problem. The wasp is native to Mexico and has the capability to suppress the boll weevil population, especially early in the season when cotton buds have just begun to form. The female *A. grandis* punctures flower buds, eats anthers and lays eggs inside the buds. Such buds will be shed by the plant as a result of non-fertilization of ovules. Boll

weevil eggs remain safe inside these flower buds until they hatch. As soon as the eggs hatch and the larvae emerge, the wasp attacks the boll weevil larvae. The wasp's ability to lay eggs close to the boll weevil eggs and its specificity to the boll weevil larvae enhances the utilization of the wasp as a potential biological method of boll weevil control. The boll weevil males also feed on anthers, but the females eat anthers more vigorously to make a place for egg laying.

Mechanism of Parasitoid Attraction to the Host

For successful parasitization of a host, the parasite must be strongly attracted to the host. Rojas et al (1994) conducted a trial on the behavior of *C. grandis* in seeking and finding the host. A wind tunnel, 175x45x45 cm in size with uniform wind pressure from one side, was prepared to release female parasites. Ten-day-old *C. grandis* females were released under uniform wind pressure to feed on uninfested squares, bioassay of boll weevil infested flower buds, larval frass and commercial compounds found in cotton buds. All diets were placed on the opposite end of the tunnel and

movement of the wasp to reach the diets was studied. The results showed that the wasp is strongly attracted to the infested squares and larval frass. There were no statistical differences in attraction between the bioassay of the infested buds and boll weevil larval frass. The results also showed that *C. grandis* females were not attracted to the uninfested flower buds and commercial compounds found in the normal flower buds. According to Rojas et al (1994), the time for locating the host is 30 to 120 minutes. Detailed studies on the movement of the biological control agent indicated that there are three ways for *C. grandis* to reach the target host:

- After the female parasites were released in the wind tunnel, some parasites flew directly to the target host
- Sometimes the parasitoid flew in vicinity of the host and then walked to the target
- After the parasitoid has flown in vicinity of the host, it may also make another short flight to reach the target host

The studies were conducted under *in vitro* conditions and it is assumed that similar behavior exists under field conditions. However, it is evident

that *C. grandis* has the ability to search and locate its host readily which is one of the most important characteristics for the parasite to control the boll weevil successfully.

***C. grandis* as a Parasitoid**

Since the importation of *C. grandis* from Mexico during the 1970s, extensive trials have been conducted to establish its usefulness for the control of boll weevil. The following conditions showed great potential for commercial utilization of *C. grandis* for boll weevil control.

- *C. grandis* has potential to search and locate its host even at low densities at a distance of 120 m. The wasp also searches for the most suitable stages of the host (most commonly third instar larvae) for effective parasitization
- *C. grandis* has a high rate of increase relative to boll weevil
- *C. grandis* proved to be a very effective parasitoid. Small scale trials under field conditions showed that *C. grandis* has a competitive superiority over all other native biological control agents of boll weevil

- *C. grandis* has developmental synchrony with the host and natural tendency to search the soil for a host (where the infested buds fall after they have been damaged by the boll weevil and egg laying has been completed)
- The development of an inexpensive mass rearing technology for large scale utilization of the parasite appears possible.

Once the usefulness of *C. grandis* as an effective means of biological control of boll weevil was established, the important issues for further research include laboratory rearing of the wasp at economical costs, the quantity of the wasp and time of release, augmentation with the current agronomic practices including pesticide application, and the effects on other species.

Artificial Rearing

Extensive efforts have been made to rear the wasp artificially and use it on a commercial scale. In this regard, the work done in the last four years is of special significance. The initial efforts to rear *C. grandis* required placing the third instar boll weevil larvae into hollowed cotton squares, sealing the hollowed square with an artificial medium and exposing the artificially im-

planted larvae to *C. grandis*. Cate (1987) gave a simple procedure of encapsulating the third instar host larvae in parafilm instead of artificially infested hollowed squares. Even this was not an efficient and economical method for commercial utilization.

Initial work to enhance the rate of artificial rearing of *C. grandis* did not prove successful. One major problem was the formation of cavities in the parafilm for the placement of host larvae. Roberson and Harsh (1993) tried high air pressure to form cavities, but it did not work. Then they were able to correct the problem by using an automobile tube (1.6 mm thick) to apply 160 ppsi pressure. Manual encapsulation of larvae produced 5 sheets/person/day which was not economical. Significant production output of encapsulated larvae sheets was achieved using a semi-mechanized process. Electric hydraulic pressing resulted in the production of 50 sheets/person/day, greatly reducing the cost of rearing the parasite.

Infochemicals released by the host play a critical role in guiding the parasitoid. For successful parasitization of a host, synchronized and stimulated release of infochemicals enhance the chances of finding a host quickly. Oviposition stimulant n-hexane was tried in the artificial diet and showed a

positive effect on parasitization activity of *C. grandis* (Guená et al, 1994). They also investigated medium contamination and the cost of mass rearing of *C. grandis*. The parafilm used to cover the oviposition containers resulted in physical egg damage and was also expensive. Despite the addition of the antibiotic gentamicin, bacteria and fungus infected the medium. Guená et al (1994) concluded that the addition of penicillin, streptomycin and amphotericin did not contaminate the medium and the replacement of parafilm with polyethylene plastic membrane reduced the cost significantly.

Field performance of *in vitro*-reared *C. grandis* has shown successful parasitism of boll weevil. Morales-Ramos et al (1994) propagated *C. grandis* on a medium devoid of insect component and released 400 females in the field twice a week. The results showed a high percentage of parasitism of second instar larvae 36.4-100%, third instar larvae 18.4-57.1% and pupae 0-75%, which resulted in 63.2-100%, 31.9-60% and 0-75% mortality, respectively. Such a high mortality rate is still lower than that reported in the other work mentioned above, but it was almost equal to the *in vivo*-reared *C. grandis* tried by Morales-Ramos et al in 1994 at a different site. However, it has been confirmed that *in vitro* *C. grandis* maintains the same searching ability as *in vivo* *C. grandis*.

In vitro propagation requires additional research before *C. grandis* can be successfully used on a commercial scale. Because only the females of the *C. grandis* parasitize boll weevil, the proportion of females in the artificially reared population must be increased. The possibility of manipulating directed multiplication of sex ratios still needs to be explored.

Effect of Agronomic Practices on Parasitization

Some cultivation practices have drastic effects on effective parasitization of the host. Summy et al (1994) studied the effect of mechanical weed control operations on parasitization in a short-season production system and under lab conditions. Mechanical cultivation of boll weevil infested fields with roller and sweep cultivators, at the time of need for parasitization in the field, seriously affected the parasitoid activity. There were no differences in the type of implements used. Both the implements buried 44-48% flower buds and bolls on the ground with a single operation, and the samples taken from underground showed no signs of parasitization. In a lab experiment, the squares having third instar larvae or pupae of the boll weevil

were fed to *C. grandis*. One set of petri dishes was covered with a thin layer (mm) of topsoil. Covered and uncovered flower buds were exposed to 350 females of *C. grandis* for a period of three hours, after which the squares were removed and dissected to measure the intensity of parasitism. In contrast to the relatively high percentage of parasitization occurring on the soil surface (92.8%), no parasitization was observed in the petri dishes covered with thin layer of topsoil. Less than one mm covering is not likely to be a mechanical hindrance; thus, the reasons for non-parasitization are not very clear. The results of both of these experiments suggested that the use of mechanical cultivation in parasite release sites would require precise timing.

It was also observed that herbicides and growth regulators had little or no effect on the parasitization efficacy of *C. grandis*, but properly timing the release of parasitoid in the field was important. Insecticides must degrade to nontoxic levels before biological control is applied. Though the products vary in the time taken to degrade, it was very important to base integration of wasp releases with the production practices on pretested authentic information for any particular area.

Quantity of *C. grandis* Released

The size of the population of *C. grandis* needed to infest 100% of the boll weevil population will depend on a number of factors. The population of boll weevil larvae per unit area and proper augmentation releases are very important, but parasitoid rearing conditions also play an important role in activities of the parasitoid. Morales-Ramos et al (1994) observed that storage of the parasitoid at 5°C or 10°C for more than ten days reduces the effectiveness of *C. grandis* females by 50%. They also found that storage for 20 days may even result in sterility or reduced emergence. The development of *C. grandis* at low temperatures has the same effect as storing pupae at low temperatures for ten days. According to Summy et al (1993), 2500 females/ha released each week for eight weeks provided up to 99% host mortality.

C. grandis female pupae are more than double the size of male pupae. Greenberg et al (1994) concluded that even the weight of the pupae is important for high fecundity of *C. grandis*. They grouped female pupae into five groups: less than 4 mg, 4.1 to 5 mg, 5.1 to 6 mg, 6.1 to 7 mg and over 7 mg. Male pupae were grouped into three groups; up to 1 mg, 1.1 to 2 mg

and over 2 mg. Male and female pupae were reared at 20°C temperature, 65% relative humidity and a light to dark ratio of 12:12 per day. The average weight of the female pupae ranged from 3.0 to 9.8 mg as against 0.5 to 2.9 mg for male pupae with a mean weight of 5.74 ± 1.08 mg and 1.54 ± 0.46 mg, respectively. The frequency of female groups was 5.3, 21.7, 28.1, 35.4 and 9.5% as against 12.6, 75.7 and 11.7% for male pupae. They observed that the process of *C. grandis* production may be satisfactory if the weight of female pupae is not less than 5.1 mg and percent emergence is more than 90% and the sex ratio is 60-65% females.

In 1992, researchers at USDA-ARS, Weslaco, TX, released 2500 female wasps of *C. grandis* per hectare to investigate their impact on boll weevil control. These small scale test plots showed 100% control of young boll weevils. The wasp appears harmless to other insects, human beings and animals.

The work done on augmentative releases showed that the density of the immigrating population is important for proper releases. Yield losses and boll weevil mortality are not correlated. 60% parasitization can suppress the boll weevil population if the immigrating population is low. 90% mortal-

ity may not be effective if the immigrating population is more than 200 adults/ha/day.

Summy et al (1993) studied the effect of *C. grandis* in the absence of insecticide use. They released 2,470 female parasites at weekly intervals starting from April 30 to June 29 in two sets of experiments in comparison with untreated plots. Treated and untreated plots were monitored at weekly interval for boll weevil densities, incidence of mortality occurring at various age categories and intensity of damage to fruit forms. To measure damage to the plant, all infected squares, flowers and bolls on the plant and on the ground per unit area were taken into consideration. Insecticides were not applied to the treated or untreated plots. Boll weevil mortality was characterized based on the life stage of the weevil. The results showed that 96.5% mortality of the third instar larvae and 95.0% mortality of the pupae occurred in the treated plots as against 9.5% and 7.9% in case of untreated plots. Like untreated plots, treated plots also showed a good percentage of unexplained larvae and pupae mortality. High unexplained mortality in the treated plots could be ascribed to aftereffects of *C. grandis* parasitization. The parasite was effective in reducing multiplication of the first and second generations of boll weevil. Consequently, damage to the

fruiting parts by the third and fourth generations was significantly reduced. Treated plots even in the absence of insecticides showed eight week average boll weevil damage of 0.2% and 0.3% in two plots. In the two untreated plots, 48.3% and 90.5% fruiting forms were affected under unsprayed conditions.

Limitations to the Use of *C. grandis* on a Commercial Scale

According to King et al (1993), the two main limitations for commercial utilization of *C. grandis* are extensive use of insecticides at the time of boll formation and mechanical cultivation at an early stage of plant development which buries the flower buds and prevents the parasite from finding the host. King et al (1993) proposed the following safe *C. grandis* release periods for some chemicals.

Growth regulators mepiquat chloride and Ethephon have low toxicity and one day was a safe period to release parasites. However, frequent use of insecticides and mechanical cultivation of cotton fields creates the need to undertake detailed studies on augmentative releases of the parasite. If the

first and second generations of over-wintering boll weevils are strongly attacked by *C. grandis*, the population of the third and fourth generations, which actually coincides with the peak fruit formation stage in cotton, can be significantly reduced. Mass propagation of the parasitoid is also one of the main constraints for commercial utilization of the biological control method. As already mentioned above, *in vitro*-rearing conditions need to be improved to make them less expensive and faster. In this regard, it is essential to develop artificial diets for faster multiplication of the biological control agent. Several diet combinations have been tried by researchers in the past three years, and some of them have shown promise. Apparently, it is possible to propagate *C. grandis* on commercial scale more quickly and inexpensively.

Compound	Immediate Toxicity	Toxic Period (days)
Dicrotophos	High	<6
Acephate	High	<9
Dimethoate	High	<6
Malathion	High	<6
Azinphosmethyl	High	<14
Azinphosmethyl + oil	High	<6
Methyl parathion	High	<6
Oxamyl	High	>21

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Growth Regulators in the Cotton Production System

The cotton plant is naturally a perennial tree and, since its domestication, researchers have tried to shorten its growing period. Initial efforts were successful in making the cotton plant behave like an annual tree: Plant it every year, harvest the yield, uproot the plant and replant it the next year. Efforts made were not only directed toward minimizing the growing period to make it fit to the current cropping systems, but also toward reducing the height of the plant. The cotton plant, being very flexible, accepted the pressures of the researchers and continued changing its behavior. During the 1970s, cotton breeders, in an understanding with physiologists, devised the term "determinant varieties" to describe types that would exhibit cut-out at a certain date under normal production practices. The mechanism used was high sensitivity to growing conditions rather than any change to the genetic nature of cotton to grow indeterminately. Based on available technology, it does not seem possible to change the botanical nature of the cotton plant. The indeterminate nature of the cotton plant and its high

response to growing conditions dictates that plant growth must be kept under control in order to obtain optimum yield.

How growth can be controlled without disturbing the balance between vegetative growth and reproductive development is a complex phenomenon. Enhancing the vegetative growth rate through frequent irrigation and the addition of nitrogenous fertilizers is easy, but it is usually difficult to check growth without affecting the ultimate yield. Under current production practices, it is very important that an extension in the growing period, for even few days, is not sacrificed. A prolonged growing season and formation/maturation of bolls under different ambient conditions results in significant variation in fiber characteristics. Abundant literature is available on the fact that late formed bolls always give rise to comparatively less mature and weak fibers.

Investigations into the feasibility of using synthetic chemicals have proved that they can be successfully used to manipulate vegetative and reproductive development in cotton. The chemicals which have a direct bearing on plant growth are called growth regulators. In cotton, growth regulators are usually used for the following purposes.

- For the sake of the best utilization of inputs, growth regulators are applied to keep a balance between the vegetative growth and the formation of reproductive forms. Fertilizers and insecticides are applied to produce and protect bolls on the plant. If such inputs are utilized by the plant mainly to produce vegetative mass without the desired fruit formation and development, it is considered a wasteful expenditure.
- Some varieties have the morphological characteristics to grow taller even under optimum growing conditions. Growth regulators are more commonly used on such varieties to check their plant height, maybe without any additional advantage of higher yield. Shorter plant height or lower vegetative mass means less nutritional stress on the soil.
- Growth regulators are also frequently used for the sake of early crop maturity. Early maturity can be induced through various phenomenon including early boll formation. Formation of bolls closer to the main stem also induces early maturity.
- Growth regulators are also used to enhance uniformity of the crop produced. Late-formed bolls develop at low temperatures and usually take longer to complete their heat units for opening. In countries where winter

is usually very severe, boll formation beyond certain dates does not contribute toward productivity. Under such conditions, it is important to terminate the crop at a certain date for the sake of diverting food toward proper maturation of bolls already formed and induce early maturity. Forced opening of such bolls through desiccation and defoliation devices for machine picking results in immature fibers with below normal micronaire. Growth regulators are used to induce early cut out to avoid inclusion of late-formed bolls in the productivity of the crop.

Effect of Growth Regulators on Agronomic, Yield and Fiber Characters

Growth regulators affect cell growth which may have a significant impact on plant morphology, yield and fiber quality. However, effects on agronomic characters are more pronounced. Plant height and flowering time are the most commonly affected characters. Plant height, particularly in tall-growing varieties with a lower percentage of boll retention, is reduced by 20-30% and the crop gets into the boll formation stage earlier than untreated plots. The plant canopy is also decreased by over 20%. The length

of lateral branches is generally reduced. The position of bolls on the plant is changed, as the proportion of bolls closer to the main stem (first and second position bolls) is usually significantly increased. In many cases, the rate of boll formation may also be affected. Because growth regulators depress the growth rate, internodal length is significantly reduced. Reduced plant height and canopy enhance penetration of light down to the bottom bolls, thus reducing the chances of growing fungus on the bolls closer to the ground, particularly in the humid zone. Of course, all these effects are determined by the type of product used, the time of application and the quantity of the chemical applied, in addition to growing conditions. Researchers found different results with different chemicals. Some chemicals applied for the sake of checking growth had a gametocide effect and induced male sterility, thus affecting the number of seeds/boll and ultimately lint yield.

Timely application of growth regulators makes the crop mature early. Termination of late formed bolls also helps to reduce the population of late season insects. A lower insect population going into diapause at the end of the season means a lower population emerging from over-wintering and less attack on the crop the following season.

Traditional efforts to increase yield through increased boll set have remained less successful. However, changes in the chemical processes may have many indirect effects. Indirect effects on some morphological characters, if they are a limiting factor in yield, may result in increased yield. The regulatory mechanism of the plant is such that it should shed some flower buds. Efforts made to bring changes in the regulatory mechanism, for the sake of higher fruit setting, did show a significant improvement, but still a high percentage of flower buds are shed. However, fruit retention and abscission are affected by endogenous growth regulators. The retention:abscission ratio depends on the balance between nitrogen and the plant's own growth regulators, i.e., gibberellic acid and abscisic acid. Gibberellic acid and abscisic acid levels are low in the retained fruit compared with abscised buds. Retained fruit has high N levels compared with abscised fruits. The absolute amount of gibberellic acid and abscisic acid has no effect on fruit retention. Results have also shown that another endogenous regulator "Cytokinin" is negatively correlated with abscission. Some growth regulators are said to have effects on transpiration, thus making it possible to enhance yield through reduced photorespiration rates. Reduced height sometimes may also result in reduced yield. Late season termination of

the crop at a certain stage may also bring some relief from insect damage and contribute toward yield improvement. No clear results in support of higher yield are available.

The main objectives of using growth regulators are to improve yield through earliness or check growth and to make the plant more efficient. Growth regulators are not applied to alter or to improve fiber characteristics, but the effects on some fiber characters have been noted. The fiber elongation and secondary wall thickening periods overlap and, if the latter period is prolonged by any means, including growth regulators, the fibers have more time to mature. Prolonged thickening of the secondary wall ensures proper deposition of cellulose, thus improving maturity, strength and dye absorbency characteristics of the fiber. Too much prolongation in the period may also result in coarser fiber, as has been noted in the application of chemicals like Cycocel®. At higher concentrations, Cycocel® increases length but decreases strength, maturity and yield. Application of gibberellic acid increased length in one variety but had no effect on length in another variety.

Commonly Used Chemicals and Their Modes of Action

Some chemicals commonly used as growth regulators include mepiquat chloride, Cycocel® (CCC), TD-1132, Thidiazuran, acetic acid and phosphoric acid. The herbicide “Glyphosate” is also sometimes used as a growth regulator. Chemicals may be used alone or in combination. For any good growth regulator, prompt absorption into the plant tissues and efficient translocation to growing tips are important. The chemical must start retarding growth as soon as possible without affecting boll development. Growth regulators are meant to slow, not stop growth, and to divert carbohydrates toward fruit formation.

Mepiquat chloride or Pix® is a gibberellic acid used as a suppressant which reduces cell elongation, thus affecting plant height, main stem nodes, vegetative growth and fruiting pattern. PGR-IV® is gibberellic acid and butyric acid. Cytokin® is Cytokinin used for the sake of improving root development, fruit retention, reducing stress and improving fiber quality. Most chemicals have little residual effect and disappear in the atmosphere

a few days after application. However, arsenic acid stays in the plant and in the atmosphere for many days and thus has been prohibited for use on cotton in the USA.

Use of Growth Regulators

The decision to use growth regulators depends mainly on the morphology of a variety. Short stature, early-maturing varieties do not require measures to check vegetative growth; hence, there is no need for growth regulators. However, excessive doses of nitrogen fertilizers may keep the plant in the vegetative phase for a longer period of time, thus emphasizing the need for checking growth. In 1993, the ICAC undertook a survey of cotton production practices, including the use of growth regulators. According to the survey, growth regulators are most commonly used in China (Mainland), Spain and the USA. Many countries do not use growth regulators and perhaps there is no need for them. According to the ICAC survey, the percentage of cotton area treated with growth regulators in different countries is as given in the following table.

Use of Growth Regulators in Different Countries

Country	Region	Area treated in %
Argentina	National/Chaco	10-15
Australia	New South Wales	20
	Queensland	20
Brazil	North Minas Gerais	-
	Parana	-
	Sao Paulo	20
	South Minas Gerais	1
Bulgaria	National	10
Chad	National	-
China (Mainland)	Yangtze River Valley	60-80
	Yellow River Valley	50-80
Colombia	Costa-Meta	-
	Tolima	10
	Valle del Costa	35
Greece	National	30
Guatemala	National	37
India	National	1
Israel	Upland	5
	Extra-fine	-
Mali	National	-
Morocco	National	-
Pakistan	National/Punjab	-
Paraguay	National	1
Philippines	National	-
Senegal	West Africa	-
South Africa	Central Transvaal	-
	Northern Natal	10
Spain	Andalucia	90

Use of Growth Regulators in Different Countries

Country	Region	Area treated in %
	Levante	5
Syria	National	-
Thailand	National	-
Togo	National	-
Turkey	Adana	42
USA	Delta-Midsouth	50
	Irrigated West	54
	Southeast	64
	Southwest	30
	Average	36
Uganda	BPA and SATU	-
Uruguay	Litoral West	-
Zimbabwe	Southern Africa	5

Interregional Coordinated Trials

The Interregional Cooperative Research Network for the Mediterranean and Middle East Region has a Working Group on Plant Growth Regulators. Dr. K. Kosmidou-Dimitropoulou of the Hellenic Cotton Board, Greece, is the current chair of the working group. The group has the responsibility of undertaking coordinated trials on growth regulators in various countries. The group has met three times since 1992 and its member countries in-

clude Bulgaria, Egypt, France, Greece, Spain, Syria and Turkey. Dr. Derrick M. Oosterhuis of the University of Arkansas, USA, also joined the group at the last two meetings held in Greece and Egypt. Pakistan, Russia and Uzbekistan were represented at the Egypt meeting in March 1995. The group has prepared a list of publications on growth regulators, a directory of researchers and an inventory of growth regulators used on cotton.

In January 1994, the group decided to lay out uniform trials in the member countries. It was decided to test PGR-IV®, Cytokin® and PHCA (Cenergy) for three years from 1994-1996. PGR-IV® was applied in three treatments, i.e., T1=73 ml/ha in furrows at the time of planting, T2=146 ml/ha as a foliar application at the pinhead square stage + 292 ml/ha at first flower, and T3=T1+T2. Cytokin® was also applied at the rate of 280 ml/ha at the pinhead square stage + 560 ml/ha at first flower + 560 ml/ha at 2-3 weeks after first flower. PHCA was also applied at the same times, but the doses were 560, 1120 and 1120 ml/ha, respectively.

Data for the first year from some countries are available. In Greece, it was observed (Kosmidou-Dimitropoulou et al., 1995) that seed cotton yield increased in the treated plots by 12-22% over the control. The differences

were statistically significant at the 95% level of confidence. PGR-IV® T3 and PHCA gave the highest increase of 20% and 22% over the control, respectively. It seems from the data given below that increased yield was the cumulative effect of bigger bolls and a slightly higher number of bolls/plant.

Effect of Growth Regulators on Yield and Plant Characters in Greece

Treatment	Nodes Above White Flower on Aug. 7	Boll Weight	Bolls/plant	Seedcotton Yield
Control	4.3	7.6	10.2	4898
PGR-IV T1	4.1	7.6	10.4	5464
PGR T2	4.2	7.9	10.4	5543
PGR T3	4.3	8.0	10.6	5858
Cytokinin	4.1	7.7	10.4	5555
PHCA	4.2	7.8	10.1	5995
F test	NS	NS	NS	Significant
LSD	0.36	0.34	3.5	334

Data were also recorded on fiber length, strength and micronaire value of cotton from treated vs. untreated plots. Fiber length and strength were not affected by growth regulators. However, micronaire value increased by a significant margin over the untreated plots. As in the case of yield, PGR-

IV® T3 and PHCA gave the highest micronaire value of 4.43 and 4.53, respectively, as against 4.0 in the case of the control.

The trial conducted in the USA by Dr. Derrick Oosterhuis (1995) under the same protocol with little variation in the doses also showed a significant increase in lint yield because of increased vigorous growth and boll development. The highest yield was obtained in the in-furrow and foliar treated plots. PGR-IV® and PHCA decreased plant height by 15 and 16 cm, respectively, without any significant effect on node number. Cytokin® had no significant effect on plant height. In the treated plots, crop maturity was enhanced by a few days, but the differences were insignificant.

In Egypt, growth regulators in the form of retardants, promoters and defoliants have been tried since 1970, but the results have remained inconclusive. The latest trials conducted (Abdel al et al., 1995) on Cytokin®, applied individually at pinhead square stage, first flower stage, two weeks after flowering and at all stages together, showed no increase in yield. Crop maturity and seed weight were the only characters among 20 other characters measured which significantly improved in the treated plots.

In Syria, Pix® and Cycocel® were tested during 1990, 1991, and 1993, while PGR IV® and Cytokin® were tested during 1994 at two locations on two varieties (Zibdieh et al., 1995). Nitrogen and phosphorous were applied at the rate of 150 kg/ha and 120 kg/ha, respectively, to treated and control plots. Growth regulators showed no significant effect on yield and quality characteristics. Although application of PGR IV® and Cytokin® lowered seed cotton yield, the differences were statistically insignificant. Cytokin® application in Turkey also did not show any significant improvement in yield, yield components or fiber quality.

In Pakistan and many other countries, trials have been conducted for many years on the use of growth regulators, but the results remain inconclusive. The latest trials conducted in Pakistan during 1992/93 and 1993/94 also remained inconclusive. Mepiquat chloride was applied at pin-head square stage, at first flower, 15 days after first flower and at peak flowering stage. Multiple applications of mepiquat chloride showed no effect on seed cotton yield during 1992/93, but yield increased significantly during 1993/94 because of a greater number of bolls/plant than in the check plants.

Trials in the USA

Growth regulators can have varied effects on the plant. Growth regulators can be applied to encourage early stage root development and square retention, in addition to diverting vegetative growth toward reproductive growth. In the last twenty years, growth regulators have been extensively tested in the USA to achieve various objectives. The results have shown that lint yield might increase at one location year after year or it may increase only in certain years. The results are not consistent for any one product, though some products are applied more commonly than others. Fletcher et al (1994) tested feedback vs. scheduled application of Pix® on upland cotton. The results showed that application of Pix® based on vegetative data of the plant rather than stage of growth had a significant effect on lint yield. If the crop conditions, irrespective of the variety planted, are indicative of the excessive vegetative growth, Pix® application might contribute to improving lint. If vegetative growth is not high in proportion to the reproductive forms on the plant, application of growth regulators might even decrease lint yield. Undesirably high doses of Pix® might also have a

negative effect, even if the chemical would have had a positive effect on yield applied in proper doses.

Livingston and Parker (1995) tested seven different doses of PGR IV® and mepiquat chloride on five varieties at two locations and observed that, in all varieties, yield increased significantly over the control in five treatments. The increase in yield was due to larger boll size and not boll number, which increased inconsistently. Yield increases were not significant at the second location, thus emphasizing the need for considering growing conditions before deciding to apply growth regulators. Ginning outturn and fiber quality were not affected at any location. However, some varieties exhibited early maturity.

Weir et al (1994) tried PGR-IV® on *G. hirsutum* and *G. barbadense* in the San Joaquin Valley of California under irrigated conditions for two years. They observed that treated plots showed a trend toward more green bolls and a higher percentage of second position bolls on the lower branches. They also observed that PGR-IV® application produced a greater number of bolls and ultimately a higher yield but the differences were insignificant except at one location out of two in 1992 and four in 1993. Hood (1994)

tested Cytokin® and Pix® and also found an inconsistent effect on plant morphology and yield. He observed a yield increase in 1992 but not in 1993.

Conclusion

Based on the latest available information, growth regulators do not always result in increased lint yield. Growth regulators may prove useful in improving yield and enhancing crop maturity through early boll setting only if they are applied on tall-growing varieties. With the release of short stature varieties in many countries, the chances of expanding the use of growth regulators have decreased further. Growth regulators should only be applied if there is a need for redirecting the growth pattern at an early stage of plant development. Management practices aimed at early season growth and square retention may also require a strict balance between vegetative and reproductive growth of the plant. Because different chemicals affect different plant parts, it is important to decide which chemical/product should be applied. The time of application and doses need to be decided in relation to actual growth data rather than the growth stage of the plant.

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Zibdieh, A., Mouharram, M. Sh. and Khouri, F. 1995. Effect of growth regulators PGR IV® and Cytokin® in Syria in 1994. Paper presented in the meeting of the Working Group on Growth Regulators of the Interregional Cooperative Research Network for the Mediterranean and Middle East Region, March 1995, Cairo, Egypt.

Short Notes

- **Bt Cotton**

Much has been heard about genetically engineered Bt cotton, but now it will soon be available to growers for utilization. Genetically engineered Bt cotton called “Bollgard” with resistance to lepidopteran insects will hopefully be available to growers for commercial planting in the USA in 1996. About 11,000 hectares of Bollgard brand Bt cotton will be grown during 1995/96 for seed multiplication. As reported in the last issue of THE ICAC RECORDER, Bollgard brand Bt cotton will be regulated by the US Environmental Protection Agency as a pesticide because the transgenic plant has pesticidal properties. According to Delta and Pine Land Company (D&PL), who will be marketing the Bt cotton for planting, Bollgard brand Bt cotton seed will cost US\$ 34-35 compared to US\$ 8-9 per hectare for non-engineered cotton seed. Large-scale benefits will be available to the majority of US cotton growers in four to five years. Once the usefulness of cotton resistant to American bollworm, tobacco budworm and other Lepidopteran insects becomes popular among US cotton growers, Bollgard brand Bt cotton might become available to growers outside the US

under agreements with D&PL. However, a limitation of growing only D&PL varieties will apply. Countries where D&PL varieties are not grown must transfer the resistant gene into their own commercial varieties to utilize this technology.

- **Biotechnology Advisory Commission**

An International Biotechnology Advisory Commission (BAC) has been established by the Stockholm Environment Institute (Address: Box 2142, S 103, 14 Stockholm, Sweden). This group will, on request, provide national authorities with impartial advice for evaluating the applicability and safety of biotechnologies. Members of the Commission are based in 11 countries around the world and, in combination, have many years of experience with scientific, economic and legal issues surrounding biotechnology research and development. The BAC is prepared to assist with the risk and benefit analyses of proposed specific introductions of genetically modified organisms through independent reviews.

In response to specific requests, for example, how to assess a particular genetically modified organism prior to field testing, BAC will provide evaluations of the important, relevant issues. Any advice offered will be

based upon background data provided by the applicant, information obtained through special sources (e.g., ad hoc Task Forces sponsored by the Commission), and the collective knowledge and experience of the members. It is intended that advice will be in a form that may be useful to regulatory authorities in their decision making.

Recognized internationally in their respective fields, Commission Members are scientific, economic and legal experts whose judgment commands respect. This is evidenced by their extensive experience in national and international biotechnology programs. Members are based in developing and industrialized countries. They have been drawn from the public and private sectors. While an environmental focus is prominent in their backgrounds, they provide expertise in the fields of applied ecology; ecological genetics; microbial ecology; microbial biochemistry; molecular biology of plants and microorganisms; molecular genetics; entomology; genetics; marine biotechnology; plant breeding; plant pathology; international, environmental and regulatory law; and economics.

Consistent with the formation of an independent commission, the BAC will

1. In the first instance provide advisory services solely on an on-request basis to appropriate governmental and intergovernmental authorities responsible for the evaluation of applications of biotechnology products in developing countries. At the discretion of the Commission members, requests from other entities may be accepted;
2. Initially focus on products currently being considered for testing in the developing world. Accordingly, genetically modified plants and microorganisms with various traits are likely to feature prominently in the first reviews, but other applications of biotechnology will be considered; and
3. Safeguard proprietary information and respect requests for confidentiality. However, the extent of privacy requests should be considered in light of the intent for BAC recommendations to be transparent and, whenever possible, made publicly available.

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- **World Cotton Production**

Currently, world cotton production for 1995/96 is forecast at 19.09 million tons as against 18.36 million tons during 1994/95. The USA is expected to produce 4.58 million tons, 7% more than in 1994/95, mainly because of an increase in planted area. The Acreage Reduction Program for cotton is set at 0% in 1995 against 11% in 1994 and 7.5% in 1993. The crop index in early June was 5 percentage points below last year. Turkey is also expected to increase production by 19% over 1994/95 to 0.75 million tons mainly because of an increase in area and extended irrigation facilities.

The bollworm problem will persist in China (Mainland) during 1995/96. Because of less severe winter conditions, the pest is anticipated to be more harmful than last year. Not only will emergence be higher, but insecticide resistance will also add to the problem.

In India, the leaf curl virus may also affect cotton production during 1995/96, but a sudden outbreak is not anticipated. A shorter growing season and milder summer conditions, coupled with input procurement and distribution problems are likely to reduce cotton production in Uzbekistan to 1.25 million tons in 1995/96. In Pakistan, high cotton prices obtained by farmers during 1994/95 will encourage farmers to enhance insecticide use and control the whitefly (a major vector of the leaf curl virus) more vigorously. Higher insecticide use and more experience in tackling the disease are expected to have a positive effect on yield. Increases in area under varieties tolerant to the leaf curl virus and increased total planted area will also contribute to an increase in total production.

In 1995/96, world cotton production will still only match world consumption of 19.13 million tons. After four years of higher consumption than production, increased area will boost production in 1996/97 to an estimated 20.5 million tons, against estimated world consumption of 19.6 million tons.

Powered by near-record Chinese (Mainland) imports and a record-low ratio of world-less-China (Mainland) ending stocks-to-use, the Cotlook A Index rose to an average of 91 cents per pound during the period from August 1994 through May 1995, 24 cents higher than the average during the same period in 1993/94. At the end of April, the A Index reached a record US\$1.18 per pound. High prices are encouraging substantial increases in planted area in many countries.

A DIALOG Search from the Agricola Database on Pheromones to Control Cotton Insects

A DIALOG search of the Agricola Database was conducted on the development and use of sex pheromones to control insects in cotton. The key words used are **Cotton** and **Pheromones**. 72 references for the period from 1980 to date are reported.

92060660 20426925 Holding Library: AGL

Cotton leafperforator (Lepidoptera: Lyonetiidae) pheromone studies

Leggett, J.E.; Henneberry, T.J. and White, R.D.

The Southwestern Entomologist. Sept 1994. v. 19 (3) p. 229-236.

Dallas, Tex. : Southwestern Entomological Society. ISSN: 0147-1724

CODEN: SENTDD

DNAL CALL NO: QL461.S65

Language: English Includes references

Place of Publication: Texas

Subfile: IND; OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

92057788 20423983 Holding Library: AGL

Relationships between environmental factors and capture time of male pink bollworm (Lepidoptera: Gelechiidae) moths in traps baited with sex pheromone

Beasley, C.A. and Adams, C.J.

Journal of Economic Entomology. Aug 1994. v. 87 (4) p. 986-992. Lanham, Md.: Entomological Society of America, 1908.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references

Place of Publication: Maryland

Subfile: IND; OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

92057786 0423981 Holding Library: AGL

Automated pheromone traps show male pink bollworm (Lepidoptera: Gelechiidae) mating response is dependent on weather conditions

Schouest, L.P. Jr.; Miller, T.A.

Journal of Economic Entomology. Aug 1994. v. 87 (4) p. 965-974. Lanham, Md.: Entomological Society of America, 1908-

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references

Place of Publication: Maryland

Subfile: IND; OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

92044451 20413520 Holding Library: AGL

Mating response behavior of sterile pink bollworms (Lepidoptera: Gelechiidae) compared with natives

Miller, T.A.; Miller, E.; Staten, R.; Middleham, K.

Journal of Economic Entomology. June 1994. v. 87 (3) p. 680-686. Lanham, Md.: Entomological Society of America, 1908-

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references

Place of Publication: Maryland

Subfile: IND; OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

92016464 20386362 Holding Library: AGL

Pheromone trap catches as a means of predicting damage by pink bollworm larvae in cotton

Qureshi, Z.A.; Ahmad, N.; Hussain, T.

Crop Protection. Dec 1993. v. 12 (8) p. 597-600. Oxford : Butterworths-Heinemann Ltd.
ISSN: 0261-2194 CODEN: CRPTD6

DNAL CALL NO: SB599.C8

Language: English

Includes references

Place of Publication: England

Subfile: IND; OTHER FOREIGN;

Document Type: Article

92011668 20382357 Holding Library: AGL

The influence of slow release PVC resin pheromone formulations on the mating behaviour and control of the cotton bollworm complex (Lepidoptera: Gelechiidae and Noctuidae) in Pakistan

Chamberlain, D.J.; Ahmad, Z.; Attique, M.R.; Chaudhry, M.A.

Bulletin of Entomological Research. Sept 1993. v. 83 (3) p. 335-343. London: Commonwealth Agricultural Bureaux International.

ISSN: 0007-4853 CODEN: BERE A2

DNAL CALL NO: 421 B87

Language: English

Includes references

Place of Publication: England

Subfile: IND; OTHER FOREIGN;

Document Type: Article

91140975 20364671 Holding Library: AGL

Cotton bollworms: male moth catches in pheromone traps and relationship to oviposition and boll infestation in cotton fields in middle Egypt

Gergis, M.F.; Younis, A.M.

Proceedings of Beltwide Cotton Conferences 1993. v. 2 p. 1048-1051. Memphis, Tenn.: National Cotton Council of America, 1991-

ISSN: 1059-2644

DNAL CALL NO: SB249.N6

Language: English

Includes references

Place of Publication: Tennessee

Subfile: IND; OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

91118476 93050785 Holding Library: AGL

Overwintering by the boll weevil (Coleoptera: Curculionidae) in Conservation Reserve Program grasses on the Texas High Plains

Carroll, S.C.; Rummel, D.R.; Segarra, E.

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ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

91118451 93050760 Holding Library: AGL

Preventive insecticide resistance strategy in *Helicoverpa* (*Heliothis*) *armigera* (Lepidoptera: Noctuidae) in Israeli cotton

Horowitz, A.R.; Seligman, I.M.; Forer, G.; Bar, D.; Ishaaya, I.

Journal of Economic Entomology. Apr 1993. v. 86 (2) p. 205-212. Lanham, Md.: Entomological Society of America.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

91100779 93037134 Holding Library: AGL

Pollen feeding and survival of the boll weevil (Coleoptera: Curculionidae) on selected plant species in northeastern Mexico

Jones, R.W.; Cate, J.R.; Hernandez, E.M.; Sosa, E.S.

Texas A&M University, College Station, TX

Environmental entomology. Feb 1993. v. 22 (1) p. 99-108. Lanham, Md. : Entomological Society of America.

ISSN: 0046-225X CODEN: EVETBX

DNAL CALL NO: QL461.E532

Language: English Summary Language: Spanish

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

91100771 93037126 Holding Library: AGL

Aerial concentrations of gossypure, the sex pheromone of the pink bollworm (Lepidoptera: Gelechiidae), within and above cotton fields treated with long-lasting dispensers

Flint, H.M.; Yamamoto, A.K.; Parks, N.J.; Nyomura, K.

Western Cotton Research Laboratory, USDA-ARS, Phoenix, AZ

Environmental Entomology. Feb 1993. v. 22 (1) p. 43-48. Lanham, Md. : Entomological Society of America.

ISSN: 0046-225X CODEN: EVETBX

DNAL CALL NO: QL461.E532

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

91094005 93032259 Holding Library: AGL

Sex pheromones: achievements in monitoring and mating disruption of cotton pests in Israel

Kehat, M.; Dunkelblum, E.

The Volcani Center, Bet Dagan, Israel

Archives of Insect Biochemistry and Physiology. 1993. v. 22 (3/4) p. 425-431. New York, N.Y. : Wiley-Liss.

ISSN: 0739-4462

DNAL CALL NO: QL495.A7

Language: English

Literature review

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article; Surveys of Literature

91078866 93020520 Holding Library: AGL

Use of multi-component pheromone formulation for control of cotton bollworms (Lepidoptera: Gelechiidae and Noctuidae) in Pakistan

Chamberlain, D.J.; Critchley, B.R.; Campion, D.G.; Attique, M.R.; Rafique, M.; Arif, M.I.

Natural Resources Institute, Chatham Maritime, UK

Bulletin of Entomological Research. Dec 1992. v. 82 (4) p. 449-458. London: Commonwealth Agricultural Bureaux International.

ISSN: 0007-4853 CODEN: BEREAA

DNAL CALL NO: 421 B87

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

91044668 92072443 Holding Library: AGL

Influence of sex pheromone trap placement relative to field edge on catch of bollworm males in cotton

Witz, J.A.; Lopez, J.D. Jr; Goodenough, J.L.

Texas A&M University, College Station, TX

The Southwestern Entomologist. Mar 1992. v. 17 (1) p. 1-6. Dalla, Tex. : Southwestern Entomological Society.

ISSN: 0147-1724 CODEN: SENTD

DNAL CALL NO: QL461.S65

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

91008636 92048507 Holding Library: AGL

Effect of pheromone trap placement on capture of male European corn borer (Lepidoptera: Pyralidae) in three North Carolina crops

Derrick, M.E.; Van Duyn, J.W.; Sorenson, C.E.; Kennedy, G.C.
North Carolina State University, Raleigh, NC
Environmental Entomology. Apr 1992. v. 21 (2) p. 240-246.
Lanham, Md. : Entomological Society of America.
ISSN: 0046-225X CODEN: EVETEX

DNAL CALL NO: QL461.E532

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90138478 92035938 Holding Library: AGL

Hosts and seasonal activity of the boll weevil (Coleoptera: Curculiononidae) in tropical and subtropical habitats of northeastern Mexico

Jones, R.W.; Cate, J.R.; Hernandez, E.M.; Navarro, R.T.

Texas A&M University, College Station, TX

Journal of Economic Entomology. Feb 1992. v. 85 (1) p. 74-82. ill., maps. Lanham, Md.: Entomological Society of America.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English, Summary Language: Spanish

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90128457 92028008 Holding Library: AGL

Pattern of *Heliothis* spp. pheromone trap captures on cotton in the Brazos River Valley of Texas 1987-89

Latheef, M.A.; Lopez, J.D. Jr.; Witz, J.A.

USDA, ARS, Pest Management Research Unit, College Station, TX

Proceedings - Beltwide Cotton Production Research Conferences. 1990. p. 250-255.

Memphis, Tenn.: National Cotton Council of America.

CODEN: BCOPB

DNAL CALL NO: SB249.N6

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90128437 92027988 Holding Library: AGL

Relating *Heliothis* spp. pheromone trap captures to egg counts in cotton. III. Third year data from the Mississippi Delta

Hayes, J.L.;

USDA, ARS, Stoneville, MS

Proceedings - Beltwide Cotton Production Research Conferences. 1990. p. 198-202.

Memphis, Tenn. : National Cotton Council of America.

CODEN: BCOPB

DNAL CALL NO: SB249.N6

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90119501 92021256 Holding Library: AGL

Integrated use of pink bollworm pheromone formulations and selected conventional insecticides for the control of the cotton pest complex in Pakistan

Critchley, B.R.; Chamberlain, D.J.; Campion, D.G.; Attique, M.R.; Ali, M.; Ghaffar, A.

Natural Resources Institute, Kent, UK

Bulletin of Entomological Research. Dec 1991. v. 81 (4) p. 371-378. London: Commonwealth Agricultural Bureaux International.

ISSN: 0007-4853 CODEN: BERE A

DNAL CALL NO: 421 B87

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

90096056 92003264 Holding Library: AGL

Relating *Heliothis* spp. pheromone trap captures to egg counts in cotton. II. Second year data from the Mississippi Delta

Hayes, J.L.; Coleman, R.J.

Southern Field Crop Insect Management Laboratory, USDA, ARS, Stoneville, MS
Proceedings - Beltwide Cotton Conferences. 1989. (Book 1) p. 313-317. Memphis, Tenn. : National Cotton Council of America.

CODEN: BCOPB

DNAL CALL NO: SB249.N6

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90096032 92003240 Holding Library: AGL

Seasonal detection of boll weevils in non-cotton habitats in south Texas and northern Mexico

Wright, J.E.; Chandler, L.D.

ARS, USDA, Subtropical Cotton Insect Research, Weslaco, TX
Proceedings - Beltwide Cotton Conferences. 1989. (Book 1) p. 252-254. Memphis, Tenn. : National Cotton Council of America.

CODEN: BCOPB

DNAL CALL NO: SB249.N6

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90060105 91036820 Holding Library: AGL

Dynamics of nocturnal activity of moths in the *Heliothis* complex (Lepidoptera: Noctuidae) in cotton

Hayes, J.L.;

USDA-FS, SFES, Pineville, LA

Journal of Economic Entomology. June 1991. v. 84 (3) p. 855-865. Lanham, Md. : Entomological Society of America.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90044677 91027000 Holding Library: AGL

Large-scale use of hollow fibre and microencapsulated pink bollworm pheromone formulations integrated with conventional insecticides for the control of the cotton pest complex in Egypt

Moawad, G.; Khidr, A.A.; Zaki, M.; Critchley, B.R.; McVeigh, L.J.; Campion, D.G.

Ministry of Agriculture, Cairo, Egypt

Tropical Pest Management. Jan/Mar 1991. v. 37 (1) p. 10-16. London: Taylor & Francis.

ISSN: 0143-6147 CODEN: PANSC

DNAL CALL NO: SB950.A1P3

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

90009955 91004905 Holding Library: AGL

Aerial concentrations of gossyplure, the sex pheromone of the pink bollworm (Lepidoptera: Gelechiidae), in cotton fields treated with long-lasting dispensers

Flint, H.M.; Yamamoto, A.; Parks, N.J.; Nyomura, K.

Western Cotton Research Laboratory, USDA, ARS, AZ

Environmental Entomology. Dec 1990. v. 19 (6) p. 1845-1851. Lanham, Md. : Entomological Society of America.

ISSN: 0046-225X CODEN: EVETEX

DNAL CALL NO: QL461.E532

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

90002832 90057792 Holding Library: AGL

Dependence of gypsy moth (Lepidoptera: Lymantriidae) capture on pheromone release rate from laminate and other dispensers

Leonhardt, B.A.; Mastro, V.C.; Paszek, E.C.; Schwalbe, C.P.; Devilbiss, E.D.

Insect Chemical Ecology Laboratory, USDA, ARS, Beltsville, MD

Journal of Economic Entomology. Oct 1990. v. 83 (5) p. 1977-1981. Lanham, Md. : Entomological Society of America.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

89140241 90054660 Holding Library: AGL

Seasonal occurrence and damage by *Pectinophora gossypiella* (Saunders)(Lepidoptera: Gelechiidae) to cotton in Eastern Tanzania

Kabissa, J.C.B.;

Agricultural Research Institute Ilonga, P.O. Kilosa, Tanzania

Tropical Pest Management. Oct/Dec 1990. v. 36 (4) p. 356-358.

London : Taylor & Francis.

ISSN: 0143-6147 CODEN: PANSC

DNAL CALL NO: SB950.A1P3

Language: English
Includes references.
Subfile: OTHER FOREIGN;
Document Type: Article

89125637 90044984 Holding Library: AGL

Comparison of pheromone traps and the texcim model for predicting *Heliothis* spp. egg timing in cotton

Witz, J.A.; Hayes, J.L.; Latheef, M.A.; Lopez, J.D.; Proshold, F.I.

USDA, ARS, Southern Crops Research Laboratory, College Station, TX

The Southwestern Entomologist. June 1990. v. 15 (2) p. 217-229. College Station, Tex.
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ISSN: 0147-1724 CODEN: SENTD

DNAL CALL NO: QL461.S65

Language: English
Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);
Document Type: Article

89088256 90021447 Holding Library: AGL

Population dynamics of *Heliothis virescens* and *H. zea* (Lepidoptera: Noctuidae) in the Imperial Valley of California

Pearson, A.C.; Sevacherian, V.; Ballmer, G.R.; Vail, P.V.; Henneberry, T.J.

USDA, ARS, Fresno, CA

Environmental Entomology. Dec 1989. v. 18 (6) p. 970-979. Lanham, Md. : Entomological Society of America.

ISSN: 0046-225X CODEN: EVETEX

DNAL CALL NO: QL461.E532

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

89060739 89065300 Holding Library: AGL

Heliothis sp. (Lepidoptera: Noctuidae) captures in pheromone traps: species composition and relationship to oviposition in cotton

Leonard, B.R.; Graves, J.B.; Burris, G.E.; Pavloff, A.M.; Church, G.

Louisiana State University Agricultural Center, Baton Rouge, LA

Journal of Economic Entomology. Apr 1989. v. 82 (2) p. 574-579. Lanham, Md. : Entomological Society of America.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

89046863 89056467 Holding Library: AGL

Assessment of pheromone traps for monitoring and early warning of *Heliothis armigera* Hubner (Lepidoptera, Noctuidae) in the western cotton-growing areas of Tanzania

Nyambo, B.T.;

ICIPE Mbita Point, Mbita Point, Kenya

Crop Protection. June 1989. v. 8 (3) p. 188-192. Guildford: Butterworths.

ISSN: 0261-2194 CODEN: CRPTD6

DNAL CALL NO: SB599.C8

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

89008289 89030414 Holding Library: AGL

Temporal and spatial patterns in pheromone-trap catches of *Helicoverpa* spp. (Lepidoptera: Noctuidae) in cotton-growing areas of Australia

Fitt, G.P.; Zalucki, M.P.; Twine, P.

Bulletin of Entomological Research. Mar 1989. v. 79 (1) p. 145-161. maps. London: Commonwealth Agricultural Bureaux International.

ISSN: 0007-4853 CODEN: BERE A

DNAL CALL NO: 421 B87

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

88135144 89012414 Holding Library: AGL

Pink bollworm (Lepidoptera: Gelechiidae): large-scale field trials with a high-rate gossypure formulation

Staten, R.T.; Flint, H.M.; Weddle, R.C.; Quintero, E.; Zarate, R.E.; Finnell, C.M.; Hernandez, M.; Yamamoto, A.

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ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

88134088 89010794 Holding Library: AGL

Pheromone production of the boll weevil in response to seven cotton genotypes grown in two environments

Chang, J.F.; Benedict, J.H.; Payne, T.L.; Camp, B.J.

Environmental Entomology. Dec 1988. v. 17 (6) p. 921-925. Lanham, Md. : Entomological Society of America. ISSN: 0046-225X CODEN: EVETEX

DNAL CALL NO: QL461.E532

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

88126056 89005357 Holding Library: AGL

Inhibition of chemical communication between male and female bollworms (Lepidoptera: Noctuidae) by sublethal amounts of permethrin

Moore, R.F.;

Journal of economic entomology. Feb 1988. v. 81 (1) p. 78-82. ill. Lanham, Md. : Entomological Society of America.

ISSN: 0022-0493 CODEN: JEENAI

DNAL CALL NO: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

88107866 88037461 Holding Library: AGL

Relating *Heliothis* spp. pheromone trap captures to egg counts in cotton. I. Data from the Delta of Mississippi

Hayes, J.L.; Coleman, R.J.; King, E.G.

Proceedings - Beltwide Cotton Production Research Conferences. 1988. p. 265-268. ill.
Memphis, Tenn. : National Cotton Council and The Cotton Foundation. CODEN: BCOPB
DNAL CALL NO: SB249.N6

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

88075231 88030441 Holding Library: AGL

Study of the stabilization of cis-hexadec-11-enal, the main component of the sex pheromone of the cotton boll worm, by tocopherol

Verba, G.G.; Mukhamedzhanova, E.N.; Dalimov, D.N.; Abduvakhabov, A.A.

Chemistry of Natural Compounds. Mar 1988. v. 23 (5) p. 622-624. New York, N.Y. : Consultants Bureau.

ISSN: 0009-3130 CODEN: CHNCA8

DNAL CALL NO: QD241.K453

Language: English; Russian

Translated from: Khimiia Prirodnykh Soedinenii, (5), 1987, p. 744-747. (QD241.K45).

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

88018388 87101834 Holding Library: AGL

Insect pheromones and their analogues. XVI. Practical synthesis of hexadec-9Z-enal, a component of the sex pheromone of the cotton bollworm *Heliothis armigera*

Odinolov, V.N.; Dzhemilev, U.M.; Ishmuratov, G.Yu.; Botsman, L.P.; Vostrikova, O.S.; Ladenkova, I.M.; Sultanov, R.M.; Nagaeva, N.A.; Tolstikov, G.A.

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ISSN: 0009-3130 CODEN: CHNCA8

DNAL CALL NO: QD241.K453

Language: English; Russian

Translated from: Khimiia Prirodnykh Soedinenii, (2), 1987, p. 286-289. (QD241.K45).

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

87057363 87020213 Holding Library: AGL

Prospects of using sex pheromone for the control of spiny bollworm in cotton growing in Syria

El-Mosa, H.;

Dirasat. May 1986. v. 13 (5) p. 165-174. ill. Amman: University of Jordan. ISSN: 0255-8033 CODEN: DSNJDI

DNAL CALL NO: Q1.A3D5

Language: English Summary Language: Arabic

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

87013615 86073535 Holding Library: AGL

Use of pheromone trap catches to predict damage by pink/spotted bollworm larvae in cotton

Page, F.D.; Modini, M.P.; Stone, M.E.

Proceedings of the fourth Australian Applied Entomological Research Conference : Adelaide 24-28 September 1984: pest control : recent advances

and future prospects/editors: Peter Bailey and Don Swi p. 68-72.

Adelaide, S. Aust. : [South Australian Dept. of Agriculture?], 1984.

ISBN: 0724386653

DNAL CALL NO: QL468.5.A8 1984

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

86123988 86043161 Holding Library: AGL

Boll weevil pheromone production in response to selected cotton cultivars

Chang, J.F.; Benedict, J.H.; Payne, T.L.; Camp, B.J.; McGovern, W.L.; McKibben, G.H.

Proceedings - Beltwide Cotton Production Research Conferences. 1986. p. 489-492.
Memphis, Tenn. : National Cotton Council and The Cotton Foundation. CODEN: BCOPB
DNAL CALL NO: SB249.N6

Language: English

Paper presented at the "Beltwide Cotton Production Research Conferences," January 4-9, 1986, Las Vegas, Nevada.

Includes 10 references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

86123912 86043084 Holding Library: AGL

Pheromone trap captures and insecticide use in the southeastern boll weevil eradication program

Dickerson, W.A.; Ridgway, R.L.; Planer, F.R.; Brazzel, J.R.; Bradway, T.J.

Proceedings - Beltwide Cotton Production Research Conferences. 1986. p. 231-232.

Memphis, Tenn. : National Cotton Council and The Cotton Foundation. CODEN: BCOPB
DNAL CALL NO: SB249.N6

Language: English

Paper presented at the "Beltwide Cotton Production Research Conferences," January 4-9, 1986, Las Vegas, Nevada.

Includes 8 references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

86056103 85069480 Holding Library: AGL

Trapping of cotton terpene volatiles and boll weevil pheromone

Chang, J.F.; Benedict, J.H.; Payne, T.L.

Proceedings - Beltwide Cotton Production Research Conferences. 1985. p. 397-398.

Memphis, Tenn. : National Cotton Council and The Cotton Foundation.

CODEN: BCOPB

DNAL CALL NO: SB249.N6

Language: English

Includes 3 references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

86023774 85042541 Holding Library: AGL

Insect pheromones and their analogues. IX. Stereospecific synthesis of (Z)-dodeca-9,11-dienyl acetate, a component of the sex pheromone of the cotton bollworm moth *Di-paropsis cactanea*

Balezina, G.G.; Ishmuratov, G.Yu.; Odinkov, V.N.; Selimov, F.A.; Dzhemilev, U.M.; Tolstikov, G.A.

Chemistry of Natural Compounds. May/June 1984. v. 20 (3) p. 354-357. ill. New York, N.Y. : Consultants Bureau.

ISSN: 0009-3130 CODEN: CHNCA8

NAL CALL NO: QD241.K453

Language: English; Russian

Translated from: Khimiia prirodnikh Soedinenii, p. 378-382. (QD241.K45).

Includes 10 references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: Article

85146165 85019821 Holding Library: AGL

Distribution of moths of the Egyptian cotton leafworm, *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae), in the Nile Delta interpreted from catches in a pheromone trap network in relation to meteorological factors

Nasr, E.A.; Tucker, M.R.; Campion, D.G.

Bulletin of Entomological Research. Sept 1984. v. 74 (3) p. 487-494. maps. London: Commonwealth Agricultural Bureaux.

ISSN: 0007-4853 CODEN: BERE A

DNAL CALL NO: 421 B87

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: Article

85087995 84106642 Holding Library: AGL

Introduction of a new method of boll weevil control using the grandlure pheromone (*Anthonomus grandis*, cotton pest, USA). Introducao de um novo controle do bicudo atraves do uso do feromonio grandlure

Lipsi, J.P.;

Ecossistema. v. 8, Oct 1983. p. 190-191. Sao Paulo: Faculdade de Agronomia e Zootecnia "Manoel Carlos Goncalves."

ISSN: 0100-4107

NAL: S542.B7E3

Language: Portuguese

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

85060924 84091995 Holding Library: AGL

Trimerization of *Earias insulana* sex pheromone, (E,E)-10,12-hexadecadiena I, a phenomenon affecting trapping efficiency (Spiny bollworm, cotton)

Dunkelblum, E.; Kehat, M.; Klug, J.T.; Shani, A.

Journal of Chemical Ecology. v. 10 (3) Mar 1984. p. 421-428. New York, N.Y. : Plenum Press.

ISSN: 0098-0331 NAL: QD415.A1J6

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: ARTICLE

85032808 84062880 Holding Library: AGL

Sex pheromone production in male boll weevils, fed cotton squares and laboratory diet (*Anthonomus grandis*)

Wiygul, G.; Wright, J.E.

Entomologia Experimentalis et Applicata. v. 34 (3), 1983. p. 333-335. Amsterdam : Nederlandse Entomologische Vereniging.

ISSN: 0013-8703

NAL: 421 EN895

Language: English ; French

Includes references.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

85022711 84054329 Holding Library: AGL

Relationship between tobacco budworm (Lepidoptera: Noctuidae) catches when using pheromone traps and egg counts in cotton (*Heliothis virescens*)

Johnson, D.R.;

Journal of Economic Entomology. v. 76 (1), Feb 1983. p. 182-183. College Park, Md. : Entomological Society of America.

ISSN: 0022-0493

NAL: 421 J822

Language: English

Includes references.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);

Document Type: ARTICLE

85012176 84046387 Holding Library: AGL

Volatile plant constituents as pheromone inhibitors in cotton leaf worm, *Spodoptera littoralis* Boisd. (Lepidoptera : Noctuidae).

Fluechtige Pflanzenstoffe als Pheromoninhibitoren beim Aegyptischen Baumwollwurm *Spodoptera littoralis* Boisd. (Lepid. : Noctuidae)

Klingauf, F.; Ela, A.A.

Mededelingen van de Faculteit Landbouwwetenschappen Rijksuniversiteit. v. 47 (2), 1982. p. 473-480. ill. Gent, Belgium : , Het Faculteit.

ISSN: 0035-533X

NAL: 105.1 G344

Language: German ; English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

85000006 84036856 Holding Library: AGL

The population level of adult male moths of pink bollworm in cotton season (*Pectinophora gossypiella*, sex pheromone)

Satpute, U.S.; Bhalerao, P.D.; Taley, Y.M.

Cotton Development. v. 13 (2), July 1983. p. 39. Bombay : Directorate of Cotton Development.

ISSN: 0045-8759

NAL: SB251.I5C6

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

84117875 84008175 Holding Library: AGL

Wind tunnel studies on the effects of secondary sex pheromone components on the behaviour of male Egyptian cotton leafworm moths, *Spodoptera littoralis*

Haines, L.C. PENTD;

Physiological Entomology. v. 8 (1) , Mar 1983. p. 29-40.

Oxford : , Blackwell Scientific Publications.

ISSN: 0307-6962

NAL: QL461.P5

Language: English

Includes references.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

84042867 83087821 Holding Library: AGL

Mating disruption of the cotton leafworm, *Spodoptera littoralis* (Lepidoptera: Noctuidae), by release of sex pheromone from widely separated hercon-laminated dispensers

Kehat, M. EVETB; Dunkelblum, E.; Gothilf, S.
Environmental Entomology. v. 12 (4) , Aug 1983. p. 1265-1269.
College Park : , Entomological Society of America.
ISSN: 0046-225X
NAL: QL461.E532
Language: English
Includes references.
Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);
Document Type: ARTICLE

84016243 83065489 Holding Library: AGL
Tobacco budworm: behavioral effects in dispensing virescence or seven-component pheromone in small cotton plots (*Heliothis virescens*)
Raulston, J.R. EVETB; Lopez, P.P.; Gonzales, G.E.; Houghtaling, J.E.
Environmental entomology. v. 12 (3), June 1983. p. 738-743.
College Park : , Entomological Society of America.
ISSN: 0046-225X
NAL: QL461.E532
Language: English
Includes references.
Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);
Document Type: ARTICLE

83108117 83012475 Holding Library: AGL

The relative efficiency of three types of sex pheromone traps in catching the male moths of *Spodoptera littoralis* (Boisd.) (Cotton leafworm, Egypt)

Nasr, S.A. AGRRA; Hosny, M.M.; Radwan, S.M.

Agricultural Research Review. v. 58 (1), 1980 (pub. 1982). p. 157-165. ill. Cairo : General Administration of Agrarian Culture.

ISSN: 0374-5252

NAL: 24 EG94

Language: English ; Arapahoe

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Subfile: OTHER FOREIGN;

Document Type: ARTICLE

83034146 82070638 Holding Library: AGL

Sex pheromone traps as a means of improving control programs for the cotton bollworm, *Heliothis armigera* (Lepidoptera: Noctuidae) (Israel)

Kehat, M.; Gothilf, S.; Dunkelblum, E.; Greenberg, S.

Environmental Entomology. v. 11 (3 , June 15, 1982. p. 727-729. ill. College Park, Md., Entomological Society of America.

ISSN: 0046-225X

NAL: QL461.E532

Language: English

10 ref.

Subfile: OTHER US (NOT EXP STN, EXT, USDA; SINCE 12/76);
Document Type: ARTICLE

83021531 82059382 Holding Library: AGL

Physical and meteorological factors affecting aerial application of sex pheromone for control of the pink bollworm of cotton in Egypt (*Pectinophora gossypiella*)

Johnstone, D.R.;

Agricultural Meteorology. v. 26 (2), Apr 1982. p. 117-126. ill. Amsterdam, Elsevier.

ISSN: 0002-1571

NAL: 340.8 AG8

Language: English

Includes 13 ref.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

82145313 82036911 Holding Library: AGL

Enhancement of boll weevil *Anthonomus grandis* Boh. (Coleoptera: Curculionidae) pheromone biosynthesis with JH III (Juvenile hormone, cotton pest)

Hedin, P.A.; Lindig, O.H.; Wiygul, G.

Experientia. v. 38 (3), Mar 15, 1982. p. 375-376. ill. Basel, Birkhauser.

ISSN: 0014-4754

NAL: 475 EX7

Language: English

Includes 13 ref.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

82107920 82006569 Holding Library: AGL

Sex pheromone traps as a potential means of improving control programs for the spiny bollworm, *Earias insulana* (Adult populations in cotton fields).

Kehat, M.; Gothilf, S.; Dunkelblum, E.; Mazor, M.

Phytoparasitica. v. 9 (3), 1981. p. 191-196. ill. Bet Dagan, Agricultural Research Organization.

ISSN: 0334-2123

NAL: SB599.P53

Language: English

8 ref.

Subfile: OTHER FOREIGN;

Document Type: ARTICLE

82071409 81759891 Holding Library: AGL; AGL

The relationship between heights of pheromone traps and catches of *Spodoptera littoralis* (Boisd) male moths

Nasr, El-Sayed A.; Campion, D. G.; Green, Sheila.

10 leaves, (5) leaves of plates : ill. ; 29 cm. (Cairo?, s.n. , 1980?)

NAL: SB945.C85N35

Bibliography: leaf 10.

Place of Publication: va

Subfile: OTHER FOREIGN;

Document Type: MONOGRAPH

82071408 81759890 Holding Library: AGL; AGL

The relative efficiency of three types of sex pheromone traps in catching the male moths of *Spodoptera littoralis* (Boisd.).

Nasr, El-Sayed A.; Hosny, M. M.; Radwan, Samir M.

7 leaves, (4) leaves of plates: ill. ; 29 cm. (Cairo?, s.n., 1980?)

NAL: SB945.C85N36

Caption title.

Bibliography: leaf 7.

Place of Publication: va

Subfile: OTHER FOREIGN;

Document Type: MONOGRAPH

82071406 81759888 Holding Library: AGL; AGL

Control of the cotton leafworm, *Spodoptera littoralis* (Boisd.) with pheromone-disruption method

Nasr, El-Sayed A.; El-Shafei, Saoud M.

20 leaves, (9) leaves of plates : ill. ; 29 cm. (Cairo?, s.n., 1981?)

NAL: SB945.C85N39

Caption title.

Bibliography: leaves 19-20.

Place of Publication: va

Subfile: OTHER FOREIGN;

Document Type: MONOGRAPH

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Evaluation of microencapsulated formulations of pheromone components of the Egyptian cotton leafworm (*Spodoptera littoralis*) in Crete.

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