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Introduction

The third issue of *The ICAC Recorder* opens with an article on delivery systems for biopesticides. The question is whether to build in beneficial genes in the plant or alternatively incorporate them in other organisms like bacteria or endophytes. The article is a summary of several presentations held at the Agbiotech '89 International Conference, Arlington, Virginia, USA. It is especially relevant for cotton since the crop is a major target crop for the biotechnology industry. Also we present the second article of a series of two on the use of computers in crop production. This time the potential and limitations of crop expert systems are discussed. A system called Cotflex, developed at Texas A&M University in the USA, is used as an example.

Further articles concern the cotton research program in Argentina, and breeding for host-plant resistance against bacterial blight. The literature search conducted on the database of the National Agricultural Library of the USA presents an overview of the most recent literature in the field of plant physiology.

We would like to express our gratitude to all those who have returned the survey forms on cotton production practices. The quality of responses shows that many researchers have devoted a considerable amount of their valuable time to provide us with this information. A first report will be presented at the 48th Plenary Meeting in Arizona, USA, in October of this year. In the coming few years we intend to complete the data for all producing countries, using secondary data sources and repeat surveys.

Delivery Systems of Biopesticides

As has been reported in a previous issue of *The ICAC Recorder*, the most widely used gene in biopesticides springs from different strains of *Bacillus thuringiensis* or *B.t.*, which is an aerobic spore-forming bacteria. The toxins produced by this bacterium are highly specific, easily degradable and, because of its complicated mode of action, there is no imminent danger of resistance development. Also, there is no toxicity to man and animals (on this we come back later). Effective endotoxins produced by different strains of *B.t.* have proved to be effective against insect species of the orders Lepidoptera, Dipteria and Coleoptera.

However, delivery of the toxin-producing genes to the plant by direct use of live *B.t.* strains into pesticides has some disadvantages. Because of the short life cycle of the bacteria and the high degradability of the toxins, the exposure time between the biopesticide and the target insect is rather low (only a few days) which, of course, limits its efficiency. Furthermore, because the product consists of live organisms, it loses some of its effectiveness during storage and may produce undesirable gases. Also, it has not been possible, so far, to obtain proprietary rights on live organisms which, for commercial reasons, inhibits further development in this direction. Some commercial products using live naturally occurring strains of *B.t.* are still on the market but are mainly used in gardens and in high value-added crops like vegetables.

Since the availability of the recombinant DNA technology, it has become possible to isolate the gene responsible for producing the toxic proteins in *B.t.* strains and insert it into other organisms. Initially, this was uniquely done by using another bacterium, *Agrobacter tumefaciens*, which can exchange its own DNA with DNA of plant chromosomes when the two are brought together in a Petri-dish. Lately, more gene-transfer mechanisms have been developed which make gene engineering easier and, more important, faster. One such method, referred to as ballistic transfer, basically shoots foreign genes into plant tissue. Using this method, a tobacco plant can regenerate completely in little more than six weeks after some of its cells have been genetically altered.

Several companies are involved now in using *B.t.* isolated genes for insect control in agricultural crops. Basically, three different delivery systems are under development: the “dead cell” method, developed and patented by Mycogen Corporation of San Diego, California; the “endophyte” system used by Crop Genetics International of Hanover, Maryland, USA; and the “host plant” system under development by several companies. Each system has its advantages and disadvantages in technical and commercial terms. At the recently held Agbiotech ‘89 Conference, the arguments and prospects of all three methods were discussed by representatives of the involved biotech companies.

The “dead cell” method, known commercially as Mcap, was invented by Andrew C. Barnes of Mycogen. The *B.t.* isolated gene is inserted in another bacterium, *Pseudomaras fluorescens*, which then starts producing the toxins within its cell walls during a process of fermentation. When a substantial production is reached, but before the cell wall breaks open, the bacteria are killed using a chemical which, at the same time, stabilizes the cell wall. In this way the toxin is capsuled in the now dead cell. This product is sprayed in the crop and when ingested by the target insect the cell wall is broken down and the toxic substance is released.

This technology has the obvious advantage that the often long and costly procedure to get clearance for field tests from the legislative authorities is much easier, as it concerns dead material. This reduces development costs significantly. The technology was tested in 1987 and 1988, and has proved its efficiency. According to a spokesman of Mycogen Inc., the commercial product will be marketed at comparable costs to competing chemical products. At present, primary targets of the biopesticide are the Colorado potato beetle and caterpillars in vegetables. The manufacturing of the product, according to Barnes, is efficient and applicable for large scale production. In contrast with other synthetic capsulation processes used int he pesticide industry, the Mcap system reaches 100 percent capsulation and the method of producing toxic substances by natural fermentation is less costly than producing synthetic toxins using conventional technologies.

The second method of delivering *B.t.* genes discussed during the seminar was the one developed by Crop Genetics International. This method was developed in response to the commercial problems encountered by other companies. As has been pointed out, these problems partly stem from the fact that the use of natural *B.t.* strains do not provide the manufacturers with proprietary rights to protect them against competitors. Also, when built into non-hybrid plants, the *B.t.* gene simply passes on from one generation to another and the prospect for repeated sales of these high valued seeds is limited. This prospect has led Dr. Peter Calson, the founder of CGI, to the idea of using endophytes, bacteria living within plants, as carriers of the *B.t.* genes. If a proper endophyte could be found, the *B.t.* genes could do their job especially on those insects living within the plants like stalk borers and bollworms. At the end of the plant's life the endophytes are killed as well, and the farmer will come back to the seed company for new *B.t.*-containing seeds.

After five years of intensive research, Calson succeeded in isolating an endophyte with exactly the proper set of desired characteristics: no pathological effect on the host, no persistence in the environment, no dispersal from the inoculation site and subject to relatively easy genetic engineering. The bacterium with the scientific name *Clavibacter xyli*, coded CXC, has Bermuda grass as its natural host, but can live in maize as well.

The genetically engineered version of CXC was subject to field tests in 1988 with maize as the first target crop. It was the first time genetically altered bacteria were tested on open field sites. The test particularly sought to explore if and when the altered bacterium is transferred from one host to another. The preliminary results of the field trials were positive. No natural transmission of the bacterium was recorded and no transmission occurred when using standard agricultural practices. Only in some extreme cases a minimum of transmission did occur.

The endophytes are added to the seeds of the target crop by fist exposing the seeds to a vacuum and subsequently releasing the endophytes with the incoming air as the pressure is being restored. Air and endophytes are absorbed into the tiny open spaces in the seeds. Crop Genetics International will seek agreements with seed producing companies to “enrich” their products and rely on their marketing. The company is actually screening endophytes useful for cotton, but compared to maize and rice (which will host the same endophyte as for maize), this activity is still at an early stage.

The third delivery system for the *B.t.* gene is to engineer the gene into the plant itself. The new gene-transfer mechanisms have provided a boost in this line of research too. The advantages of this delivery method are precise delivery to target areas, no multiple pesticide applications for one pest, no scouting costs and no spraying costs. Most companies involved in developing genetically altered plants use tobacco, which regenerates relatively fast after its cells have been altered, as a model crop. However, cotton is the real focus of attention as it represents a multimillion dollar market for pesticides. Also, it should be noted that for the monocotyledons like rice and maize, the recombinant DNA technology relying on agrobacterium transfer was not available until very recently. Field tests with genetically engineered tomato plants in 1987 have shown that gene expression, that is the genes' actual production of the desired toxin, was rather poor. Much of the research of the last few years has been devoted to improving this aspect. The actual expression of genes is regulated by the so-called promoters which are stretches of DNA directly adjacent to the gene and which interact with m-RNA. The development of more efficient promoters has enhanced the efficiency of the *B.t.* genes, has added up to a thousandfold increase in the performance of plant-added *B.t.* genes.

Companies involved in producing genetically altered cotton plants are Monsanto, Agracetus, Calgene and Plant Genetic Systems. Most companies are about to conduct their first field tests with these plants. Initially, these products provide protection from bollworms only. One interesting question to be answered is to what extent the energy used by the plant for producing these toxins has an impact on yield or fiber quality. Especially when more *B.t.* genes are included to ensure protection against different insect species, this might have an impact. So far, only a few cotton varieties have been selected to be altered genetically. An important criterion is the regenerating capacity of single cells. In this respect some of the Coker varieties are performing well. A question often raised in connection with plant delivery of pesticide genes, but also applicable to the other delivery systems, is the eventual buildup of resistance against *B.t.* toxins. Dr. David N. Ferro, addressing this question at the Agbiotech '89 Conference, stated that provided the length of time *Bacillus thuringiensis* has been around, it is highly probable that some insect mutants exist which by lack of survival pressure, so far, have no advantage over other individuals and, thus, do not have a higher than average survival rate. However, *B.t.* toxins' complicated mode of action, which even today is not fully understood, will delay resistance development almost certainly because resistant species will have to possess several gene mutants at the same time. Also, it has been proven that there exists no crossover resistance with synthetic compounds, nor among various *B.t.* toxins.

So far, the literature shows that in only two out of many experiments researchers have succeeded in developing somewhat resistant insects (*Heliothis virescens*) against the natural *B.t.* products by putting them under severe selection pressure. Resistance in these laboratory experiments was noticeable after 7 and 23 generations respectively. These results, although far from alarming, have resulted in an industry work group which will further study this phenomenon and closely monitor lab and field tests in this respect. Dr. Ferro made a final point by stressing the need for farmer-education projects for the use of *B.t.* products. In their experience, farmers tend to be discouraged when they observe insects crawling on plants two or three days after spraying. *B.t.* products, especially the newer ones, are efficient but simply work more slowly compared to chemical compounds.

It was emphasized that the best way to avoid field failures of pesticides was to include them into an integrated pest management program in which the harmful insects are subjected to several stress factors at the same time. In this respect, it was suggested that farmers might eventually opt for plant populations consisting of 30 or 40 percent of insect resistant plants and that other pest management practices might protect the remainder.

Source:

Proceedings of the Agbiotech ‘89 International Conference Exposition , Arlington, VA, March 28-30, 1989.

Use of Computers in Cotton Production: Crop Simulation Models and Expert Systems

Part 2.
Expert systems

In today's environment crop production is becoming an increasingly complex activity. The farm manager finds himself in an explosion of technology and information which has increased both his options and limitations. To find his way through this new environment the farmer has, in one way or the other, to decide which information to acquire, from where to select his sources and how to digest this information before making a decision.

Computers may play an important role in this process, as they can store and organize great amounts of information in an efficient way. The rise of the microcomputer in recent years has created the possibility that farmers themselves operate these machines from their homes, thereby eliminating another step in the information flow.

In the previous issue of *The ICAC Recorder* an example of a crop simulation model was discussed. In this article an expert system will be reviewed. It should be kept in mind that the two types of programs, simulation models and expert systems, are not mutually exclusive. An expert system may very well contain one or more --mostly small-- simulation models, and a crop simulation model might contain elements of an expert system especially in its users interface (that part of the program which communicates with the user). The difference is that in a crop simulation model the knowledge comes exclusively from the simulation and is fully integrated (meaning that the influence of every variable included in the model has been accounted for), while expert systems may draw on more sources of information (lists of facts or expert opinions).

The development of expert systems is a branch of the science of artificial intelligence. It tries to simulate intelligent or rational decisions made by human beings. An expert system consists basically of three main components: a knowledge base, an inference engine, and a user-interface. The knowledge base may consist of various sources of knowledge and ideally includes a memory update system which makes sure that new updated knowledge is available for the next problem. The inference system is a set of rules which breaks down a problem into its most fundamental elements and solves it step by step. The user-interface is the part of the system which communicates with the user: asks for inputs and provides the output, both in user friendly fashion.

The use of expert systems in business is only a very recent development. Although expert systems have been used in universities since the early 1970's, the first business applications appeared in Japan only in 1981. The potential for the use of expert systems in agriculture was indicated in an article by McKinion and Lemmon in 1985. The challenge to develop an expert system for crop management as an entity, as opposed to one specific element in farming, has been especially big since any decision on a farm is a synthesis of physical, biologic and economic factors and involves a certain amount of uncertainty. This last element also makes the decision maker's attitude towards risk a factor in the process.

One of the first whole-farm management expert systems developed in agriculture is the Cotflex-system designed by researchers from Texas A&M

University in the USA. The system developers aimed at producing a single decision-aid system for farmers, extension personnel and financial institutions. The first step of the researchers was to make a detailed dynamic decomposition of the main decisions involved in cotton growing. A two-dimensional production decision time-line was devised, which breaks up decisions into seven classes: agronomic practices (cultivation, planting, fertilization etc.); disease mangement; insect management; weed management; crop-mix decisions; marketing decisions; and policy decisions (crop insurance and farm program participation). Decisions in each of these subsets is projected in time. In the Cotflex system each subset of decisions is covered by different modules all of which have access to the same knowledge base. The modules are called advisors.

Cotflex's inference engine uses a computer language called CLIPS (C-Language Integrated Production System) which was developed by the US National Aeronautics and Space Administration (NASA). For the purpose of Cotflex, CLIPS was further expanded by the researchers from Texas A&M providing a hierarchical structure in the fact base. This allows the system to quickly combine facts when confronted with complex problems. At present the Cotflex system can be installed on an IBM-type microcomputer of either model XT or AT.

Up to now three advisors have been developed in Cotflex. The pest management advisor, the farm management advisor, and the farm policy advisor. The first assists the farmer in decisions concerning the management of three major insect pests: the cotton fleahopper, the boll weevil and the cotton bollworm. The latter two concern mainly economic decisions such as crop insurance and the application for farm subsidies. The knowledge base for the farm management and farm policy advisor consists of a relatively simple whole-farm simulation model which calculates gross and net returns under different assumptions concerning yields, prices and costs. The pest management advisor relies on a combination of facts and rules provided by entomologists, and on an insect population dynamics and crop phenology simulation model. At present, the advisors only apply to the conditions in the Southern Blacklands of Texas.

Before using the expert system the user first has to provide extensive information about his farm. This includes details about farmland, machinery, and past agricultural practices. To operate the system the user will first answer a series of questions which enables the computer to identify the problem and select the appropriate advisor. On the basis of the problem definition, a chain of components is selected which will solve the problem step by step by asking the user or other outside system for more information, making use of the knowledge base within the system and feeding all this information in the inference engine.

If we take the example of a user seeking advise about a spraying decision for cotton fleahopper, the expert system might come up with the following sequence: seek past weather data from outside source - feed data into crop phenology model- calculate expected boll set - seek actual boll set from user - calculate infestation rate - seek scouting data from user - feed scouting data into population dynamics model - apply population dynamics data and present infestation data to spray threshold rule - consider past decisions on control for other insects - advise user. In case of the Cotflex pest management advisor, the advise may take the form of a recommendation to spray immediately, to wait 3 or 7 days and sample again, or not to spray for the moment.

An expert system like Cotflex seems to have a few clear advantages as compared with comprehensive simulation models discussed in part 1 of this article. First, it seems that it takes considerable less time to develop an expert system and will therefore be less expensive. Another advantage is that it is relatively easy to incorporate preexisting components like simulation models and databases in the system. This is possible because in the knowledge base of an expert system, components can function more or less independently, while in a comprehensive simulation model everything is connected with everything.

Due to the same reason, the expert systems are also somewhat simpler in their setup which makes them easier to access for system engineers and therefore easier to expand and adapt. It is expected that in the coming few years “blank” expert systems will be sold as off-the-shelf software. However, it cannot be known yet if these programs will lend themselves easily to applications in farm management as they are mainly designed for knowledge management in physics, chemistry and related sciences.

The disadvantage of an expert system as compared to a comprehensive simulation model is that the knowledge is processed in a much more simplified way (unless of course a comprehensive simulation model is part of the knowledge base of the expert system). Part of the complicated mathematical relations in the comprehensive simulation model is replaced by simple rules of thumb. In its most rudimentary form the expert system will only generate a little extra higher-valued knowledge. Its benefits will, therefore, be found in improved knowledge storage and management. Added benefits of comprehensive simulation models in terms of identification of research topics, promotion of multi-disciplinary research topics, promotion of multi-disciplinary research and short cuts in applied research are not obtained with expert systems.

In summary, expert systems and comprehensive simulation models are designed to assist extension agents and farmers in their day-to-day activities. Simulation models also are a useful tool for researchers. They attempt to simulate nature and will provide their users with new knowledge which, when interpreted carefully, can greatly increase the quality of farm management decisions. The expert system simulates the human mind and is less of a “black box” to its user. The added value above non-computer-assisted decisions depends on the ability to effectively decompose a complex problem into a sequence of steps and to feed the system with a good blend of facts, expert knowledge and partial simulation models.

Sources:

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Cotton Research in Argentina: Adaption and Innovation

Argentinian farmers now grow close to 500,000 hectares of upland cotton. The crop is grown in a belt stretching from Santiago del Estero in the north-west to Misiones in the northeast. The highest concentration, about 66 per-cent of the total area, is to be found in the province of Chaco in the center of the cotton belt. Situated between the Tropic of Capricorn and the 30É southern latitude, the crop is planted from 15 September onwards and in principle benefits from an extended growing season with virtually no risks of frost. Because of erratic rainfall, however, most years the sowing period extends to early January. Harvesting starts in March and usually continues until early June.

Total rainfall ranges from 1500 mm. In the most eastern growing area to a mere 500 mm. In some pockets in the west. Average rainfall in Chaco is about 900 mm. per year. About 90 percent of the crop is produced under rainfed conditions. About 45,000 hectares of irrigated cotton are located in the west, around Santiago del Estero. It is estimated that around 80 percent of the area is planted on farms having less than 20 hectares. On the small farms ploughing is done with animal traction, and insect spraying is done with hand-held sprayers. On the larger farms, ploughs are pulled by tractors and spraying is done either by tractor or by aerial application.

Agricultural research is carried out by the Instituto Nacional de Tecnología Agropecuaria (INTA), which is a branch of the Ministry of Agriculture. Headquartered in Buenos Aires, INTA has about fifteen regional centers throughout the country in areas representative of the various agro-climatical zones. The INTA center in Saenz Peña, in Chaco province, is the national center for cotton research. The departments for plant breeding, plant physiology, entomology, phytopathology, fiber technology and farm mechanization employ a total of about ten full-time cotton researchers and another twenty who devote only part of their time to cotton problems. A full-time program coordinator assures an interdisciplinary approach to research.

The INTA research station in Saenz Peña has more than 100 hectares at its disposal. The largest part is used as range land (a second field of research at the center), while about 100 hectares are available for research in four experimental stations spreading over the cotton belt. Agricultural extension is also part of INTA's activities. For this purpose fifteen extension centers were established, each staffed with at least an agricultural engineer and a community worker. There is no major university research program in the field of cotton.

Breeding/Plant Physiology

Before the establishment of INTA-Saenz Peña in 1964, cotton production was dominated by two varieties from the USA: Toba and La Banda (irrigated). Both varieties are crosses between Stoneville and Deltapine cottons and were cultivated for more than twenty years. No major efforts were devoted to maintain genetic purity. In the 1960's the varietal situation changed with the uncontrolled introduction of Reba B-50 from Paraguay. Reba B-50 is a variety resistant to bacterial blight, developed by IRCT in Africa and introduced to Paraguay by the same institute. It is characterized by good fiber length and partly because of its resistance against bacterial blight, a widespread disease in the Argentine cotton belt. It has a good yield potential as well.

The first commercial variety released by INTA was Chaco 510. This variety, made available in 1978, is a crossing between a HAR (triple hybrid of *G. Hirsutum, G. arboreaum, G. raimondii*) line developed by IRCT breeders in Côte d'Ivoire and the "Empire" line SP 5425. Chaco 510, which until this day is still cultivated on about 4 percent of the total area, has a fiber length of 28-30 mm., strength of 23/24 grams/tex (stelometer) and a micronaire of 4.4. In the meantime breeders in Paraguay replaced Reba B-50 by a new variety, Reba P279 (a crossing between Reba B-50 and a Deltapine SL), which showed improvements in ginning percentage, earliness and yield, and is immune to bacterial blight.

In recent years the breeding program has produced four additional new varieties, all crossings between the older Chaco 510 and the Reba P279 from Paraguay. The objective of the program is to release varieties well adapted to each agro-climatical zone as well as to the various farming systems practiced in the area. Seed purity is to be maintained by the implementation of a rigid seed production program involving seed production associations specializing in the production of certified and registered seed. The breeders use a wide variety of genetic sources including material from almost every major cotton producing country.

First generation crossings in the breeding program are screened for resistance against bacterial blight by exposing all F2 and F3 lines to artificial inoculations of various strains of *Xanthomonas campestris*. A second main objective of the breeding program was earliness. This trait is important because with the prolonged planting period a substantial part of the crop is threatened by adverse weather conditions toward the end of the season. Also a reduced growing cycle would diminish insect populations feeding on the crop. With the release of the variety “Guazuncho”, which has a life-cycle of 140-150 days, no further improvements in the direction of earliness are deemed necessary.

In later years, more attention has been devoted to improving the fiber quality of the commercial varieties. In accordance with the expressed needs of the Argentine spinning industry new targets for fiber quality have been set: strength of 20-21 g/tex (stelometer), fiber length of 28-30 mm., micronaire of max. 4.5. Ironically the older variety Chaco 510 largely meets those standards, but with a market system in place which does not reward for quality and somewhat lower yields, this variety has been almost completely replaced by the new higher yielding varieties. Estimated area and fiber quality parameters of the newly released varieties and two varieties to be released shortly are summarized in the table below.

Presently Cultivated and New Varieties in Argentina

Variety	% of Prod.	Days	Gin %	Length (mm.)	Strength (g/tex)	Mike	Recommendation
Guazuncho	40	140-150	38-40	26-28	18-19	4.2-4.4	High fertility soils
Quebrancho	10	160-170	36-38	28-30	20-21	4.0-4.2	Low fertility soils
Pora	30-40	170-180	38-39	27-29	19-20	4.6-4.8	Small farmers
Mataco	10	180	37-39	26-28	19-20	4.6-4.8	Fusarium resistant
Chaco 510		170-180	34-36	28-30	23-24	4.4	New varieties
Gringo		160-170	36-38	28	21-22	4.4	Replace Chaco 510
Guazuncho 2		140-150	39-41	27-28.5	19-20	4.4	Replace Guazuncho 2

Guazuncho is the highest yielding variety and may produce up to 1 ton of fiber per hectare under real farm conditions without supplemental fertilization or irrigation. Pora and Mataco are especially useful for small farmers as they mature over a longer period of time, which facilitates hand picking with a small labor force. Mataco is especially grown on sandy soils infested by Fusarium wilt.

The breeding department is capable of doing 200 crosses per year in the field and greenhouse. Using a modified pedigree system the crossings go through six generations on the research station before being tested for another three years in regional trials on the experimental stations.

The plant physiology department has been closely involved in the development of the new varieties. Promising lines are checked on physiological parameters related to earliness such as length of vegetative period, rhythm of boll development and shedding percentage. The objective is to find a plant type which makes optimal use of the most favorable period for fruit production, which is October/November. The most valuable resource for earliness was found in an “Empire” variety originating from the USA. This trait, incorporated in the Guazuncho variety, results in a total life-cycle of 140-150 days and a period of only three to four weeks after first flowering in which 80 percent of the bolls are set.

Extensive research has been done as well on optimal plant populations. It was found in a multi-year experiment that population sizes below 50,000 plants/ha. hampered the earliness of the crop, while populations over 200,000 plants/ha. reduce yield. Optimal plant populations varied between 80,000 and 120,000 plants/ha. Depending on the year and variety. The currently recommended plant density is 100,000 plants/ha. It is anticipated that in the near future this recommendation will be differentiated per variety and soil type.

The crop physiology department has collected extensive data on the relation between crop development, insect infestations and accumulated degree-days. This database will be used to develop crop development models, refine the screening of advanced lines in the breeding program and develop criteria for insect monitoring.

Phytopathology/Entomology

The phytopathology department focuses its efforts on the primary diseases in the cotton belt which are: damping off, Fusarium wilt, bacterial blight and a disease preliminarily labeled “red wilt,” for which the causing agent has not yet been identified. Seed treatment for seedling diseases is compulsory in Argentine since 1983. However, because farmers can acquire seeds from many sources, effective control of this measure has been a problem. Presently, researchers are studying various organisms (*Trichodesma, Pseudomonas*) of potential use in biological control programs of seedling diseases.

The incidence of Fusarium wilt has actually diminished over the last five years. Presently, it is estimated that about 50,000 hectares are still affected by this disease. The strategy is to identify infested areas and study the dynamics of the disease and its association with nematodes. Control is accomplished by growing resistant varieties in the infested pockets. Also, in the case of bacterial blight the main strategy is monitoring the losses combined with the development of resistant varieties. The naturally occurring races of *Xanthomonas campestris* pv. *malvacearum* are 6, 10 and 16. All three races are not known to be able to overcome the resistance present in the new varieties. In the case of the "red wilt" disease all efforts are concentrated on identifying the causal agent. The disease appeared at the same time as the Reba varieties were introduced from Paraguay.

Generally crop damage caused by diseases is aggravated by poor plant health caused by low nutrient availability and sometimes poor root development associated with the presence of plough pans. It is expected that with the introduction of compensatory fertilization and improved soil management practices losses can be reduced substantially.

In the field of entomology, for every major pest INTA has established a treatment threshold level. Courses on insect scouting and control measures are conducted for young farmers. The major insect pests are aphids, thrips, mirids (*Horcias nobilellus*), cotton leafworm (*Alabama argillacea*), pink bollworm (*Platiendra gossypiella*) and the stem borer *Eutinobothrus braziliensis* (“Broca”). In the last few years *Heliothis* has ceased to be a primary pest. A major concern for the department is the expected introduction of the boll weevil from Brazil. Recently the boll weevil has advanced until about 200 miles east from the cotton growing regions in Paraguay. It is expected that the boll weevil will reach Argentina in a period of two to five years. Most spraying programs are based on pyrethroids. No resistance against these chemicals has yet been measured.

Mechanization/Fiber Technology

With the rising costs of labor and the scarcity of agricultural laborers in the harvesting season, mechanized harvesting has become of increasing importance in recent years. Most machines are of the spindle type and were imported from the USA. In 1986 three machine harvesters from the USSR were introduced for testing. The Soviet machines pick cotton with a system of vertical rolls mounted on a drum. The rolls, constructed in pairs, are covered with a steel plate containing a series of teeth which attach to the fiber when the plant is squeezed between the rolls.

A preliminary report, presented at ICAC’s 46th Plenary Meeting in Brussels indicated that the Soviet harvesters appeared to be efficient but that the impurity content of the cotton raised some concerns. In large field trials problems were encountered in operating the machines after heavy rainfall, mainly because of their high weight. Following this first experience, INTA-Saenz Peña decided to design an adapted model using the same picking technology as the Soviet machines but much lighter, covering only two rows. This machine is currently being tested at several places and appears to perform very well. The model weighs only three tons and costs the equivalent of $50,000. INTA has made an agreement with a machine manufacturer which will market the harvester.

INTA has a fully equipped fiber technology lab which handles 15,000 samples a year. It is planned that the lab will acquire an HVI machine in the course of 1990. Two local textile manufacturers have already installed HVI lines in their mills. A mini-spinning plant, accurately rebuilt from a model used in the USA, is used to assess directly the spinning value of the cottons. A mini-ginning plant, dating from 1950, with bypasses to vary the intensity of seed cotton and lint cleaning, is used to determine optimal ginning layout. Recently the fiber technology department has started courses on fiber quality and ginning for private gin operators. INTA collaborates with its sister organization INTI (industrial technology research) to test fiber samples on rotor spinning systems. The department also has close relations with the local textile industry.

INTA has a collaborative agreement with the Soviet Union promoting the exchange of experience in cotton production research. Argentine researchers have visited the Soviet Union and vice versa. So far, three potential areas for increased collaboration have been determined: exchange of breeding material, assistance in development of appropriate harvest technology, and expansion of biological control of insect pests.

New Evidence of a Genetic Resistance Mechanism Against Bacterial Blight

Since the appearance of a new strain of *Xanthomonas campestris* pv. *malvacearum* at various places in Africa in the early 1980's the debate about the genetic mechanism providing immunity against attacks by the bacterium has become of current interest again. Since the pioneering work carried out by R.L. Knight in the Sudan in the late 1940's breeders throughout the world have succeeded in developing cultivars resistant or immune against the most virulent races of bacterial blight. The most important sources for resistance in these breeding programs originated from either a West-African cultivar called N'Kourala (*G. hirsutum* race *punctatum*) or the Nigerian variety Allen. In the USA the variety Stoneville 20 has been widely used to obtain resistance and immunity against the disease.

Initially Knight has identified ten major genes which control resistance. In subsequent years other researchers have identified six more. Also two polygene complexes have been identified (B-sm and B-dm) which provide protection against the disease as well. Various hypotheses have been posed concerning genetic interaction between these genes in case of expression of resistance. Some authors argue that resistance is largely monogenic with very little influence of other genes, while others point at the importance of linkages and minor genes which promote the expression of resistance.

For practical purposes breeders have usually made use of combinations of genes, the most certain way to ensure prolonged resistance or immunity. The most successful combinations are B2-B3-B6, B2-B6 (both *punctatum* sources), B9l-B10l (the “Allen”-source used in Paraguay and Argentina), and B2-B9k. The MAR (Multi Adversity Resistance) breeding program conducted at Texas A&M University uses an accumulation of at least three major genes along with some minor gene complexes to attain not only resistance to bacterial blight but also generally improved plant health which enables the plants to cope better with several environmental stress factors.

In a recent article by Follin, Girardot, Mangano and Benitez, the authors express some dissatisfaction with some of the methodologies used to determine the gene or gene combinations controlling resistance. They argue that some results were obtained as part of practical breeding programs whose prime objective was to come up with resistant varieties and not so much to determine exactly the genetic details of the process. They particularly point at the practice of ignoring the possibility of variation of pathogens in breeding programs in Africa, and the practice of using inoculations of mixes of strains of *Xanthomonas*, a practice which might obscure the virulence of individual strains then a resistance reaction is triggered by a non virulent strain.

The appearance of the new strain of *Xanthomonas*, which has been able to overcome resistance in all commercial varieties, has induced the authors to go back to the basics and carry out straightforward segregation tests using the backcross method. Tests were carried out both in Paraguay (at the Instituto Agronómico Nacional in Caacupé) and France (at the research station of IRCT in Montpellier) and involved the strain 18 (the most virulent before the appearance of the new strain) and the new strain itself (isolated in Burkina Faso and baptized in HV1). Crosses included the sources B2-B3, B91-B10l and a not yet identified source of resistance against the HV1-strain detected in the line S295, originating from the breeding program in Chad. Observations were made seven days after inoculation and included only the ratings “resistant,” “sensitive” or “no reaction."

Results indicate that **total** leaf resistance to strain 18, originating from both Allen and N'Kourala, are identical and are caused by a single factor. The authors further indicate that the very variable **partial** resistance is controlled by some minor genes, which explains why certain crosses immune to strain 18 keep providing some protection against the new strain while others don't. Concerning the resistance mechanism present in the S295 line, the authors feel most comfortable with the hypothesis that it is controlled by the same genes active against strain 18 along with a minor gene which is closely linked to this complex. In support to this hypothesis they indicate that, so far, no crossings of the type "sensitive to strain 18 but resistant to the new strain" have been obtained, and that none of the parents of S295 possessed total resistance against HV1, implying that only a genetic reorganization could result in total resistance.

For practical purposes the findings of the research indicate that the line S295 can be used as a new source for total resistance against bacterial blight. The source of resistance in S295 is dominant and is inherited "as if it were monogenic." Also it appears that in screening for resistance researchers may limit the inoculation to only the new strain HV1 as the result of the observed strong linkage between resistance against all the older strains and the new strain. The authors warn, however, against the fact that it is not known how long the new total resistance might hold up and, therefore, it remains impossible to assess the economic payoff of this new round of breeding. If its life-cycle is short then breeders might consider shifting their objectives to high or partial resistance and using recurrent selection to obtain the necessary accumulation of major and minor genes.

Source:

Follin, J.C.; Girardot, B.; Mangano, V.; Benitez, R., "Nouveaux résultats sur le déterminisme génétique de la résistance foliaire totale du cotonnier á la bactériose," *Coton et Fibres Tropicales*, Vol. 43, fasc. 3, 1988.

Short Notes

- New ideas on optimal plant configuration are emerging from California. University of California cotton extension specialist, Dr. Tom Kerby, believes that both yield and fiber qualtiy might be considerably raised by growing thin, cylindrical (“columnar cottons”) plants in high density populations using 30 inch row spacings. The plants are 15 percent taller than the SJ-2 variety and produce 80 percent of the bolls on the first fruiting position of each branch. There is only very limited lateral growth of each branch. According to Kerby, population densities of up to 175,000 plants/ha. might be achieved this way. Improved quality is achieved because, generally, it has been determined that bolls from the No. 1 position have better fiber quality. The material, originally developed by the late Gus Hyer, plant breeder at Shafter, California, has been improved over the last five years by crossing it with some commercial varieties. Germplasm is now made available for cotton breeders. (From *California-Arizona Cotton*.)

- Researchers in Belgium continue their research on the causes of high percentage of seed coat fragments in some cottons. To accurately measure this phenomenon, Mr. L. Verschraege and Dr. T. Fransen, both of State University Ghent, have designed a small instrument which snatches off fiber bundles from ten seeds at one time. Seeds are prepared by removing all fibers except for a small bundle at the chalazal end of the seed. Stable results were obtained after testing three sets of ten seeds. A total of eleven varieties were tested and it could be shown that there existed considerable inter-varietal difference in the tendency to produce seed coat fragments. Subsequent tests showed that variations in fiber strength did not explain these differences. Also, fiber density per se was not an explaining factor. However, it was observed that for most varieties the fiber densities on the detached seed coat fragment were much higher than the “average” fiber density on the chalazal end of the seed. This led the researchers to pose the hypothesis that irregularities in fiber densities on the seed coat might be an important factor. The influence of agronomic conditions during the growing season was identified as another explaining variable. Four US cottons, each harvested at three different moments at an interval of 14 days, showed varying degrees of the problem. Also a test conducted on Argentinian cotton varieties showed that not only genetic factors are in play but that growing conditions matter as well. (From *Coton et Fibres Tropicales*.)

- The future of Siratac, the computer based insect management system developed by CSIRO and the Department of Agriculture in Australia, is unsure again. The use of the system for extension purposes led to 1981 to the creation of Siratac Ltd., a public company created with seed money from the cotton industry. However, the adoption rate of the program remained too low to provide a solid commercial future for the company. Twelve months ago a new more aggressive marketing approach was adopted by the company. Although this approach has led to some increase in the contracted acreage, it has not proved to be enough to save the company. In the crop year 1988/89 about 47,500 hectares were under contract at an average of $7.80 per hectare. One problem was the high turnover of customers as a large proportion of growers used Siratac only for one season. The general manager of Siratac Ltd. has recommended to dissolve the company and the directors have accepted this proposal. The software, which is owned by CSIRO and the New South Wales Department of Agriculture and Fisheries, will remain available to any organization accepting to provide computerized extension services for pest management. At present negotiations are held with some organizations in this respect. (From *Australian Cotton Grower.*)

- At the 1988 International Cotton Conferences in Bremen two new fiber quality measurement machines which have the potential to give a new push to precision measurement of fiber quality parameters were discussed and, thereby, will make the argument for HVI system-based marketing of cotton even stronger. The first machine, under evaluation at the USDA-ARS fiber lab in Clemson, NC, measures fiber length of each individual fiber carried on aerodynamical forces is measured in free flow as it passes electro-optical sensors. The instrument is able to measure 10,000 fibers in less than a minute. The entire length distribution, including the “short fiber” content, is plotted directly on on-line equipment. The corresponding fiber diameter frequency distribution can be obtained as well as the bivariate distribution of length and diameter. According to Dr. Charles Bragg, of the USDA-ARS Cotton Quality Research Station, this machine has the potential to “provide textile users with a degree of understanding of fiber contributions to processing efficiency and yarn and fabric quality that has never been available practically.” A second machine of great interest is presently developed by Schaffner Technologies (a company which has recently been acquired by Zellweger Uster) as part of the Advanced Fiber Information Systems project. Also using electro-optical sensors, this machine is able to provide the number of neps in a 500 mg. sample as well as the size distribution of the neps. The processing time for each subsample is 3 minutes and 20 seconds. Tests have revealed that in order to obtain stable results four subsamples per sample have to be measured. This machine will add the nep content parameter to the list of fiber quality parameters routinely measured by producers and users of cotton. (From *Proceedings of International Cotton Conference*, Bremen, 1988.)

- A new book on *Insect Pheromones in Plant Protection* has been published by John Wiley & Sons. The two editors are A.R. Jutsum and R.F.S. Gordon. The book is divided in four parts. The first is a "background" section dealing with the role of pheromones in the behavior of insects. The second section is entitled "Evaluation and Use of Behaviour-Modifying Chemicals," and contains chapters about monitoring insect populations, mass trapping and mating disruption. In the last chapter, experiences in controlling the pink bollworm with sex pheromones are presented from the USA, Egypt, Pakistan and Peru. The third section handles "Production, Formulation and Application" of pheromones, and the final section looks at the marketing aspects of pheromones and the need for further research.

- Cotton prices continued to climb during August as a result of the currently very low stocks-to-cotton-use ratio. Presently the Cotlook A Index has exceeded 80 cents per pound (CIF Northern Europe) and further increases are likely. Pressure on prices probably will only level off as the new Southern Hemisphere crop becomes available in early 1990. In the meantime, world cotton consumption in 1989/90 is expected to reach a record level of 86 million bales, the result of strong demand in all the major consumption regions. As world economic growth is expected to slow down somewhat in 1990, cotton consumption might be somewhat lower next season. Cotton production this season is now forecast at 80.2 million bales. (From ICAC's *Cotton: Review of the World Situation*, Volume 42-Number 6, July-August 1989.)

A DIALOG Search from the Agricola Database on Cotton Physiology

New findings in cotton physiology over the past ten years have significantly altered the way the crop is grown today. The application of growth regulators and defoliants is only one example of this. In this literature search, references of articles on cotton physiology published during the last two years are included. The search was carried out exclusively on the *Agricola* database of the National Agricultural Library of the USA. Due to lack of space the search is presented in two parts. The second part will be published in the December issue of The ICAC Recorder

SAMPLE RECORD

The positions of the key fields are shown. in the following sample record.

AN HL	88037272 88003307 holding Library: AGL
TI	Interspecific gene flow in Cucurbita: C. texana vs. C. pepo
AU	Kirkpatrick, K.,J.; Wilson, H.D.
JN PY	American journal of botany. Apr 1988. v. 75 (4) 519-527. maps. Columbus, Ohio : Botanical Society of America.

SN CO	ISSN: 0002-9122 CODEN: AJBOAA
CA	DNAL CALL NO: 450 AM36
LA	Language: English
	Includes references
SF	Subfile: OTHER US (NOT EXP STN. EXT, USDA; SINCE 12/76);
DT	Document Type: Article
DE	DESCRIPTORS: cucurbita texana; cucurbita pepo; gene flow; biogeography; pollination; xenoglossa; pollinators;
ID	Identifiers: xenoglossa strenua
GL	Geographic Location: texas
SH	Section Headings: PLANT BREEDING(F200); PLANT TAXONOMY AND GEOGPAPHY(F700): ENTOMOLOGY RELATED(L001)

Key to Data Fields

AN	DIALOG Accession Number
AN	AGRICOLA Accession Number
AU	Author
CA	Call Number
CO	CODEN
DE	Descriptor
DT	Document Type
GL	Geographic Location

HL	Holding Library
ID	Identifier
JN	Journal Name
LA	Language
PY	Publication Year
SF	Subfile
SH	Section Heading/Code
SN	ISSN
TI	Title

Data present in record depend on output format requested and type of record.

89008215 89030236 Holding Library: AGL

Maternal effects and generation mean analysis of seed-oil content in cotton (Gossypium hirsutum L.)

Dani, R.G.; Kohel, R.J.

Theoretical and applied genetics. 1989. v. 77 (4) p. 569-575.

Berlin. W. Ger. : Springer International. ISSN: 0040-5752 CODEN: THAGA

DNAL CALL NO: 442.8 ZB

Language: English

89006426 89028335 Holding Library: AGL

Effect of age of cell suspension cultures on susceptibility to a fungal elicitor

Apostol, I.: Low, P.S.: Heinstein, P.
Plant cell reports. 1989. v. 7 (8) p. 692-695.
Berlin, W. Ger. : Springer International. ISSN: 0721-7714 CODEN: PCRPD8
DNAL CALL NO: QK725.P54
Language: English

89004747 89026373 Holding Library: AGL
Histochemical localization of desoxyhemigossypol, a phytoalexin in Verticillium dahliae-infected cotton stems
Mace, M.E.; Stipanovic, R.D.; Bell, A.A.
The New phytologist. Feb 1989. v. 111 (2) p. 229-232. ill.
New York, N.Y. : Cambridge University Press.
ISSN: 0028-646X CODEN: NEPHA
DNAL CALL NO: 450 N42
Language: English

89002698 89024018 Holding Library: AGL
Changes in amide-linked and ester indole-3-acetic acid in cotton fruiting forms during their development
Guinn, G.; Brummett, D.L.
Plant physiology. Iar 1989. v. 89 (3) p. 941-944.
Rockville. Md. : American Society of Plant Physiologists.
ISSN: 0032-0889 CODEN: PLPHA

DNAL CALL NO: 450 P692
Language: English

88145527 89021691 Holding Library: AGL
Ovule and suspension culture of a cotton fiber development mutant
Triplett, B.A.; Busch. W.H.; Goynes, W.R. Or.
In vitro cellular & developmental biology : journal of the Tissue Culture Association . Feb 1989. v. 25 (2) p. 197-200. Ill.
Gaithersburg, Md. : The Association. ISSN: 0883-8364
CODEN: ITCSA
DNAL CALL NO: QH585.A1I58
Language: English

88144572 89020503 Holding Library: AGL
Cotton root growth as influenced by phosphorus nutrition and vesicular-arbuscular my - corrhizas
Price, N.S.; Roncadori. R.W.; Hussey, R.S.
The New phytologist. Jan 1989. v. 111 (1) p. 61-66.
New York, N.Y. : Cambridge University Press. ISSN: 0028-646X CODEN: NEPHA
DNAL CALL NO: 450 N42
Language: English

88138719 89016337 Holding Library: AGL
Seasonal leaf area-leaf weight relationships in the cotton canopy
Reddy, V.R.; Acock, B.; Baker, D.N.; Acock. M.
Agronomy journal. Jan/Feb 1989. v. 81 (1) p. 1-4.
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ISSN: 0002-1962 CODEN: AGJOAT
DNAL CALLNO: 4 AM34P
Language: English

88128741 89008210 Holding Library: AGL
Relationship between cottonseed malate synthase aggregation behavior and suborgan -
ellar location in glyoxysomes and endoplasmic reticulum
Chapman, K.D.; Turley, R.B.; Trelease, R.N.
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Rockville, Md. : American Society of Plant Physiologists.
ISSN: 0032-0889 CODEN: PLPHA
DNAL CALL NO: 450 P692
Language: English

88128727 89008196 Holding Library: AGL
Water transport properties of cortical cells in roots of nitrogen- and phosphorus-deficie nt
cotton seedlings
Radin. J.W.; Matthews, M.A.

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ISSN: 0032-0889 CODEN: PLPHA
DNAL CALL NO: 450 P692
Language: English

89008215 89030236 Holding Library: AGL
Maternal effects and generation mean analysis of seed-oil content in cotton (Gossypium hirsutum L.)
Dani. R.G.; Kohel, R.J.
Theoretical and applied genetics. 1989. v. 77 (4) p. 569-575.
Berlin, W. Ger. : Springer International. ISSN: 0040-5752 CODEN: THAGA
DNAL CALL NO: 442.8 Z8
Language: English

89007884 89029844 Holding Library: AGL
Large scale evapotranspiration from remotely sensed surface temperature
Hatfield, J.L.;
Planning now for irrigation and drainage in the 21st century : proc of a conference : Lin - coln. Nebraska. July 18-21. 1988 /
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DNAL CALL NO: TC823.P52
Language: English

89007820 89029780 Holding Library: AGL
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Reddy, V.R.;Baker. D.N.; McKinion, J.M.; Siefker, J.H.
Proceedings of the Plant Growth Regulator Society of America. 1988.(15th) p. 85-86.
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CODEN: PPGGD
DNAL CALL NO: SB128.P5
Language: English

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Apostol, I.; Low, P.S.; Heinstein, P.
Plant cell reports. 1989. v. 7 (8) p. 692-695.
Berlin, W. Ger. : Springer International. ISSN: 0721-7714 CODEN: PCRPD8
DNAL CALL NO: QK725.P54
Language: English

89006250 89028158 Holding Library: AGL

Physicochemical properties of gossypin (11S Protein) and congossypin (7S protein) of glanded cottonseed

Mohan Reddy, I.; Narasinga Roa. M.S.

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DNAL CALL NO: 381 J8223

Language: English

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Development of pink bollworm populations (Lepidoptera: Gelechidae) an nectaried and nectariless Deltapine cotton in field cages

Flint, H.M.; Curtice, N.J.; Wilson, F.D.

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89005065 89026798 Holding Library: AGL

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Kuo, T.M.; Van Middlesworth, J.F.; Wolf. W.J.

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DNAL CALL NO: 381 08223
Language: English

89004747 89026373 Holding Library: AGL

Histochemical localization of desoxyhemigossypol, a phytoalexin in Verticillium dahliae-infected cotton stems

Mace, M.E.; Stipanovic. R.D.; Bell. A.A.

The New phytologist. Feb 1989. v. 111 (2) p. 229-232. ill. New York. N.Y. : Cambridge University Press.

ISSN: 0028-646X CODEN: NEPHA
DNAL CALL NO: 450 N42
Language: English

89002980 89024408 Holding Library: AGL

Interaction of gossypol with gossypin (11S protein) and congossypin (7S protein) of cottonseed and glycinin (11S protein) of soybean. 2. Effect of pH, ionic strength, and temperature

Reddy, I.M.; Rao, M.S.N.

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89002888 89024269 Holding Library: AGL
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Stipanovic. R.D.; Altman, D.W.; Begin. D.L.; Greenblatt. G.A.; Benedict. J.H.
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Changes in amide-linked and ester indole-3-acetic acid in cotton fruiting forms during their development
Guinn, G.: Brummett. D.L.
Plant physiology. Jan 1989. v. 89 (3) p. 941-944.
Rockville. Md. : American Society of Plant Physiologists.
ISSN: 0032-0889 CODEN: PLPHA
DNAL CALL NO: 450 P692
Language: English

89002600 89023920 Holding Library: AGL
Use of fusicoccin as antistress factor in seed germination
Muromtseva, D.G.; Khudayarov, A.A.; Muromtsev, G.S.; Selivankina, S.Yu.; Kulaeva, O.N.

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Language: English; Russian

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Cotton main-stem leaves in relation to vegetative development and yield
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Mien hua shih yen fang fa / Hung Chi-jen ... (et al] pien
Mianhua shiyan fangfa
Hung, Chi-jen.
Ti 1 pan.
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Pei-ching : Nung yeh ch u pan she : Hsin hua shu tien Pei-ching fa hsing so fa hsing. 1985.
LCCN: 86179118 /ACN
DNAL CALL NO: SB249.M542 1985
Language: Chinese

88145527 89021691 Holding Library: AGL
Ovule and suspension culture of a cotton fiber development mutant
Triplett, B.A.; Busch. W.H.; Goynes, W.R. Jr.
In vitro cellular & developmental biology : journal of the Tissue Culture Association . Feb 1989. v. 25 (2) p- 197-200. ill.
Gaithersburg, Md. : The Association. ISSN: 0883-8364
CODEN: ITCSA
DNAL CALL NO: QH585.A1I58
Language: English

88144572 89020503 Holding Library: AGL

Cotton root growth as influenced by phosphorus nutrition and vesicular-arbuscular my -
corrhizas

Price, N.S.; Roncadori. R.W.; Hussey. R.S.

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ISSN: 0028-646X CODEN: NEPHA

DNAL CALL NO: 450 N42

Language: English

88143299 89018993 Holding Library: AGL

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leaves

Gausman, H.W.;

Remote sensing of environment. July 1983. v. 13 (3) p. 233-238.

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Status : in commemoration of the centennial of Utah State University, July 6-10. 1987. Logan, Utah. v. 2 p. 133-138.

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DNAL CALL NO: QK87O.I5 1987

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8814183l 89017097 Holding Library: AGL.

Measurement of cotton leaf temperatures with imaging IR radiometer

Meron. M.;

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88141829 89017095 Holding Library: AGL

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Oosterhuis, D.M.; Wullschleger, S.D.
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Language: English

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Language: English

88139481 89017781 Holding Library: AGL
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Zeitschrift fur Acker- und Pflanzenbau. Dec 1988. v. 161 (5) p. 305-309.
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DNAL CALL NO: 18 J825
Language: English Summary Language: German

88131719 89016337 Holding Library: AGL
Seasonal leaf area-leaf weight relationships in the cotton canopy
Reddy, V.R.; Acock, B.; Baker, D.N.; Acock. M.
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Language: English

88138659 89016276 Holding Library: AGL
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Koryakina, N.I.; Kasymova. G.F.; Burichenko, V.K.; Negmatov, M.N.
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DNAL CALL NO: QK1.F5
Language: Russian Summary Language: English

88138248 89015746 Holding Library: AGL
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Huete, A.R.; Jackson, R.D.
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