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LSU AgCenter Research & Extension

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Cotton Issue

News Briefs

New Research Tool – PDA

LSU AgCenter scientists have found a new tool for their precision agriculture research – the personal digital assistant, also known as the PDA.

This small hand-held device that most people use to manage their schedules can also be used for global positioning information. The software that provides this information also shows a map on the PDA's screen.

"We use the PDAs for navigating within a field," said Ralph Bagwell, associate professor at the Macon Ridge Research Station, near Winnsboro, La.

Researchers can count insects at that location, for example, and record this data as they develop a prescription for pesticide application.

"This is off-the-shelf technology, affordable and easy-to-use for the farmer," Bagwell said.

Researchers are exploring how to most effectively use this technology as part of the research project described starting on page 9 of this issue.

AgCenter Cotton Lives On In Nematode-tolerant Variety

Stoneville Pedigreed Seed Co. is marketing a nematode-tolerant cotton variety that has its roots in an LSU AgCenter variety. Stoneville developed the variety ST5599BR from germplasm of LA887, a cotton variety owned by the LSU AgCenter and developed by Jack Jones, a professor who is now retired. The company added two genes. One, called Bollgard, protects the plants from certain insect pests, and another provides tolerance for the herbicide Roundup.

"I'm proud to see Jack Jones' original LA887 germplasm, which was successful in its own right, get another chance to contribute to southern producers through this new transgenic variety," said Bill Brown, vice chancellor for research. "It proves to be an enduring, widely adapted germplasm base."

Sanders, Burts Named Endowed Professors

Two AgCenter faculty members are now endowed professors, thanks to the generosity of Evelyn Edmiston Howell of Houston, Texas. Dearl Sanders, weed scientist and coordinator of the Idlewild Research Station, near Clinton, was named the Floyd S. Edmiston Sr. Professor in Agriculture and Natural Resource Management, and Diane Burts was named the Grace Drews Lehmann Professor in Human Ecology. Howell designated Sanders' professorship in memory of her father, Floyd S. Edmiston Sr. He was a long-time county agent in Louisiana. Howell gave Burts' professorship in memory of Grace Drews Lehmann, who was Howell's classmate in home economics at LSU.

ON THE COVER

LSU AgCenter scientists are experimenting with technology that will make it possible for aerial applicators to spray precisely what's needed over every square foot of a field. This will be good for the aerial applicator business as well as for farmers. See story on page 9. Photo by John Wozniak.

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The Louisiana Agricultural Experiment Station provides equal opportunities in programs and employment.

Page 9

Page 15

Page 18

Page 22

Page 28

LOUISIANA AGRICULTURE

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Volume 46, Number 2, Spring 2003

CONTENTS

4 PERSPECTIVE - Cotton: The Fabric of Louisiana Agriculture
Robert L. "Bob" Hutchinson

6 OVERVIEW - Louisiana: A Leader in Cotton Research
Donald J. Boquet and B. Rogers Leonard

9 Precision Agriculture Aids Cotton Pest Management
Ralph D. Bagwell, B. Rogers Leonard, Jay W. Hardwick, Edwards Barham, Dale Magoun, Randy Price, Robert G. Downer and Kenneth W. Paxton

11 Using Remote Sensing and GPS in Nematode Control
Eugene "Gene" Burris, Richard Costello, Boyd Padgett, Charles Overstreet and Maurice Wolcott

13 Improving Cotton Varieties in Louisiana
W. David Caldwell, Gerald O. Myers, Steve Hague and James A. Hayes

15 Economics of Technology Use in Cotton
Kenneth W. Paxton

18 Stink Bug Damage Increases in Louisiana Cotton
Melissa M. Willrich and B. Rogers Leonard

20 Tarnished Plant Bug Problems and Weed Host Control
Richard Costello, Eugene Burris, Gordon Snodgrass and William Scott

22 Managing Fusarium Wilt/Root-knot Nematode Complex
Patrick D. Colyer and Philip R. Vernon

24 Fungus Helps Control Louisiana Cotton Aphids
Robert H. Jones, B. Rogers Leonard and Ralph D. Bagwell

26 Poultry Litter Increases Cotton Yields
Eddie P. Millhollon, James L. Rabb, Jose F. Liscano and Russell A. Anderson

28 Cotton Defoliation: The Science of the Art
Alexander M. "Sandy" Stewart, Donnie K. Miller and Joel C. Faircloth

30 Irrigating Cotton on Alluvial Soils in Louisiana
Steve Hague, Alphonse Coco and Donald J. Boquet

32 Conservation Tillage, Cover Crop BMPs for Cotton
Donald J. Boquet, Robert L. Hutchinson and Kenneth W. Paxton

34 Nontransgenic Cotton Response to Off-target Herbicides
Donnie K. Miller, Robert G. Downer, Steve T. Kelly and P. Roy Vidrine

SCIENCE NOTES

14 Cotton History
Donald J. Boquet, B. Rogers Leonard and W. David Caldwell

17 Insecticide Resistance Monitoring Programs in Louisiana Cotton
Stephen Micinski, Donald R. Cook, B. Rogers Leonard, Ralph D. Bagwell, Eugene Burris and Alexander M. Stewart

21 Effect of Soil-applied Insecticides on Tarnished Plant Bugs
Donald R. Cook, Eugene Burris and B. Rogers Leonard

29 Tillage and Cover Crop Effects on Herbicide Degradation
Lewis Gaston

35 Effects of Pre-plant Application of 2,4-D on Cotton
Donnie K. Miller, P. Roy Vidrine, Steve T. Kelly and Rebecca G. Frederick

Assuring Our Future Through Scientific Research and Education

Cotton: *The Fabric of Louisiana Agriculture*

Robert L. "Bob" Hutchinson

For more than 100 years cotton has been the most important crop grown in northeast Louisiana. At one time cotton was grown all across the state, but over the years it has become increasingly concentrated in the northeast part because of more favorable environmental conditions and because other crops, especially sugarcane and rice, are preferred in south Louisiana. For most of the communities in northeastern Louisiana, cotton production and related businesses constitute the foundation of the economy.

The largest acreage ever produced in Louisiana was planted in 1930 (1.95 million acres), and the lowest acreage was in 1975 (310,000 acres). In the last five years, acreage has ranged from 610,000 to 849,000, with an average farm gate value of more than $270 million annually.

About 80 percent of the state's cotton crop is grown on the alluvial soils bordering the Mississippi and Ouachita Rivers and the loess (wind-deposited) soils of the geological formation known as the Macon Ridge. About 20 percent is grown on Red River alluvial soils in northwest and central Louisiana.

Dramatic changes

Louisiana's cotton farms have changed dramatically in the past 50 years. In the early 1950s, the average cotton farmer grew fewer than 20 acres of cotton. During the 1960s and 1970s, farms became much more mechanized, and effective pesticides were developed to reduce the need for manual labor for tillage, planting, weed control, insecticide application and, perhaps most important, harvesting. The mechanical cotton picker revolutionized the harvest process and increased the efficiency of cotton farmers. By the late 1970s, a single farmer was able to manage more than 185 acres of cotton. The trend toward larger and more mechanized farm units has continued, and today a typical farmer grows 400 to 500 acres of cotton with little seasonal labor.

Cotton yields have also increased gradually during this period. Average yield in the early 1950s was about 375 pounds of lint per acre compared to about 660 pounds for 1997 to 2001. Some farmers consistently produce more than 1,000 pounds per acre.

LSU AgCenter's role

For many years Louisiana's cotton producers have depended heavily on the Louisiana Agricultural Experiment Station and Louisiana Cooperative Extension Service of the LSU AgCenter to supply research-based information to increase yields, reduce production costs and minimize losses from a myriad of insects, weeds, nematodes and plant diseases.

Most of the applied field experiments are conducted at four branch research stations—Northeast at St. Joseph, Macon Ridge at Winnsboro, Red River at Bossier City and Dean Lee at Alexandria. The research conducted at these locations is often performed in cooperation with researchers from other research stations and scientists from several campus-based departments. Numerous basic or fundamental research projects are conducted in the AgCenter's campus-based departments and laboratories. In addition, much of this research is conducted in cooperation with researchers from other land-grant universities as well as state and federal agencies.

Photo by John Wozniak

Robert L. Hutchinson

Funding sources

Most of the funds needed to support AgCenter cotton research projects are provided by Louisiana's taxpayers through appropriations from the state legislature; however, cotton producers in Louisiana provide significant funding to support research through a check-off program jointly administered by Louisiana's cotton producers and Cotton Incorporated. In addition, significant grant funding is received through joint projects with other universities, private companies and various government agencies. Grant support from all of these sources has grown significantly and has become an indispensable part of the cotton research budget.

Competitive production

AgCenter researchers and educators have done a commendable job of solving problems, developing new technology to increase productivity and helping producers incorporate these tools into their farming systems. This relationship has helped Louisiana's cotton farmers remain competitive through many difficult challenges.

Nevertheless, the cotton industry now faces many serious challenges and problems that must be met and overcome if this industry is to remain viable. Plant breeding and variety testing programs must be fully funded and equipped to develop new germplasm and varieties that are adapted to Louisiana's environmental conditions, resistant to damage from various pests, with high yield potential and that exhibit fiber traits demanded by modern high speed textile manufacturing machinery. Cotton fiber data from the U.S. Department of Agriculture's Cotton Classing Office in Rayville, La., suggests that fiber length (staple) has declined in the

Robert L. Hutchinson, Director, North Central Region, LSU AgCenter, Winnsboro, La.

past 15 years while coarseness (micronaire) has increased. As a result, in recent years a high percentage of our cotton is discounted heavily because the fibers are too coarse and too short. Cotton breeding programs that emphasize fiber quality improvement as well as yield can address these problems effectively.

Numerous agronomic studies have refined recommendations for fertilization, irrigation, planting date, row spacing, crop rotation, cover crops, tillage and other inputs to improve the biological efficiency of cotton while minimizing production costs. Although great strides have been made, considerable research is needed to fully realize the economic and environmental benefits of these practices.

New weed and insect management programs that use transgenic (genetically engineered) cotton varieties and new classes of pesticides have provided powerful tools to minimize economic losses from weeds and insects while enhancing safety to humans, animals and the environment. Furthermore, in the past 15 to 20 years, AgCenter researchers have gained national and international recognition as leaders in the development of cotton production systems, including conservation tillage, that conserve natural resources and protect the environment. Much of this research has been used to develop best management practices, known as BMPs, that have been adopted by most crop producers. More research is needed to integrate all of these practices and technologies for the maximum benefit to producers and the environment.

Photo by Robert L. Hutchinson

Conservation tillage has been a primary focus of LSU AgCenter research. This is a spray rig designed to accurately apply herbicides as a directed spray beneath the cotton plants and to the row middles to control weeds with no injury to the cotton plants. This method minimizes soil disturbance and reduces soil erosion.

Challenges

Many challenges lie ahead that threaten the viability of the cotton industry in Louisiana and across the Cotton Belt. Because of increased international production and competition, prices for cotton have reached the lowest levels in several decades, while prices for inputs have risen steadily. Strict environmental regulations have reduced the number of effective pesticides available to producers to manage insects, weeds and insects. To make matters worse, the new materials are typically much more expensive than the older materials and have a much narrower spectrum of activity and shorter residual efficacy.

The Boll Weevil Eradication Program administered by the Louisiana Department of Agriculture and Forestry has been extremely successful in eliminating this pest from much of the state's production areas. In 2004, the entire state should reach weevil-free status and enter a maintenance program to prevent re-infestation. Although this program is a tremendous asset to cotton producers, most of the insect management guidelines will need to be revised to address new pest concerns in post-eradication cotton fields.

Louisiana water quality regulations will likely place additional constraints on producers and require adoption of strict conservation tillage practices and precision inputs of fertilizers and pesticides to minimize adverse effects on water bodies. Increased competition from foreign producers and synthetic fibers will require cotton breeders to develop new cotton varieties with improved staple length, fineness, strength and uniformity. Increased environmental regulation and expense of pesticides will require geneticists and breeders to develop transgenic varieties that resist damage from a wider range of pests and allow the use of safer and more economical weed control programs. Finally, newly initiated precision agriculture research in Louisiana will help producers target expensive inputs to specific areas in fields that provide positive net returns rather than applying these inputs to areas less likely to provide a positive return. This research has tremendous potential to increase profitability of producers while reducing the need for pesticides, fertilizer and other inputs.

Cotton research programs of the past have helped to increase yields and profitability of cotton while conserving our soil and water resources. Future research programs will continue to develop new technology to address the challenges as long as adequate funding is provided to support these efforts. The greatest beneficiaries of these efforts will be the consumers of all the products derived from cotton lint and seeds and the numerous communities in north Louisiana, where economic survival depends on cotton production, ginning and warehousing. ■

Louisiana: *A Leader in Cotton Research*

Donald J. Boquet and B. Rogers Leonard

Despite its success throughout history, cotton as a crop in the U.S. suffers from many problems for many different reasons. There are seedling, stem, root and boll rot diseases, a diverse group of insect species that feed on leaves, plant juices, immature fruit and bolls, and dozens of competing weed species. Adverse weather in early spring is hard on this tropical plant, and rainy periods during late summer and fall often cause yield losses through boll rot and delayed harvest. Costs of production for cotton are among the highest for agronomic crops, but prices received for cotton in the past several years were lower than in the 1960s.

Research-based information and technology developed by the LSU AgCenter have been important factors in maintaining profitability in the Louisiana cotton industry. In 1929, a group of north Louisiana cotton farmers who recognized the need for problem-solving research purchased land near St. Joseph in the Mississippi River Delta and donated it to the Louisiana Agricultural Experiment Station. This station, known today as the Northeast Research Station, has continuously conducted research on the Mississippi River alluvial soils and is internationally recognized as one of the leading cotton research organizations in the country. In 1958, the Northeast Research Station established a substation in Winnsboro on loess soils (wind-deposited silt loam), known today as the Macon Ridge Research Station.

Another research station active in cotton research is the Red River Research Station near Bossier City. Established in 1948, the Red River Station is uniquely situated to conduct research in two areas of consequence to the region—cotton insect pests and poultry litter. Evaluation of the technology to control insect pests with less reliance on insecticides is one of its missions. Northwest Louisiana is also proximate to extensive poultry production that generates thousands of tons of animal waste each year. If not properly disposed of, this waste poses serious environmental problems. Research on the safe and beneficial use of poultry litter is providing benefits to agricultural interests and to the public in northwest Louisiana.

With the recent return of cotton production to central Louisiana, cotton research at the Dean Lee Research Station near Alexandria has taken on new life. It is more difficult to produce cotton in this area of the state because growing conditions are influenced by the sea breeze effect of the Gulf of Mexico. Research at this location focuses on the interactions of weather with production input variables.

These four research stations are involved either directly or collaboratively with LSU AgCenter departments, including agricultural economics, agronomy, entomology, plant pathology and crop physiology, and other research organizations. Louisiana Cooperative Extension Service faculty are also located in north Louisiana at the Scott Research and Extension Center in Winnsboro because of the concentration of the crop in northeast Louisiana.

Cotton Breeding Continues

Improving the genetics of cotton varieties to make them more suitable for Louisiana conditions has been a long-term commitment of the AgCenter. The cotton breeding program in Louisiana was one of the first such research efforts established at a land-grant university, dating back to the 1920s.

Because cotton is a tropical perennial species, it requires considerable genetic manipulation to develop into a productive annual crop for a temperate environment. Breeding new varieties, however, involves much more than adapting cotton types to the environment. Cotton is unique in that acceptable fiber quality, and not only yielding ability, must be bred into varieties. Fiber quality is composed of several distinct genetically complex properties, each of which must be separately bred and selected for. Development of pest-resistant plants that can overcome infestations of insects and nematodes to minimize use of pesticides also is important. The Louisiana breeding program has used unique plant traits such as leaf shape and color, bract shape and nectar-producing inhibition to discourage insect pests. The only current cotton varieties for the South resistant to root-knot nematode were developed in the LAES cotton breeding program. The

Donald J. Boquet

B. Rogers Leonard

Photos by John Wozniak

Donald J. Boquet and B. Rogers Leonard, both Professors, Macon Ridge Research Station, Winnsboro, La.

contributions of the LAES cotton breeding program are reported in this issue. See page 13.

Best Management Practices Help with Profits

Historically, cotton in the Mid-South has been monoculture and grown as a summer annual crop in fields that were intensively tilled. Fields were left fallow in winter, which, because of our wet climate, exposed the soil to potential runoff losses of sediment and nutrients. This runoff can contribute to nonpoint-source pollution of surface water bodies.

Since 1991, the AgCenter, Natural Resources Conservation Service, Louisiana Farm Bureau and other organizations have cooperated to develop management practices that protect the soil and minimize field runoff. Agricultural practices designed to reduce runoff from agricultural land are referred to as best management practices (BMPs). These BMPs had to be implemented without compromising the long-term productivity or profitability of farms.

The development of agronomic BMPs that improve crop productivity while also protecting water quality has been the focus of several projects. On the highly erodible land of the Macon Ridge area, research has proved the benefits of using reduced tillage and winter cover crops to protect the land. Soil loss from research plots planted using the BMPs of winter cover crops of wheat or hairy vetch and no-tillage practices has been negligible, while soil loss from plots without cover crops and conventionally tilled exceeded seven tons per acre per year.

In addition to the environmental benefits, winter cover crops and no-till BMPs increased cotton yield and decreased production costs. These practices are called productive BMPs because they protect water quality, but, equally important, the research shows they more than pay for themselves in increased yields and cost savings. Therefore, the implementation of these BMPs on individual farms to ensure the desired societal benefits of clean water can be done without adverse effects on farm profitability. The benefits of BMPs are discussed in this issue beginning on page 32.

In other BMP research at the Red River Research Station near Bossier City, researchers are examining ways to beneficially use waste from Louisiana's largest animal industry in an environmentally safe manner. Poultry litter applied to cotton fields in conjunction with conservation tillage produced higher yields than cotton grown using the conventional methods that did not employ BMPs. Soil organic matter content and the nutrient status of the soil were also improved. As an added bonus, inorganic fertilizer nitrogen was not needed where poultry litter was applied. This research demonstrates that production of a potentially harmful waste can be turned into a BMP by safely returning the waste to agricultural row cropland in a manner that improves the soil and cotton yields.

Defoliation Timing Critical

Once bolls are mature, a critical operation remains before the cotton can be picked. Harvest aids must be applied to remove leaves and temporarily halt plant growth to allow picking of the seedcotton. This process of defoliation improves the efficiency of harvesting and preserves fiber quality. Proper timing is essential to avoid yield reductions from too-early termination of growth and too-late termination that compromises harvest timing and fiber quality. Determination of the optimal defoliation timing has been described as more of an art than science. The various methods for determining the proper time of defoliation to achieve a balance between yield and quality concerns are discussed on page 28.

Irrigation Scheduling

Louisiana's highly productive soils have one major limiting factor—erratic summer rainfall. Supplemental irrigation is essential for profitable cotton production in most years on some soils (loess) and for insurance against exceptionally dry years on other soil types. In most of Louisiana, water from wells or surface sources is readily available for irrigation. Determining the need for and scheduling irrigation is not straightforward, however, because dry weather is sometimes followed by rainfall. When this happens, any benefits of the apparent needed irrigation are negated and, in fact, irrigation may cause a yield loss. Some of the ways to avoid these irrigation problems and optimize the benefits of irrigation are being evaluated at the Northeast Research Station.

Integrated Pest Management

More than most other crops, cotton requires protection from insects, nematodes and diseases. Until the last decade, more pounds of pesticide per acre were used on cotton in a given year than on any other agronomic crop. The integrated pest management (IPM) system has moderated pesticide use on cotton. In recent years, highly target-specific pesticides that can be used at low dosages (ounces rather pounds per acre) have become available. Genetic engineering has produced cotton plants resistant to insect pests and tolerant to applications of selected herbicides. In addition, a better understanding of cotton pest biology and interactions in agricultural environments has improved the ability of producers to adapt crop protection solutions to each individual need. The ultimate goal of LSU AgCenter scientists with responsibilities for improving cotton IPM is to develop practical crop protection solutions into existing production systems with minimal effects on nontarget organisms and the environment.

Weed Management Changes

Weed management in cotton has changed considerably in the past decade. The adoption of conservation tillage practices has reduced the emphasis on tillage as weed control and increased reliance on herbicides. Producers are using pre-plant herbicide applications, called burndowns, to establish weed-free seedbeds. Novel herbicides used in post-emergence, over-top applications have been successful in controlling broadleaf weed problems such as morningglory and pigweed without injury to cotton plants. Producer acceptance of herbicide-tolerant cotton has simplified weed management in cotton by reducing the emphasis on pre-plant, soil-applied and post-directed herbicides. In 2001 and 2002, herbicide-tolerant cotton varieties accounted for more than 75 percent and 55 percent, respectively, of the total planted acreage in Louisiana. Extensive research programs in the AgCenter have defined cotton plant and pesticide characteristics that enhance the differential selectivity between crop safety and weed control.

Insect Management Goes Hi-Tech

The evolution of cotton insect pest management strategies has followed a trend similar to that of weed manage-

ment. Research on highly selective novel insecticides, environmentally friendly insecticide delivery systems, transgenic insect-resistant cotton varieties and insect ecology has provided information to develop cost-effective alternatives to recommended insect pest management practices. The eradication of the boll weevil as a cotton pest has greatly reduced the application frequency of nonselective insecticides. In the absence of these treatments, which were toxic to a broad spectrum of insects, innocuous insects have emerged as significant pests that now are capable of limiting yield. Current research focuses on the development of site-specific insect management with insecticide prescriptions. Adapting precision agricultural technologies to cotton insect pest management strategies could further reduce insecticide inputs with economic and environmental benefits.

Tillage Practices Affect Disease Management

The dynamics of cotton disease management have shifted with changing tillage practices and short-season varieties. Although the pathogens plaguing cotton plants have not changed, the dynamics of cotton diseases have. Increased use of conservation-tillage practices has altered the soil environment, leading to an increase in the diversity of soil organisms. The effects of increased microbial interactions on specific plant pathogens are complex and not completely understood. Some pathogens may increase in the altered environment, and others may decrease. Research is continuing to evaluate the effects of disease pathogens, but general uncertainty has prompted producers to re-evaluate the need for additional fungicides at planting.

The impact of reduced-tillage practices on nematode populations is also not completely understood, but research is under way. The reniform nematode has emerged as the state's No. 1 nematode pest, replacing the root-knot nematode. Current research efforts are targeting management of this pest.

The sporadic occurrence of late-season maladies has had mixed effects on cotton development. Bronze wilt is usually associated with specific short-season cotton varieties and can reduce yields drastically. Boll dangle or vascular cavitation, in contrast, destroys many young bolls but is associated with high-yielding varieties and is apparently not yield-limiting.

Improved Technology Sustains Cotton Industry

Innovations in technology have greatly changed the way cotton is grown, improving production efficiency from pre-plant operations through harvesting. Although no single technology can be said to have saved the cotton industry, all of the improvements in technology during the past 50 years together have enabled the cotton industry to survive, if not prosper. Perhaps the greatest change in technology is use of transgenic seed with insect and weed control attributes, which transfer the cost and the burden onto producers of making what used to be mid- and late-season decisions at planting time. Despite problems and high cost, the use of transgenic varieties is the most rapidly adopted technology change in agricultural history.

The adoption of environmentally friendly conservation tillage practices also has had profound effects in revolutionizing cotton production practices. Although promoted for environmental benefits, conservation tillage improves efficiency and makes it easier and less costly for producers to grow cotton. Likewise, larger cotton pickers and more effective harvesting equipment such as boll buggies and modules have improved the efficiency of harvesting cotton. The improved technology has benefited cotton growers, but at a high cost. The economics of technological innovations for cotton production are discussed on page 15.

Photo by John Wozniak

Cotton "modules" now dot the landscape in cotton country during harvest. These huge white loaves are created by module builders that compress the cotton, making the transport to the gin a more efficient process. Before module builders, farmers used trailers to haul cotton from the fields to the gin. This was a slow process that delayed harvest and resulted in reduced yield and fiber quality.

The articles in this issue are examples of research and extension efforts put forth by LSU AgCenter scientists to provide solutions to problems being experienced by the Louisiana and the Mid-South cotton industry. These scientists are integrating their results into holistic, intensive and sustainable cotton production systems. All of the cotton varieties—and agricultural production systems in general—are developed so that they meet the economic and environmental challenges that face Louisiana agriculture. ■

Precision Agriculture Aids Cotton Pest Management

Photos by John Wozniak

LSU AgCenter scientists are experimenting with technology that will make it possible for aerial applicators to spray precisely what's needed over every square foot of a field. Their aim is to make this technology usable and affordable for farmers.

Geospatial tools offer great promise of increasing profitability of cotton production. These tools, however, must be adapted to the specific agronomic and plant protection needs of cotton production and made available in a user-friendly format that can be easily transferred to producers, commercial pesticide applicators and agricultural consultants.

Ralph Bagwell, above, and Roger Leonard are the lead LSU AgCenter scientists in this precision agriculture project.

In 2002, a multi-disciplinary team including LSU AgCenter scientists initiated a project to develop spatially variable pesticide applications based on remote sensing to improve the efficiency and profitability of cotton production. The objectives of the study are: 1) to correlate arthropod densities with field growth patterns, 2) to apply spatially variable pesticide applications to targeted zones in a field, 3) to perform economic comparisons of precision farming techniques to conventional plant protection strategies and 4) to develop and disseminate educational programs on the efficiency and value of precision agriculture techniques.

The study is being conducted at Hardwick Planting Co. near Somerset, La. Images are gathered with fixed wing aircraft flown at 12,000 feet. These multi-spectral images are geo-referenced and used to create a Normalized Difference Vegetation Index (NDVI) of the study site, which provides an estimate of plant vigor.

To correlate arthropod densities with multi-spectral images, test fields (300 to 450 acres total) were sectioned into one-acre grids. Five randomly selected sites are then sampled for the predominate arthropods in each one-acre grid. Arthropod density data are then correlated with multi-spectral image data.

Ralph D. Bagwell, Associate Professor, and B. Rogers Leonard, Professor, Macon Ridge Research Station, Winnsboro, La.; Jay W. Hardwick, Operator, Hardwick Planting Co., Somerset, La.; Edwards Barham, Aerial Applicator, Barham Brothers Aviation, Oak Ridge, La.; Dale Magoun, Head, Department of Mathematics, Computer Science and Physics, University of Louisiana at Monroe, Monroe, La.; Randy Price, Assistant Professor, Department of Biological and Agricultural Engineering, LSU AgCenter, Baton Rouge, La.; Robert G. Downer, Associate Professor, Department of Experimental Statistics, LSU AgCenter, Baton Rouge, La.; and Kenneth W. Paxton, Professor, Department of Agricultural Economics, LSU AgCenter, Baton Rouge, La.

Photos by John Wozniak

Shot from 12,000 feet, this aerial photo indicates through color where there is plant vigor. This can help determine where insect pests are.

To determine economic value of this technology, insecticide applications are compared with traditional broadcast applications when arthropod densities reach the treatment threshold. Areas selected for variable rates are determined by multi-spectral imaging. Generally, insecticides are applied to areas indicating high plant vigor (60 percent to 80 percent of the field) and not applied to areas with the lowest plant vigor. Four paired cotton fields (75 to 120 acres) are treated with either the variable or traditional sprays. Lint yields and production costs are then compared for the two treatments.

The third evaluation looks at yield history to determine areas where pesticide applications are rarely justified. Geo-referenced historical yields are identified and pesticide exclusion zones are created in low-yielding areas. Three to four replicates of these treatments are compared with traditional whole-field sprays. Lint yields and production costs are then compared.

The final evaluation is a replicated comparison of spatially variable defoliation treatments with traditional blanket defoliation treatments. NDVI images are used to develop multiple-rate defoliation treatments. Defoliant rates are varied by changing the output volume of the spray equipment. Treatments are replicated three to four times and are sufficient in size that one, preferably two, modules can be made from each plot. Lint yields, production costs and lint quality factors are then compared.

These research results will provide the basis for integrating geospatial technologies into the current cotton production system. A demonstration program will be developed for producers, pesticide applicators and agricultural consultants on the efficiency and value of precision agriculture in cotton IPM.

The results of this project will contribute the necessary information to integrate geospatial technologies into current IPM systems. The days of the "pesticide treadmill" with its disastrous results of pest resurgence, secondary pest outbreaks and environment contamination in cotton production systems may be eliminated if a base of information can be developed to support the appropriate development of these technologies. ■

The computer in the cockpit controls when the sprayer nozzles (below) are turned on and off.

Using Remote Sensing and GPS in Nematode Control

Eugene "Gene" Burris, Richard Costello, Boyd Padgett,
Charles Overstreet and Maurice Wolcott

LSU AgCenter scientists have launched a project to explore the use of geographical information system (GIS) and global positioning system (GPS) technologies to manage nematodes that affect cotton production in Louisiana soils. GPS-based equipment makes it possible to measure soil electrical conductivity for texture mapping, to develop topographic maps and to apply variable rate treatments. Currently, nematode treatments are usually applied uniformly across fields, often resulting in considerable over-application.

The southern root-knot nematode is a severe nematode pest in Louisiana soils. Crop rotation, root-knot nematode resistant varieties and pesticides are required to manage the pest. Agronomic options of crop rotation and use of resistant varieties are usually limited. When chemical treatments are selected as a principal means of control, costs can exceed $30 per acre for high infestations of root-knot nematodes.

In 2000-2001, preliminary data were collected from the Gin Ridge field at the LSU AgCenter's Northeast Research Station near St. Joseph, La., which was highly infested with root-knot nematode. Surveys of the Gin Ridge field included soil electrical conductivity readings measured with a Veris mapping cart (see photo this page), topography data collected using precision laser equipment and soil

Photo by Mark Claesgens

With a Veris mapping cart, scientists can measure the electrical conductivity of soils, which correlates with soil texture.

Figure 1. Overlaying a boundary using the LSU GIS database and the SSToolbox program identifies a 78.3-acre field, called the Gin Ridge field, on the Northeast Research Station at St. Joseph.

Eugene "Gene" Burris, Professor, and Richard Costello, Post Doctoral Researcher, both at the Northeast Research Station, St. Joseph, La.; Boyd Padgett, Professor, Macon Ridge Research Station, Winnsboro, La.; Charles Overstreet, Professor, and Maurice Wolcott, Research Associate, Department of Plant Pathology, LSU AgCenter, Baton Rouge, La.

Figure 2. Comparisons of electrical conductivity surface data (EC) and topographic elevation maps facilitate soil texture mapping, which is used to determine rate of application.

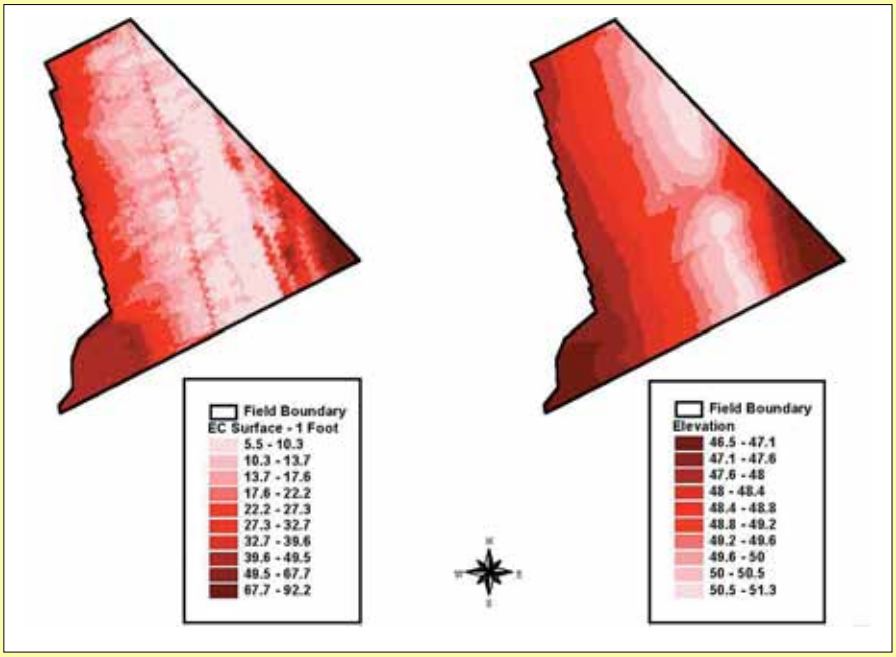
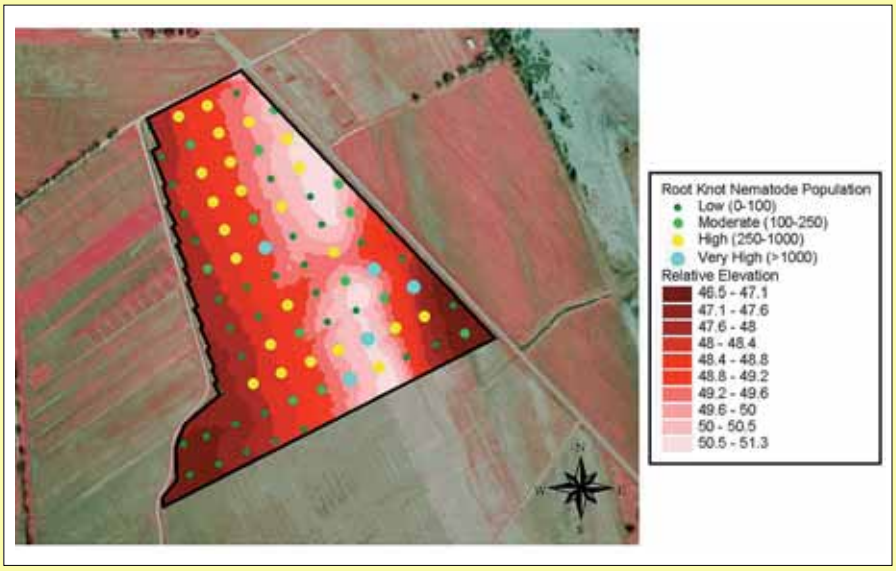


Figure 3. A grid sample overlay of the nematode population densities indicates that high or very high nematode counts were found only on the ridge areas of the field that also correspond to the lighter soil textures.



samples taken on a 1-acre grid. From these samples, soil texture and nematode population densities were determined. All applications incorporated a differential global positioning system to ensure accurate data collection. These data were used to segregate the field into zones characterized by differences in soil texture and to show the relationship of plant parasitic nematode populations within different soil zones.

Information collected was analyzed using SSToolbox, a computer program used with GIS technology. In Figure 1, the 78.3-acre Gin Ridge field boundary is outlined and overlaid on an aerial photo. In Figure 2, the comparisons of field zones are shown for the Veris electrical conductivity data and the elevation data. Several different soil textures occur in the 78.3-acre field—Commerce silt loam, Bruin silt loam, Mhoon silty clay loam and Sharkey clay. In Figure 3, the results of nematode samples collected on a 1-acre grid are overlaid on the elevation map. These graphic depictions indicate that the root-knot nematode infests only a portion of the field. This has allowed the scientists to develop variable rate prescriptions for pesticide treatment, reducing the need for nematicide by 60 percent.

With the help of a grant from the U.S. Environmental Protection Agency, the LSU AgCenter research team will expand its efforts to provide better knowledge of plant parasitic nematode distributions and densities. The team will evaluate several fields with a history of nematodes and develop Veris information, topography data guidance systems and variable rate applications. The objectives of the research include enhanced ability to sample plant parasitic nematodes and creation of GIS/GPS-based strategies that will be user-friendly so producers can more effectively manage plant parasitic nematode infestations. ■

Cotton Facts

- Louisiana is one of 14 states where 98 percent of U.S. cotton is grown. The others are: Alabama, Arkansas, Arizona, California, Georgia, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee and Texas. The remaining 2 percent is grown in Kansas, Florida and Virginia.
- Texas, which annually grows about 4.5 million bales of cotton, is the leading cotton-producing state.
- Historically, China is the country that produces the most cotton.
- U.S. paper currency is made up of 75 percent cotton and 25 percent linen.
- One bale of cotton can produce 215 pairs of jeans.

Improving Cotton Varieties in Louisiana

W. David Caldwell, Gerald O. Myers, Steve Hague and James A. Hayes

Systematic research in cotton breeding and genetic improvement began in Louisiana when H.B. Brown joined the staff of the Louisiana Agricultural Experiment Station (LAES) in 1926. The objectives of the cotton improvement and breeding program were to increase lint yield, to produce more uniform, longer cotton fiber and to produce larger bolls. Early studies by Brown also involved investigations of leaf shape and plant pubescence. In 1936, Brown was joined by John Cotton, a U.S. Department of Agriculture cotton breeder and geneticist who contributed to the improvement of disease resistance in LAES cotton germplasm.

When Brown retired in 1946, F.W. Self became the lead cotton breeder for LAES, and a major effort was initiated to improve fiber and seed quality. The release of Stardel in 1955 represented a significant advance in fiber strength and uniformity. Stardel Glandless was a commercial variety released in 1967; it was marketed as Rogers OB1.

M.T. Henderson served with Self and was involved in cotton genetics and taught many young scientists. Many of Henderson's students went on to have a major impact on the cotton industry. One of these students, Jack E. Jones, was responsible for cotton breeding and variety development at the LAES from 1950 to 1990. Jones' research focused on the Fusarium wilt-nematode disease complex, reniform nematodes, key insect pests (bollworm-budworm, boll weevils, plant bugs) and how open-canopy traits affected boll rot, earliness, insects and yield. These studies resulted in the release of three varieties with unique leaf shape: Gumbo, an okra leaf (narrow leaf) variety released in 1976; Pronto, a super okra leaf variety released in 1976; and Gumbo 500, an improved okra leaf variety released in 1981. From 1990 to 1994, Steve Calhoun conducted the cotton breeding and improvement program for the LAES. The present breeder, Gerald Myers, assumed responsibility for the program in 1994.

Fiber Improvement

While there is little direct economic incentive for producers to sacrifice yield for fiber quality, cotton breeders, especially those in the public domain, are expected to be vanguards of cotton quality. Better fiber translates into better yarn, which enables cotton to compete effectively with synthetic fiber. Therefore, the health of the cotton industry depends on high-quality fiber.

Three of the most important traits for textile operations are fiber length, strength and fineness. Although length is primarily determined by the plant's genetic makeup, stressful growing conditions can shorten fiber. Frequently, breeding lines with long fiber have low lint-to-seed ratios that can contribute to low yield. Fortunately, selection methods are being perfected to circumvent this conundrum.

Better fiber translates into better yarn, which enables cotton to compete effectively with synthetic fiber. Therefore, the health of the cotton industry depends on high-quality fiber.

Fiber strength is governed largely by genetics, with some loss attributed to severe weathering between boll opening and harvest, extreme plant stress during fiber development or harsh ginning practices. Fiber strength usually translates directly into yarn strength. This has become increasingly important in modern textile mills because machinery operates at escalating speeds with little economic cushion for work stoppages caused by breaks in the spinning and weaving processes.

Micronaire is an indicator of both fineness and maturity. Coarse fiber results in a lower fiber per thread count and a low quality fabric. Immature fibers cause more fabric imperfections and are difficult to dye. In Louisiana, most immature fiber is produced in the uppermost fruiting sites, which are often lost to late-season insect pests or not harvested by once-over picking practices. Since the bulk of Louisiana cotton develops in systems promoting fiber maturity, micronaire becomes primarily a measure of fineness. Fiber fineness is almost under complete genetic control, with environment having little effect. Unfortunately, concessions occur between development of low micronaire and high yield. With other factors being equal, an increase in micronaire results in more pounds of lint per acre.

With cooperation of researchers from several disciplines and support from producer organizations, great strides have been made in improving fiber quality and enhancing yield. Researchers at the Pee Dee Experiment Station in South Carolina were some of the first to improve yield and fiber traits simultaneously. The Texas A&M cotton breeding program at Lubbock, with support from Plains Cotton Growers, Inc., is releasing upland cotton germplasm with 35 percent better fiber length and 50 percent better strength than regional standards, with little to no trade-off in yield potential.

An important aspect of the cotton improvement effort has been the Cotton Fiber Testing Laboratory located on the LSU campus in Baton Rouge. The fiber lab, operated for many years by Wilbur Aguillard and more recently by Ivan Dickson, was recently equipped with a modern Uster High Volume Instrument for comprehensive fiber evaluation. This service is invaluable in providing information on the fiber quality.

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Principal genetic resources that enhance fiber traits are from Acala breeding lines and naturally occurring variation within adapted varieties. Acala lines are primarily grown in the western United States and Australia but have been moderately successful in Louisiana. Most cotton producers remember Deltapine 90, which had an Acala background. More recently, several lines from Australia have been commercially introduced with extensive genetic contributions from Acala lines. Cotton varieties are not entirely homogeneous populations and possess variation for most traits. Unfortunately, finding these traits can be likened to the proverbial needle in the haystack. Breeders may closely examine tens of thousands of plants before finding a single off-type improvement.

Cotton Breeding Program

The Cotton Breeding and Genetics Program of the LSU AgCenter seeks to build on its successes, which were significant in the 1990s. These include the release of several cotton varieties developed by Jack Jones—Stoneville LA 887, Paymaster (Hartz) 1215, 1220, 1244 and 1560. Transgenic versions of these varieties have also been marketed. Notable among these is Paymaster 1218BG, the most widely planted cotton variety in the Mid-South for two consecutive years in a row (2001 and 2002) and Stoneville ST 5599 BR (a transgenic version of LA 887), marketed for the first time in 2003. Both have the Bollgard gene for insect resistance and the Roundup Ready gene for herbicide resistance. Royalties from the sale of seed support the LSU AgCenter breeding program and other related research. Additional research was conducted into natural plant traits that confer resistance to insect pests and stresses, the identification of resistance to nematodes and the genetic inheritance of numerous traits. Germplasm from this research was developed and released for use by other cotton breeders.

Since 1994, the Cotton Breeding and Genetics Program has been directed by Gerald Myers and retains the historical focus of developing cotton germplasm and varieties with high yield potential, increased resistance to pests and superior fiber quality specifically adapted to Louisiana and the Mid-South. Research trials are undertaken in collaboration with LSU AgCenter scientists and research stations throughout the state, as well as cotton breeders across the United States.

The breeding program is based on a pedigree system. Recent focus areas beyond that of high and stable yield and superior fiber quality include developing germplasm with tolerance to both root-knot and reniform nematodes (highly destructive soil pests of cotton widely scattered in the state), developing germplasm with resistance to Heliothis pests and developing varieties with the okra leaf shape.

Research projects recently concluded have shown that the insertion of transgenes for insect and herbicide resistance has made subtle changes in other plant characteristics and has identified new sources of resistance to the root-knot nematode. With recent grants from Cotton Incorporated and the Louisiana Cotton State Support Committee, research projects on improving the efficiency of breeding for better yield and fiber quality and on characterizing newly acquired cotton germplasm from Uzbekistan have begun.

Beginning in 1995, the program has been conducting research in cotton molecular genetics and biotechnology. Support from the Louisiana Educational Quality Support Fund helped establish this aspect of the program, which has two focus areas: molecular mapping of genes for yield components and fiber quality and on cotton transformation. A recent paper reports on the identification of a marker associated with increased yield in cotton. This DNA marker is being further investigated for its use in marker-assisted selection of increasing cotton yield. Efforts to develop the capability to genetically transform cotton are under way. Regenerated plants have been developed and research to increase the efficiency of the process is being conducted. This research is complementary to the conventional breeding program, and it is through a combination of the two that progress by the Cotton Breeding and Genetics Program can be measured. ■

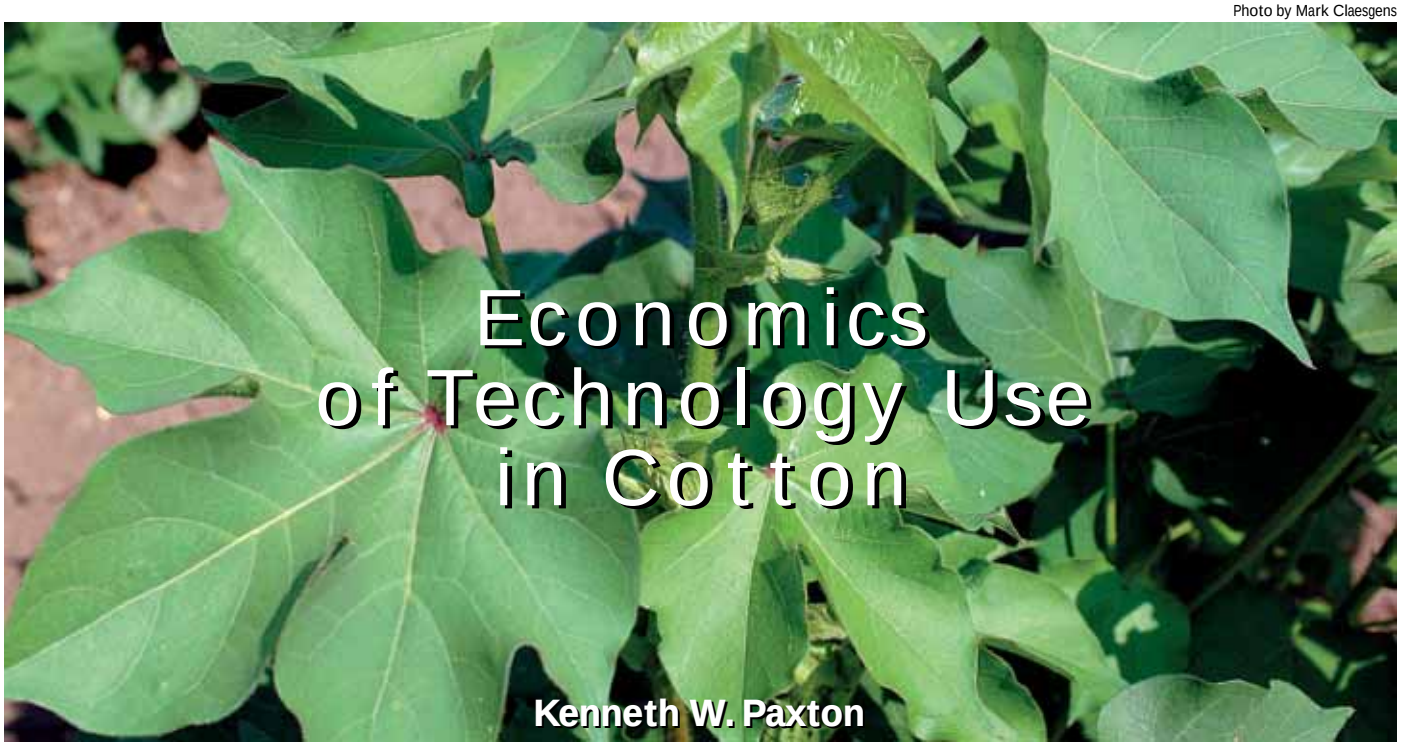
Cotton History

Farmers have been growing cotton since 4,000 B.C. in India. In the New World, cotton production goes back well before Columbus landed in the Bahamas in 1492. He took cotton back to Spain to prove he had circled the world and reached India. Until the 18th century, England was the center of the European wool clothing industry but, once introduced, cotton quickly became the preferred fiber because of its advantages over wool for summer clothing. In the 18th century, the English wool industry successfully sponsored laws to ban cotton, eventually to no avail. Because cotton was a tropical crop that could not be grown in Europe, these countries used their colonial system to support the development of extensive cotton production in many temperate and tropical areas of the world.

Cultivation of cotton in Louisiana was reported as early as 1729. At that time, cotton fiber was used in home spinning and weaving. It was not until the invention of the cotton gin in 1793 by Eli Whitney that cotton was produced in Louisiana as a cash crop, primarily for export to Europe. By 1860, the United States was producing 75 percent of the world's cotton. Between 1870 and 1920, cotton was grown on as many as 48 million acres and was the only major cash crop in the South. This quickly changed with the arrival of the boll weevil from Mexico in the 1890s. The boll weevil became the most devastating insect in the history of agriculture, forcing thousands of farmers out of the cotton business and serving as the primary impetus for the diversification of Southern agriculture, the development of the chemical insecticide industry and the aerial pesticide application industry. When the cotton picker was invented in 1927, each picker could replace more than 100 hand laborers. The loss of these jobs began the process that would eventually lead to large permanent migrations of rural Southerners to the cities in search for jobs.

Donald J. Boquet and B. Rogers Leonard, both Professors, Macon Ridge Research Station, Winnsboro, La.; and W. David Caldwell, Professor, Red River Research Station, Bossier City, La.

Photo by Mark Claesgens



Economics of Technology Use in Cotton

Kenneth W. Paxton

Our nation's cotton production has undergone tremendous adjustments in the past 50 years fueled by the forces of technical change. One prime indicator of the magnitude of changes is yield per acre. At the national level, per acre cotton yields have increased more than 64 percent since the mid 1950s. At the same time, area devoted to cotton production has decreased 17 percent. The increased yield per acre can be largely attributed to the technologies embodied in new pesticide chemistries, novel pest management systems, efficient irrigation and cultivation, and improved cotton varieties.

In Louisiana, per acre cotton yields increased more than 42 percent during the last 50 years. While Louisiana followed national trends in terms of yield per acre, the same was not true of acres planted to cotton. In the last three years, cotton producers planted about 14 percent more cotton, on average, than they did in the mid 1950s.

Another indicator of the magnitude of changes is change in efficiency made possible through technological innovations. These innovations have generally taken the form of substituting capital for labor. One example of this type of innovation is the cotton picker. When originally introduced, the one-row picker replaced several workers in the cotton harvest operation. As the mechanical picker has been improved, it has become more efficient; the new multiple row pickers allow one person to harvest several times more cotton per day than was possible with the original single-row machines.

Innovations adopted by cotton producers have been driven by economics. These innovations can be divided into two general categories—biotechnology and other technology.

Biotechnology Changes Cotton Production

Biotechnology has only recently been introduced into cotton production on a commercial scale. This has generally taken the form of insect resistance and herbicide tolerance. The adoption of these technologies by producers has been extremely rapid. Several studies have examined why the adoption of this technology has been so rapid. Generally, producers adopted the technologies because they were effective and provided some economic incentive for adoption. Several studies have examined the question of the distribution of benefits from the adoption of such technology. Results of these studies generally found that producers who adopt the technology receive the largest portion of the benefits.

Cotton varieties containing genes that provide insect or herbicide resistance were first introduced commercially in 1996. In 1999, varieties containing these genes accounted for more than 50 percent of the U.S. cotton acreage. There was considerable variation in the level of adoption of these varieties among cotton-producing states. In the West, the level of adoption was relatively low because the target insect pest is not as great a threat there. The Mid-South and Southeast areas had a considerably higher level of adoption. For example, Louisiana cotton producers planted more than 70 percent of the acreage in 2002 to insect- and herbicide-resistant varieties. Much of this acreage was planted to "stacked gene" varieties, which means they included both insect- and herbicide-resistant traits.

How effective are modified varieties? The answer is in the comparison of insect damage before and after introduction of the insect-resistant varieties. From 1990 to 1995, cotton producers in Louisiana experienced an average loss of 4.11 percent attributable to the budworm/bollworm complex. From 1996 to 2001, this dropped to a 2.1 percent average loss. The 2.1 percent includes data from 1996 to 1998 where no distinction was made between conventional and Bt varieties. During the 1999-2001 period, Bt varieties averaged a 0.92 percent loss attributable to the budworm/bollworm complex while the conventional varieties experi-

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enced an average loss of 2.24 percent. These data indicate that adoption of the Bt varieties dramatically reduced the losses attributable to the major insect pest of cotton in Louisiana.

Although comparable data are not available for the herbicide-resistant varieties, annual enterprise budget projections provide one means of comparing the stacked gene varieties against conventional varieties. Budget projections for 2002 show that herbicide costs for conventional versus stacked gene cotton are about equal. However, this cost does not reflect the higher level of management required in using herbicide-resistant varieties, which include restrictions on when over-the-top herbicides can be applied. Insecticide costs, on the other hand, are quite different between the two kinds of varieties, with the stacked gene varieties costing about $15 per acre less. However, the additional technology fee associated with these varieties offsets this advantage. Further, the boll weevil eradication program combined with the widespread adoption of insect-resistant varieties has changed the insect pest complex for cotton. While damage from the budworm/bollworm complex and boll weevil has been mitigated, other pests have emerged, and insecticide applications are required to manage these populations.

Mechanical Pickers To Precision Agriculture

Technological innovations have had a significant impact on cotton production, ranging from mechanical pickers to precision agriculture. The impact of mechanical harvesters has been well documented. Subsequent improvements in harvest machines have continued to increased productivity of labor. Not only have the harvest machines become more efficient, but their efficiency has been enhanced by introduction of the module builder and more recently the boll buggy. These innovations have significantly improved harvesting efficiency and reduced costs. Further, the module builder made it feasible to transport cotton longer distances. This enhanced transport ability led to a reduction in the number of gins required. Having fewer but larger gins has changed the nature of the ginning industry not only in Louisiana, but across the Cotton Belt.

LSU AgCenter Photo Archive

This is a tractor-mounted cotton picker. The photo was taken in 1947 in Tensas Parish.

Several innovations in tillage equipment have enabled producers to do a better job in soil preparation and crop cultivation. Much of the focus in tillage equipment innovation is on minimum or no-till equipment. Improvements have encouraged adoption of reduced tillage production systems among cotton producers in Louisiana and elsewhere. These systems not only reduce costs for the producer, but most are environmentally friendly. Because these systems maintain a cover on the soil, erosion is reduced. Some studies have demonstrated a synergistic relationship between herbicide-resistant varieties and reduced tillage systems.

Currently, much emphasis is placed on developing technology in the area of precision agriculture. Innovations range from automatic guidance systems to using remotely sensed imagery to manage crop production. Of particular interest to Louisiana cotton producers is the technology necessary to capture critical management information on a field, interpret the data and implement timely management decisions. Preliminary work in Louisiana and elsewhere in this area has demonstrated the potential of this technology to significantly reduce insecticide costs.

Central to achieving these savings is the ability to adequately and accurately describe the spatial distribution of insects and other pests across individual cotton fields. With information on the distribution of the kinds and amounts of pests in the field, prescriptions can be developed to manage those pests. This is done by using variable rate technology (VRT) to apply chemicals or other inputs to designated areas in the field in the precise amounts needed. The technology also can be used to improve soil fertility, drainage and irrigation efficiency. The potential for cotton farmers to adopt this technology depends on the same factors cited earlier for the biotechnology innovations—profitability and effectiveness.

Most studies of precision farming have found it to be profitable. Most of this work has been done with various grain crops because of the availability of yield monitors for those crops. Yield monitors for cotton have only recently become available commercially. Recent research in the Southeast on precision agriculture in cotton indicates several potential benefits—improved production efficiency, reduced input use, increased yields and higher profits.

Widespread adoption of biotechnology and precision agriculture technologies holds tremendous promise of additional benefits. These benefits go beyond the environmental benefits of reduced pesticide use and extend to the potential for reducing soil loss and contributing to a more sustainable production agriculture. ■

Insecticide Resistance Monitoring Programs in Louisiana Cotton

Resistance monitoring provides a useful tool for detecting changes in the insecticide susceptibility of field populations of insect species from year to year. During the late 1980s and into the 1990s, resistance monitoring of the tobacco budworm provided data for establishing and modifying the tobacco budworm resistance management plan implemented by Arkansas, Louisiana and Mississippi. Resistance monitoring also helps validate whether field control failures are the result of a true decrease in insecticide susceptibility or whether other factors should be examined to determine the cause of unsatisfactory control.

Development of resistance in a key cotton pest to a particular chemical or class of chemicals can threaten the profitability of the industry. This is especially true when other integrated management strategies, including alternative chemicals for that pest, are limited.

In the Mid-South, two of the most devastating cotton pests are the bollworm and tobacco budworm. The pyrethroid insecticides provided the most economical control of these two pests during the 1980s and into the 1990s. In Louisiana, pyrethroid resistance monitoring was initiated in 1986 for the tobacco budworm and in 1988 for the bollworm. Additionally, these two pests were monitored for susceptibility to a non-pyrethroid insecticide, spinosad (Tracer), beginning in 1991 for the tobacco budworm and in 2000 for the bollworm. Spinosad represents a new class of chemicals called naturalytes.

Monitoring involves the collection of male moths with wire cone traps baited with an artificial sex pheromone lure. These traps were located in several parishes across the cotton production regions of the state. Adult male moths collected from these traps were placed in glass vials treated with one of the selected insecticide concentrations or in nontreated control vials. Cypermethrin was one of the earliest pyrethroids used for control of these two cotton pests in Louisiana. Spinosad is one of the most recently registered insecticides for control of these insect pests. Mortality of the moths in both the treated and control vials were determined after 24 hours of exposure. Information presented here is based on seasonal percentage survival of these two cotton insect pests.

Figure 1 shows the percentage survival of the pests in the last 15 years to cypermethrin. Bollworm survival remained relatively constant at a level below 10 percent from 1988 to 1997. During 1998, bollworm survival reached 18 percent and was followed by two years at 16 percent. In 2002, bollworm survival increased to 34 percent.

Tobacco budworm survival was more pronounced. From 1994 to 1996, survival appeared to be stabilizing at 39 percent for the tobacco budworm. However, in 1998 survival increased to 55 percent and has remained near 60 percent for the last four years. By 1999, the pyrethroids were removed from the cotton insect recommendations for control of the tobacco budworm due to the increased likelihood of field failures due to pyrethroid resistance.

Tobacco budworm and bollworm survival to spinosad is shown in Figure 2. Tobacco budworm survival in 2002 was extremely high, reaching 52 percent. In 2001, survival was only 11 percent, which was similar to survival observed during the early 1990s. Bollworm survival followed a similar pattern. In general, results were similar to those for tobacco budworm, although overall survival was much lower. The results with spinosad are highly variable and indicate the need to continue to monitor bollworm and tobacco budworm susceptibility to spinosad. At this time, spinosad has never been implicated in any field failures.

Resistance monitoring continues to be an important tool in monitoring the susceptibility of insect populations in the field to various insecticide classes. Monitoring allows entomologists to follow long-term trends in insect susceptibility. It also provides valuable information in determining the possible causes of insecticide field failures when they occur. ■

Stephen Micinski, Associate Professor, Red River Research Station, Bossier City, La.; Donald R. Cook, Research Associate, Department of Entomology, LSU AgCenter, Baton Rouge, La.; B. Rogers Leonard, Professor, and Ralph D. Bagwell, Associate Professor, Macon Ridge Research Station, Winnsboro, La.; Eugene "Gene" Burris, Northeast Research Station, St. Joseph, La.; and A.M. "Sandy" Stewart, Assistant Professor, Dean Lee Research Station, Alexandria, La.

Figure 1. Percent seasonal survival of bollworm and tobacco budworm exposed to cypermethrin.

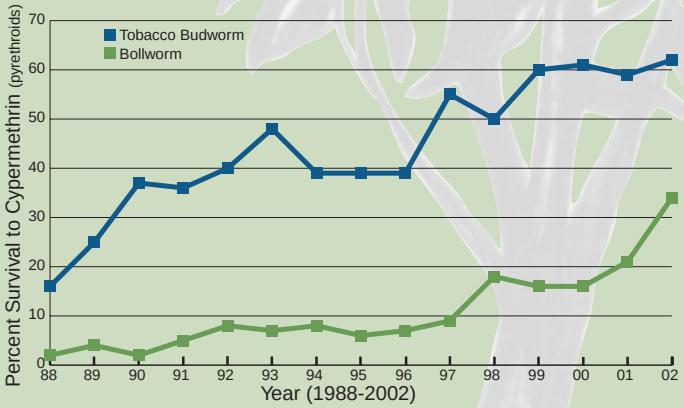
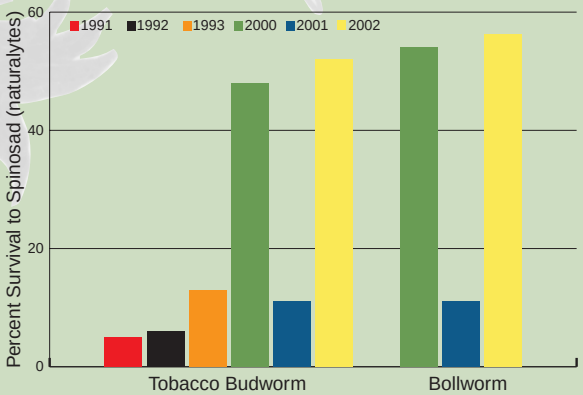


Figure 2. Percent seasonal survival of bollworm and tobacco budworm exposed to spinosad.



Stink Bug Damage Increases

Melissa M. Willrich and

The abundance of stink bugs, including southern green stink bug, brown stink bug (Figure 1) and green stink bug, has increased in Mid-South and Southeastern cotton-producing states in the last six years. Stink bugs have become more common cotton pests because of a number of changes in Louisiana's agricultural environment that have made crop and noncrop hosts available year-round. These include widespread adoption of conservation tillage, crop rotation and conservation and wetland reserve programs. In addition, eradication of the boll weevil and use of Bollgard cotton, which contains resistance to caterpillar pests, have both resulted in less use of broad-spectrum insecticides, which has turned pests once considered secondary, such as stink bugs, into significant insect problems. Mild winters also contribute to proliferation of stink bugs.

Melissa M. Willrich, Graduate Assistant, and B. Rogers Leonard, Professor, Department of Entomology, LSU AgCenter, Baton Rouge, La.

Stink bugs may be found in cotton fields from seedling emergence until harvest, but they generally prefer to feed on those parts of the plant that produce seed. Economic injury to cotton plants usually begins during boll (the fruit containing developing seed) formation. Young bolls, less than12 days after opening (anthesis), damaged by stink bugs have a high probability of dropping off (abscising) from the plant (Figure 2).

Older bolls, more than 12 days after opening, when fed upon by stink bugs, will remain on the plant. Direct injury to seed and lint can affect ultimate yield and quality until the bolls have been opened at least 20 days. Penetration of bolls by stink bugs causes discolored, yellowed lint (Figure 3).

Injured bolls may display feeding symptoms on the exocarp (exterior boll wall) and internally on the endocarp (interior boll wall), seed and lint. Indications of feeding on the exocarp may be best described as dark, circular indentations on the boll wall. These symptoms are difficult to identify and similar injury may be caused by tarnished plant bugs. Injury observed in bolls approximately 12 days after anthesis should be attributed to stink bugs because the tarnished plant bug, another cotton pest, does not have the ability to penetrate bolls of this age or older.

Photos by Melissa Willrich

Figure 1. The brown stink bug is one of the insects that has increased in numbers in the Mid-South and Southeastern cotton-producing states in the last six years.

Figure 2. Young bolls, less than 12 days after opening, damaged by stink bugs have a high probability of dropping off (abscising) from the plant.

Figure 3. Penetration of bolls by stink bugs causes discolored, yellowed lint.

in Louisiana Cotton

B. Rogers Leonard

Photos by Melissa Willrich

Figure 4. Dark feeding punctures or wart-like cellular growths are found on the internal carpel wall. This symptom can be visible on carpel walls within 72 hours of feeding.

Figure 5. Bolls that become "hard-locked" contribute little to yield because they are more difficult to harvest. Stink bug infestations can cause hard lock.

Dark feeding punctures or wart-like cellular growths are found on the internal carpel wall (Figure 4). This symptom can be visible on carpel walls within 72 hours of feeding. One or all carpels within a boll may be injured, and it is not uncommon to observe internal injury without signs of external injury.

In addition to internal warts and external punctures, stink bug damage to cotton bolls may be exhibited in other ways. At harvest, fields that have sustained stink bug infestations have been associated with "hard locked" bolls (Figure 5). Hard lock is a physiological condition that can be caused by pathogens, insects or adverse weather. Hard lock symptoms include bolls that partially open and lint that fails to fluff. These bolls usually contribute little to final yield because they are difficult to harvest with mechanical pickers.

Finally, germination rates for seed may be reduced in bolls previously punctured by stink bugs.

Producers and crop managers should become familiar with cotton boll injury symptoms caused by stink bugs. The Louisiana Cooperative Extension Service recommends insecticide treatments be initiated against stink bugs at one bug per 6 row-feet or when 20 percent of quarter-sized bolls (12-16 days after anthesis) exhibit internal injury symptoms on lint, seed or endocarp. Sampling bolls is the most reliable predictor of a stink bug infestation in cotton because of this pest's extreme mobility and the cumbersome task of estimating insect densities in late-season cotton. ■

Learn more about cotton

The following publications are available at your local LSU AgCenter parish extension office or by going to **www.lsuagcenter.com** and ordering on-line.

Aphids on Cotton, free
Armyworms in Cotton, free
Conservation Tillage Systems for Energy Reduction - Preplant Weed Control in Cotton, $0.50
Controlling Weeds in Cotton, 32 pages, $1 (or on-line)
Cotton Fertilization, free
Cotton Insect Control, $0.75 (or on-line)
Cotton Tillage Systems for Energy Reduction - Cotton Stand Establishment, free
Cotton Tillage Systems for Energy Reduction - Tillage Equipment, free
Cutworms in Cotton, free
Managing Glyphosate-Tolerant Cotton, $2 (or on-line)
Producing Early-Maturing Cotton for Management of Insecticide Resistance, free
Tarnished Plant Bugs in Cotton (on-line only)

Tarnished Plant Bug Problems and Weed Host Control

Richard Costello, Eugene Burris, Gordon Snodgrass and William Scott

The tarnished plant bug has always caused problems in cotton, but in recent years the problems have escalated. Data from 1990 to 1995, before the advent of transgenic Bt cotton, put the cost per acre to control the tarnished plant bug at $3.19 compared to $12.02 from 1996 to 2002, after Bt cotton was introduced. The total loss in cotton because of the tarnished plant bug was 0.41 percent from 1990 to 1995 compared to 1.07 percent from 1996 to 2002.

Successful boll weevil eradication and the adoption of Bt cotton, while reducing the need for insecticide applications to control the boll weevil and tobacco budworm, provided an opportunity for tarnished plant bugs to flourish. Resistance to insecticides such as the pyrethroids, organophosphates and carbamates has contributed to control problems. Resistance to these insecticides increases during the cotton-growing season.

Not only do these factors contribute to higher numbers of tarnished plant bugs, but the broad range of crops and wild hosts that this pest can use for survival is huge. The tarnished plant bug is reported to have a host range of about 390 species of plants, giving it the broadest feeding niche of any of the arthropod pests. In the Delta, research has indicated 169 hosts representing 36 families of plants. These hosts often live next to cotton. The seasonal flowering patterns of these species give the plant bug a consistent habitat from late winter though spring.

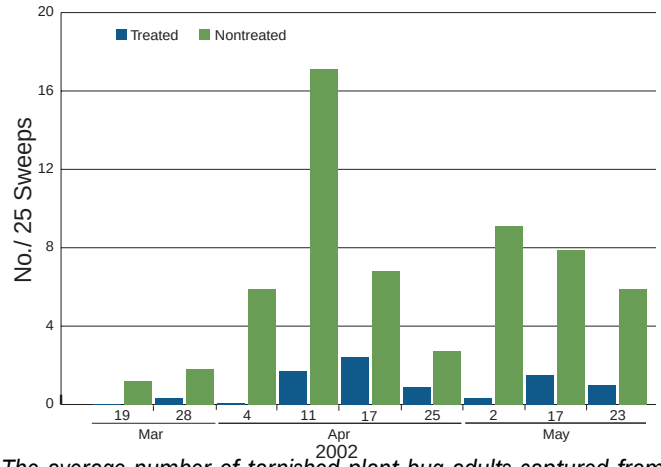
U.S. Department of Agriculture researchers have shown a 46 percent reduction in tarnished plant bugs in cotton fields in areas where wild hosts have been controlled. Research also has indicated a significant economic return on investment, of up to $10, in areas where wild hosts were controlled with herbicide applications.

LSU AgCenter researchers conducted an experiment in Tensas Parish to evaluate the potential of reducing tarnished plant bugs by managing weed hosts in field border areas adjacent to cotton fields before planting cotton. Each experimental area encompassed about 620 acres in 2000, 1,200 acres in 2001, and 1,700 acres in 2002. One test area in each year was treated with herbicide to control broadleaf weeds in field borders and ditches close to cotton fields.

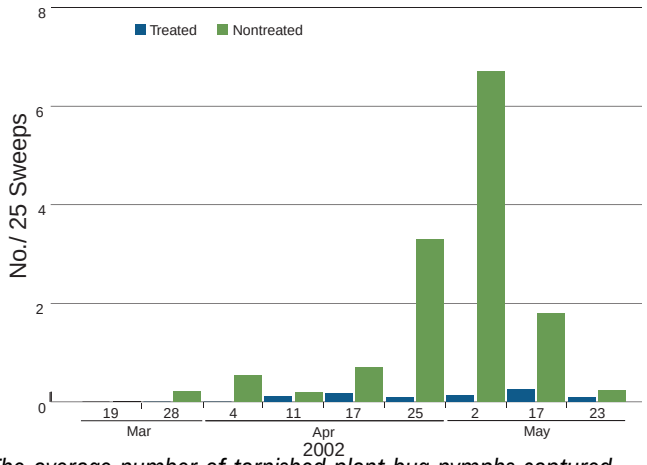
Herbicide applications were initiated February 23, 2000, and March 19, 2001. Strike 3, a combination of 2,4-D, mecoprop and dicamba, was applied at 2 quarts per acre to kill broadleaf weeds. The weed density and species data were taken before the herbicide treatments and three to four weeks post treatment. Tarnished plant bug adults and nymphs were collected within each area using a standard 15-inch sweep net. Field border sampling was initiated in February before herbicide treatments, and sweep net data from the field borders were collected weekly continuing through the first week of June. Up to 500 sweeps were made in randomly selected cotton fields beginning in mid June through the end of July.

Throughout this study, tarnished plant bug numbers were considerably lower in the areas in which the broadleaf hosts had been removed. For the most part, populations followed a similar cyclic pattern each year. In each year there were definite peaks, although the peaks occurred on different dates. In general, tarnished plant bug adults began to increase in early to mid April and nymphs in mid to late April.

In 2000, differences in the number of tarnished plant bugs caught in field borders were higher from early to mid April throughout May. Adult numbers in the treated area did not



The average number of tarnished plant bug adults captured from nontreated field borders varied widely from year to year. But the numbers captured from treated borders stayed about the same in 2000, 2001 and 2002.



The average number of tarnished plant bug nymphs captured from nontreated field borders also varied widely from year to year. But the numbers captured from treated borders stayed relatively constant in 2000, 2001 and 2002.

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exceed two insects in 25 sweeps, and nymph numbers remained below one in 25 sweeps. In the nontreated area, adult numbers began to increase in early April and peaked on May 23 at 16 in 25 sweeps. In contrast, nymph numbers in the nontreated area peaked in mid April and declined through May.

Differences in adult tarnished plant bugs between the treated and nontreated areas were evident by April 9 in 2001. Tarnished plant bug nymph populations did not begin to build until the end of April, and differences between the treated and nontreated areas were not distinguishable until May 3. Tarnished plant bug numbers in the treated area were no higher than 1.5 insects in 25 sweeps at any rating date. In the nontreated area, numbers peaked at 10 and 11 in 25 sweeps for adults and nymphs, respectively.

In the treated area in 2002, adult and nymph numbers were below three in 25 sweeps. Adults captured in 25 sweeps peaked at 17 on April 11 in the nontreated area. In general, nymph numbers in 2002 were lower than in the other years. The highest number of nymphs, seven in 25 sweeps, was caught April 2.

These data indicate that destruction of wild hosts from field borders has the potential to reduce tarnished plant bug populations; however, migration of these insects from other areas such as conservation and wetland reserve areas and corn fields, along with the inability to eliminate all wild hosts, also contributed to plant bug infestations. If used as part of an overall management strategy, wild host destruction will provide another tool to reduce insect pressure and provide economic value to the producer. ■

Photo by Donald Cook

The tarnished plant bug has always caused problems in cotton, but in recent years the problems have escalated.

Effect of Soil-applied Insecticides on Tarnished Plant Bugs

Tarnished plant bugs, which have historically been a mid-season pest of cotton, are now becoming a sporadic pest during seedling development. This is happening as agricultural conditions are changing, making it possible for more tarnished plant bugs to survive. These changes include more plant hosts because of more acres going into conservation reserve programs and an increase in conservation tillage. Another contributing factor is less use of insecticides because of boll weevil eradication and the increasing use of insect-resistant varieties.

Injury symptoms resulting from tarnished plant bug feeding during seedling development are similar to some symptoms resulting from thrips feeding. At-planting insecticides used to control thrips include seed treatments or application (granules and liquids) in the seed furrow at the time of planting.

Several at-planting insecticides recommended for thrips control were evaluated against tarnished plant bugs in 2001. The insecticide treatments included Cruiser 5FS, Gaucho 480FS, Orthene 80S and Temik 15G. Tarnished plant bug adults were caged on cotton seedlings from seven days after emergence until 26 days after emergence. Plants were infested at two- to three-day intervals, and mortality was determined 48 hours after each infestation.

Orthene and Gaucho resulted in 2.5 percent and 18.4 percent mortality of tarnished plant bug adults at seven days after emergence, respectively, and mortality declined to near 0 by 26 days after emergence. Cruiser produced 57.4 percent tarnished plant bug mortality seven days after emergence, and mortality declined to 13.4 percent by 26 days after emergence. Temik resulted in 76.6 percent tarnished plant bug mortality at seven days after emergence, with mortality declining to 29.9 percent by 26 days after emergence. Based on these results, Orthene and Gaucho provided little control of tarnished plant bugs at any evaluation. Cruiser provided low to moderate levels of tarnished plant bug control, and Temik provided moderate levels of control.

Temik and Cruiser offer some protection against tarnished plant bugs for about three weeks, but supplemental foliar insecticide applications may be necessary to control tarnished plant bugs during the seedling and floral bud development stages to minimize delays in crop maturity and improve early square retention, regardless of the at-planting insecticide used. ■

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Managing Fusarium Wilt/Root-knot Nematode Complex

Patrick D. Colyer and Philip R. Vernon

Photos by Patrick Colyer

Figure 1. This cotton plant shows symptoms of Fusarium wilt—foliar chlorosis (yellowing) and necrosis (brown, dead tissue).

Fusarium wilt and the root-knot nematode are both serious diseases of cotton that cause substantial losses across the Cotton Belt. Both pathogens are common in most cotton-producing areas and often inhabit the same fields. These two pathogens often infect cotton simultaneously, forming a complex that increases the incidence and severity of Fusarium wilt. The Fusarium wilt/root-knot nematode complex is one of the most widely recognized and economically important disease complexes in the world.

The symptoms caused by the complex are the same as those produced by the pathogens individually. Although cotton seedlings infected by the Fusarium wilt pathogen may be killed, most symptoms appear near mid-season. The symptoms of Fusarium wilt on older plants include wilting and chlorosis (yellowing) followed by necrosis (brown, dead tissue) of the foliage (Figure 1) and overall stunting of the plant. The vascular system of infected plants is discolored and readily visible when the stem is cut (Figure 2). Often, infected plants mature earlier and have fewer bolls and reduced seedcotton yield. Severe infection can kill plants. Research has demonstrated that plants may be infected with Fusarium wilt, but the only symptom observed is vascular discoloration.

> This complex is one of the most economically important in the world.

Above-ground symptoms of the root-knot nematode are not as obvious, but include stunting and yellowing or reddening of the foliage. Infected plants appear to be suffering from nutritional deficiency. The most distinctive symptom of the root-knot nematode infection is the formation of galls on the roots (Figure 3).

Patrick D. Colyer, Professor, and Philip R. Vernon, Research Associate, Red River Research Station, Bossier City, La.

Figure 2. Fusarium wilt can cause stem discoloration (right).

Difficult to Manage

Management of both diseases is difficult. Crop rotation, host resistance and the application of nematicides are considered the best approaches to managing these diseases individually or together. Crop rotation is often recommended to reduce the incidence of Fusarium wilt, but the ability of the fungus to survive in the soil for long

Photo by Patrick Colyer

Figure 3. The most distinctive symptom of the root-knot nematode infection is the formation of galls on the roots.

periods in the absence of cotton limits the effectiveness of rotations. Furthermore, long rotations are not economically feasible for most cotton growers. Because of the ability of the nematode to increase the incidence of wilt, rotations designed to reduce nematode populations may be successful in reducing the incidence of wilt.

Research has demonstrated that root-knot nematode-resistant soybeans, grain sorghum and peanuts are not hosts for the root-knot nematode and are good rotation crops for managing soil populations of the root-knot nematode. Most grasses and legumes used as winter cover are also susceptible to root knot nematode; however, since they are grown during periods of low soil temperatures, they are not conducive to nematode growth and infection. Because many weeds are hosts, fallowing is not effective unless weeds are controlled.

Tillage Impact Unclear

The impact of tillage on the disease complex is not clear. Tillage is thought to have little effect on the wilt pathogen because of its ability to survive in the soil for extended periods. Tillage may disturb the root-knot nematode and expose it to mortality, but it may also spread the nematode inoculum. A study was conducted on a field with a history of the disease complex in Bradley, Ark., to compare reduced tillage with conventional tillage following a winter fallow or the winter cover crops, hairy vetch and common vetch, on the incidence and severity of the complex. Incidence of wilt was not affected by tillage or winter cover. The severity of root-knot nematode was not affected by winter cover but was higher with reduced tillage. Although wilt was not increased in this study, the increase in the severity of root galling by the nematode associated with reduced tillage could lead to an increase in Fusarium wilt.

Nematicides

Soil fumigation, which may affect both fungal and nematode survival in the soil depending on the fumigant used, has successfully reduced the incidence of wilt. Fumigation, however, is expensive and may not be economical for most cotton production areas. The ability of nonfumigant nematicides, like aldicarb, that are applied in the furrow at planting to reduce nematode populations and root galling, has been demonstrated widely.

In a study at the Red River Research Station, the effect of aldicarb (Temik 15G) on severity of the disease complex in eight cotton cultivars with different levels of resistance to the disease complex was tested in 1994 and 1995. Disease severity for the root-knot nematode was determined by rating galling on the roots and for Fusarium wilt by rating stem discoloration. Across all cultivars, the application of aldicarb reduced root galling and stem discoloration. These differences resulted in increased seed cotton yield and lint percentage.

Host Resistance

The use of host resistance to manage the complex has been moderately successful. Although there are no wilt-immune cultivars, several commercial cultivars have moderate to high levels of wilt resistance. They should be planted in fields with a history of Fusarium wilt. Because the root-knot nematode increases the incidence of wilt, and infection by the nematode can increase the susceptibility of cultivars that are normally resistant, planting cotton cultivars with resistance to the nematode will help reduce the incidence of wilt. Regardless, wilt-resistant cultivars have a lower incidence of wilt than susceptible cultivars in the presence of the nematode. Unfortunately, only moderate resistance to the root-knot nematode is available in commercial cultivars.

Cultivars are evaluated for resistance to the disease complex annually at the Red River Research Station in a field plot with uniformly high levels of the root-knot nematode and the wilt pathogen. The results demonstrate the low level of root-knot nematode resistance available in cotton cultivars. Only three cultivars with acceptable levels of resistance to the complex have been identified: Stoneville LA 887, Paymaster 1560 and Acala Nemx. Stoneville LA 887 and Paymaster 1560 were developed in Louisiana and are well adapted to our growing conditions, but Acala Nemx was developed in California and is not adapted to the Mid-South. Based on results of these annual evaluations, it has also been determined that the transgenic relatives of Stoneville LA 887 and Paymaster 1560 cultivars do not react like their nontransgenic parents and are more susceptible to the disease complex. Apparently, the resistance to the complex was reduced during the development of these transgenic lines.

In summary, management of the Fusarium wilt/root-knot nematode complex remains difficult. Resistance would be the simplest management strategy, but, until cultivars with higher levels of resistance are available, tillage, crop rotation and the application of nematicides are alternatives. These methods are more effective at reducing the infection by the root-knot nematode than controlling the wilt pathogen. An integrated approach that includes all or most of these management options is the best strategy. ■

Fungus Helps Control Louisiana Cotton Aphids

Robert H. Jones, B. Rogers Leonard and Ralph D. Bagwell

The cotton aphid is a common secondary pest of cotton in Louisiana. Cotton aphids can infest cotton plants from seedling emergence until harvest and injure plants by continuously feeding on them. Injury symptoms may include a downward cupping of infested leaves, inter-veinal discoloration, compressed main stem nodes and reduced plant height. Severe cotton aphid infestations can cause sufficient plant stress to result in square and boll shed and delay crop maturity. In addition, cotton aphids secrete a liquid known as "honeydew." The accumulation of "honeydew" on exposed cotton lint causes the lint to become sticky, reduces harvest efficiency and creates problems at textile mills.

Numerous agronomic and pest management practices used in cotton production can affect cotton aphid populations. Cotton aphid densities in Louisiana fields have been higher in no-till production systems. High numbers also commonly occur as resurgent populations following applications of selected insecticides for other insect pests. Natural enemies of cotton aphids are often reduced after these applications, causing cotton aphids to increase to damaging levels. Cotton aphid predators include lady beetles, big-eyed bugs, minute pirate bugs, lacewings and parasitic wasps.

During the past 10 years, the most valuable and effective non-pesticidal control of cotton aphids in Louisiana has been provided by a naturally occurring fungus, *Neozygites fresenii* Batko. This fungus, which spreads by airborne spores, kills cotton aphids within three days after infection. Entire field populations are reduced from peak densities to nearly non-existent levels within five to 10 days after the initial infection by *N. fresenii* (Figure 1). These epizootics (insect epidemics) normally coincide

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Photo by Roger Leonard

Cotton aphids on leaves from a cotton field with high incidence of N. fresenii *infection.*

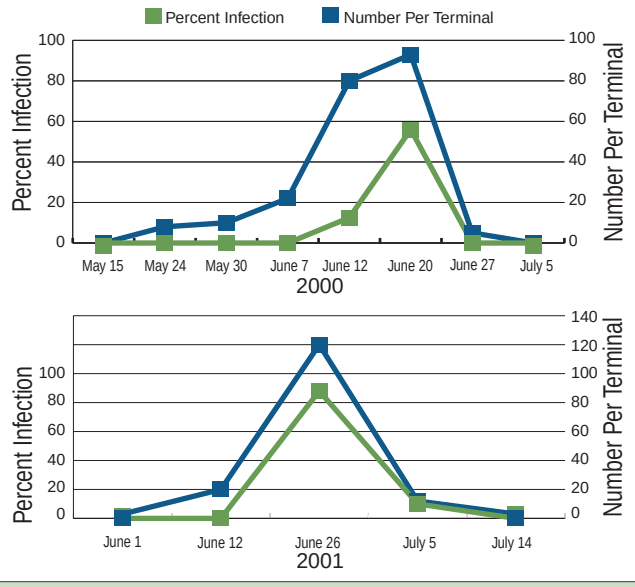
Photos by Roger Leonard

"Honey-dew" stain on a cotton leaf (left) caused by cotton aphids.

with peak cotton aphid populations during mid-June to early July. In many instances, producers can delay insecticide applications for a few days during this time, allow the disease to develop and not be required to provide any supplemental control. Usually, cotton aphid populations will not resurge during the remainder of the season after an epizootic is established, thus making *N. fresenii* more effective than insecticides.

N. fresenii has been a cost-effective and environmentally friendly pest management tool for Louisiana cotton producers. LSU AgCenter entomologists have been cooperating with scientists from the University of Arkansas to monitor the temporal and spatial occurrence of infected cotton aphids. Information on the status of the disease is distributed throughout the season, giving agricultural consultants, county agents and producers additional information to select the appropriate integrated pest management (IPM) strategy. ■

Figure 1. Cotton aphid density per cotton plant terminal and percent Neozygites fresenii infected aphids at the Macon Ridge Research Station, Winnsboro, La.



Poultry Litter *Increases Cotton Yields*

Eddie P. Millhollon, James L. Rabb, Jose F. Liscano and Russell A. Anderson

Much of the land where cotton is grown in Louisiana has been used for cotton production for decades. This has left the soil deficient in both nutrients and organic matter. Some of these deficiencies could potentially be corrected by supplementing these soils with organic waste from Louisiana's poultry industry. This is the state's largest animal industry generating tons of organic waste that must be disposed of in an environmentally friendly manner.

Litter produced by Louisiana's poultry industry includes manure and bedding material. The nutrient content of the litter varies depending upon the type of bedding material and feed used. Generally, though, each ton of poultry litter contains about 50 to 60 pounds of nitrogen (N), 50 pounds of phosphorus (P) and 40 pounds of potassium (K). The amount of nitrogen from litter that will become available for cotton growth depends upon several factors including soil pH, temperature and moisture. However, it is generally assumed that about 60 percent (30 to 36 pounds per ton) will become available. Therefore, at least two tons of litter are required to supply 60 pounds of nitrogen.

To determine the potential benefits from the use of poultry litter for cotton production in Louisiana, a study was begun in 1998 at the LSU AgCenter's Red River Research Station near Bossier City, La. The study compared applications of poultry litter and inorganic fertilizer in conventional and conservation tillage systems. For purposes of this study, conventional tillage involved incorporating shredded cotton stalks, followed by deep tillage in the fall. Rows were bedded approximately three weeks before planting. The conservation tillage system involved delayed seedbed preparation and deep tillage following the shredding of cotton stalks in the fall, but crop residue and volunteer vegetation remained on the surface until the rows were bedded about three weeks before planting. The goal was to encourage native winter cover and maintain at least 30 percent ground cover from harvest until three weeks before planting.

The study was conducted on a Caplis very fine sandy loam soil. The site consisted of approximately eight acres that were precision sloped at 2 inches per 100 feet with laser land-grading equipment. Twelve-row plots (0.25 acre) were replicated four times. Treatments consisted of conventionally tilled and conservation plots that received either 60 pounds of nitrogen or two tons of poultry litter per acre, and a conservation plot that received four tons of poultry litter per acre.

Poultry litter was applied in the spring with a spreader truck that was calibrated to apply a rate of two tons per acre. For this study, the two-ton rates were applied with a single pass and the four-ton rate with two passes. The truck traveled through the middle of each plot, and litter was spread with hydraulically driven disks mounted at the rear of the truck. The litter was spread approximately 35 feet (10 rows).

After litter application, all plots were disked to incorporate winter vegetation and litter and bedded to form 40-inch rows. Analysis of the poultry

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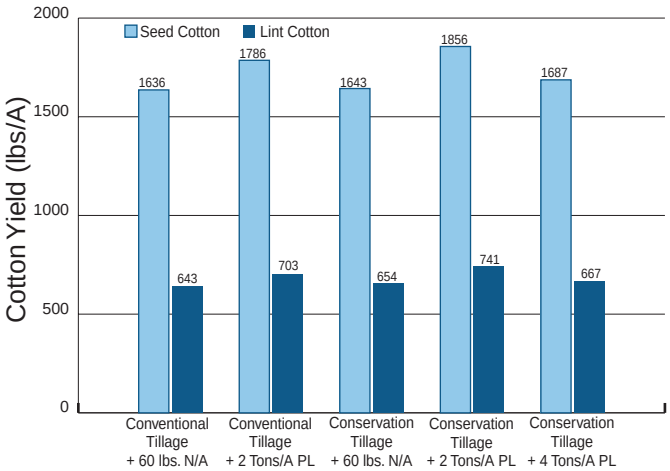
Figure 1. Two-year average (1999-2000) seed and lint cotton yield following the application of poultry litter (PL) or commercial fertilizer nitrogen in conservation and conventional tillage systems.



litter indicated that the three-year average was 65 pounds per ton of nitrogen, 33 pounds per ton of phosphorus and 59 pounds per ton of potassium.

Cultural practices for cotton production recommended by the LSU AgCenter were followed. Plots that were fertilized received nitrogen (32 percent solution at 60 pounds of nitrogen per acre) placed in the top of the row with a knife applicator. Rows in all plots were shaped with a row conditioner to provide a seedbed uniformly raised to about 4 inches. Each year, a cotton variety recommended by the LSU AgCenter was planted at the rate of 10 pounds of seed per acre. The cotton varieties planted contained the Bt and Roundup Ready genes that provided resistance to the cotton bollworm and tobacco budworm complex and to glyphosate herbicide. A pre-emerge herbicide, a seed-protecting fungicide and insecticide were applied at planting.

Poultry Litter Boosts Yield

Because cotton yield in 1998 was significantly reduced by a record drought, yield data from that year were not included in the summary presented in Figure 1. Comparing the various treatments, two tons of poultry litter per acre with conservation tillage produced the highest seed cotton and lint yield, followed by this rate of poultry litter in a conventional tillage system. Conventional tillage and 60 pounds of nitrogen per acre, considered a standard practice for cotton production, resulted in the lowest seed cotton and lint yield. All plots that received poultry litter as a soil supplement produced higher cotton yields than plots that received inorganic nitrogen fertilizer. Results indicate that two tons of poultry litter per acre appear to be the optimum rate because application of four tons of poultry litter actually decreased yield.

Table 1. Soil chemical properties at 0 to 6 inches after three years of applying poultry litter or commercial fertilizer nitrogen in conservation and conventional tillage systems. (OM = organic matter)

Treatment	P	Na	K	Ca	Mg	pH	OM
			ppm				%
Conventional Tillage + 60 lbs. N/A	149	26	133	1037	309	7.60	1.05
Conventional Tillage + 2 Tons/A PL	195	25	154	770	245	7.40	1.05
Conservation Tillage + 60 lbs. N/A	136	24	113	843	264	7.58	0.89
Conservation Tillage + 2 Tons/A PL	203	29	164	1110	286	7.60	1.19
Conservation Tillage + 4 Tons/A PL	249	28	211	819	266	7.25	1.08

Photo by Mark Claesgens

A cotton field near Wisner, La.

Litter Increases Soil Fertility

Soil chemical properties at 0 to 6 inches resulting from the different treatments at the end of three-year study are presented in Table 1. Increase in soil phosphorous and potassium content was proportionate to the rate of poultry litter applied and higher in these plots than in plots that received commercial fertilizer. This is understandable, given the levels of phosphorous and potassium in poultry litter and the fact that only nitrogen was applied to the other plots. Organic matter at 0 to 6 inches was highest in conservation tillage plots that received two tons of poultry litter per acre, followed by conservation tillage plots that received four tons per acre. Since tillage usually accelerates the breakdown of organic matter, one would expect organic matter to be lowest in plots that did not receive poultry litter and were conventionally tilled; it was somewhat surprising to find that in plots that received 60 pounds of nitrogen per acre, conservation tillage plots were lower in organic matter than conventional tillage plots.

This study demonstrates that poultry litter can be effectively used as a source of nutrients for cotton production in Louisiana with the added benefits of improvements in soil chemistry and organic matter. It also demonstrates the benefits of conservation tillage, particularly when poultry litter is used as a soil amendment. ■

COTTON DEFOLIATION

The Science of the Art

Alexander M. "Sandy" Stewart, Donnie K. Miller and Joel C. Faircloth

Cotton defoliation, a critical step in cotton production, is the process of removing leaves and preparing the crop for mechanical harvest. Leaf removal facilitates harvest and allows for more efficient and faster picker operation, quicker drying of seedcotton, straightening of lodged plants, retardation of boll rot and faster opening of green bolls. In many cases, chemicals that hasten the opening of green bolls and inhibit juvenile regrowth are included with a defoliant.

Cotton defoliation research has focused on the efficacy of labeled compounds. Environmental and crop conditions play a vital role. Most of these compounds are temperature sensitive, and the closer the plant is to full maturity, the more likely it is to defoliate well. Given the tremendous impact of these variables on defoliation, results from research trials often vary among locations and from year to year within a given location. Therefore, cotton defoliation has sometimes been referred to as more art than science, and only through a large amount of data can clear trends emerge.

Proper timing of application for defoliants is critical. Generally, the more mature and open the crop is, the more efficacious the defoliant. Premature defoliation can result in higher grades, but it also can result in yield loss. Delaying defoliation too long, however, can result in losses in yield and quality caused by weathering and expose growers to the risks of harvesting later in the season when tropical storms and wet conditions are more likely.

Trials in Louisiana and other states have investigated two timing methods. One method is timing defoliation by the percentage of open bolls of the crop. Most recommendations call for defoliation when 60 percent to 70 percent of the bolls are open. Another method is called nodes above cracked boll (NACB). Counting the number of mainstem nodes between the uppermost first-position cracked and the last harvestable boll on the plant determines NACB. Most recommendations call for defoliants to be applied at four NACB.

Photo by Mark Claesgens

Sandy Stewart, Assistant Professor at the Dean Lee Research Station, addresses a group gathered for a field day at the Northeast Research Station, St. Joseph, La.

In 2000, trials were conducted at the Northeast Research Station in St. Joseph and the Dean Lee Research Station in Alexandria. At St. Joseph, the highest yield was obtained at 42 percent open and 3.6 nodes above cracked boll; the highest yield at Alexandria was found at 75 percent open and 1.2 nodes above cracked boll. The range in the findings strongly suggests that the boll distribution on the plant must be considered before applying any recommended timing rule. No recommendation is likely to fit every situation. Researchers are investigating the relationship between the fruit distribution and the timing of harvest aids.

In a three-year, replicated study conducted in North Carolina, defoliation timing was investigated in two varieties of varying yield and quality characteristics. The study demonstrated the overall importance of defoliation timing, especially in varieties that produce relatively high micronaire values.

In a similar North Carolina study, defoliation timing was examined in cotton containing a mid- to late-season fruiting gap (late July to late August) resulting from insect pressure, fertility problems or any environmental stress. The results demonstrated that if no fruiting gap exists, cotton can be defoliated as early as 50 percent open without realizing significant yield loss. If a fruiting gap exists, however, growers should delay defoliation until approximately 75 percent of the bolls are open to allow adequate time for plants to compensate for lost fruit. In studies from other states, early season fruiting gaps (mid-July and earlier) have not been found to alter defoliation timing.

Both aforementioned studies identified a trend of increasing micronaire and yield as the percentage of open bolls increased. Additionally, the node above cracked boll technique was examined in these studies for timing defoliation and was found to be as effective as the percent open technique. This is important for growers, because

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recording the nodes above cracked boll in a field takes considerably less time than recording the percentage of open bolls.

Another area of defoliation research focuses on its economic return. It is often less expensive for producers either not to defoliate, achieve less than 100 percent defoliation or apply a desiccant to dry, but not actually defoliate, the leaves.

A large experiment was initiated at the Dean Lee Research Station to investigate the effects of three levels of defoliation on cotton quality. The three levels tested were clean 100 percent defoliation, 20 percent desiccation of green leaves and 20 percent green juvenile growth on the plant at the time of harvest. The experiment was replicated three times, and harvested cotton was stored in modules and ginned commercially to mimic commercial production as closely as possible. Results indicate that the final loan value of the cotton was highest where 100 percent defoliation was achieved. The source of discounts for the less than 100 percent defoliation treatments was primarily due to the relative yellowness of the bale samples as classed by the U.S. Department of Agriculture's High Volume Instrumentation (HVI) system. These data suggest that there is an economic value to defoliation, but further research is ongoing to determine the optimum level of defoliation to make defoliant recommendations as cost effective as possible for cotton producers.

In an effort to better understand cotton defoliation and make recommendations for producers, scientists in the LSU AgCenter continue to investigate these and other areas of cotton defoliation. Future projects will focus on evaluating new products, defoliation timing, application technology and economic returns to defoliation. ■

Acknowledgment

Donna Lee, Research Associate, Northeast Research Station; and Derek Scroggs and Brad Guillory, Research Associates, Dean Lee Research Station. The research was partially supported by the Cotton Incorporated State Support Committee.

Tillage and Cover Crop Effects on Herbicide Degradation

Management systems that include reduced tillage and cover crops are gaining popularity. These practices typically increase plant residues at the soil surface and organic matter in the surface soil. In turn, microbial activity is increased, and the soil develops a greater capacity to adsorb and retain many types of farm chemicals, including herbicides. Accordingly, tillage and cover crops variously affect the degradation of herbicides and their movement with surface water runoff and internal drainage.

Tillage

Herbicide degradation in soil is controlled by the interaction of several factors. These include non-biological properties (such as texture, organic matter and pH) and conditions (moisture and temperature) and biological conditions (numbers, types and activities of microorganisms). The main non-biological effect of tillage on herbicide degradation is probably increased herbicide adsorption onto soil solids because of increased soil organic matter with reduced tillage. This has been shown for several different cotton herbicides including Bladex (active ingredient, cyanazine), Cotoran (fluometuron), Prowl (pendimethalin) and Zorial (norflurazon), among others.

In some cases, increased adsorption of the herbicide in reduced tillage soils has led to its slower degradation and longer persistence, despite typically higher microbial populations and activities. But when the effect of adsorption on reducing the concentration of herbicide susceptible to microbial degradation is factored out, it appears that degradation would actually be faster in the reduced tillage soils. These calculations suggest that reduced tillage usually increases the rate of herbicide degradation. But from the practical standpoint of how much herbicide actually remains over time, there is no clear, general conclusion on how tillage affects herbicide degradation rates.

Cover Crops

As with reduced tillage, planted cover crops increase soil organic matter and microbial numbers and activities. Comparison of herbicide adsorption in conventionally tilled soil with and without cover crops has shown that buildup of soil organic matter because of the cover crop increases adsorption. But the differences in herbicide adsorption in reduced tillage soil because of the cover crop tend to be smaller since levels of organic matter are higher.

Given the ambiguous results for effect of tillage on herbicide degradation, it is not surprising that there is no clear trend for effect of cover crop. This is particularly true for reduced tillage soil with cover crops. In some cases, increased herbicide adsorption caused by increased soil organic matter has led to slower degradation in soil planted with cover crops than soil without a cover crop. Whether this occurs may depend on the type of cover crop and the biological and chemical properties of its residue. For example, while there was no difference in the degradation rate of Prowl in no-till Gigger silt loam soil with volunteer native annuals or a wheat cover crop, degradation of Prowl was noticeably slower with a hairy vetch cover crop.

Besides effect of cover crop on herbicide degradation in soil, interception of spray-applied herbicide by crop and cover crop residue in reduced tillage systems may affect herbicide degradation and weed control. For example, Cotoran is relatively easily washed off cover crop residue compared to Prowl. Consequently, interception of Cotoran by a dense layer of vetch residue may have a negligible effect on herbicidal efficacy. On the other hand, since Prowl tends to be retained by residue, little Prowl that is intercepted by plant residue may ever be transferred to the soil by rainfall. Instead, it is degraded by biological and chemical processes within the residue. ■

Lewis Gaston, Assistant Professor, Department of Agronomy, LSU AgCenter, Baton Rouge, La.

Irrigating Cotton *on Alluvial Soils in Louisiana*

Steve Hague, Alphonse Coco and Donald J. Boquet

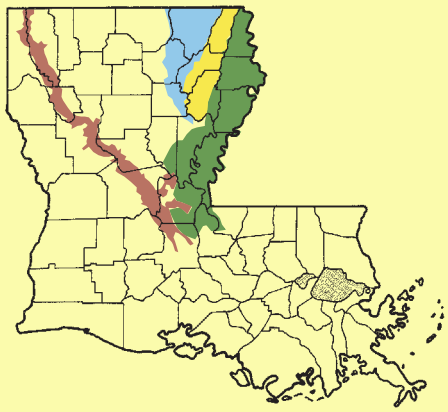
Photo by Robert L. Hutchinson

Overhead irrigation rigs are used but to a lesser extent than furrow irrigation.

Profitable cotton yields can be produced on Louisiana's alluvial soils when limiting factors are overcome. These include insect, nematode and weed pests and water. Too much or too little water within the soil profile retards cotton root development and nutrient uptake efficiency. Irrigation, properly applied, can increase yields, but improper management of irrigation can limit yields. Although 40 percent of Louisiana cotton is irrigated, the optimal criteria for when to initiate, apply and terminate irrigation are lacking for Louisiana's unsettled weather patterns.

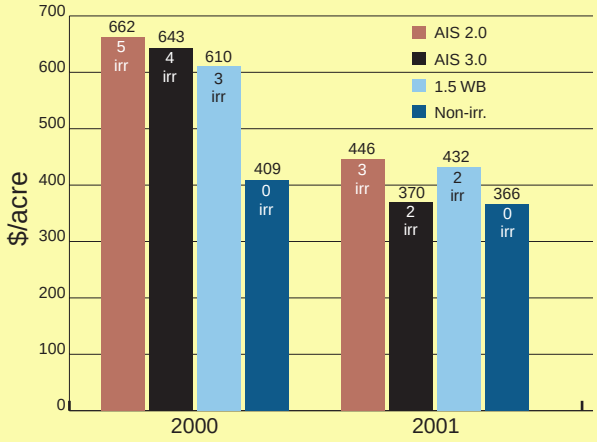
The most important reason farmers irrigate cotton on Louisiana's alluvial soils is to avoid catastrophic yield losses from severe drought. This is crucial considering the costs of equipment, labor, seed technology, fertilizer and pest control in the early part of the growing season. The most effective cotton irrigation schemes probably will take several years to provide a return on investment. Economic benefits from irrigation systems may be increased if producers rotate cotton with other crops such as soybean, corn or rice, which have a higher water-use demand. If producers choose to irrigate cotton on alluvial soils, timing is critical.

LSU AgCenter research focuses on low-input programs that offer the best opportunity for producers to realize a return on investment. Furrow irrigation tests were conducted on both Sharkey clay and Commerce silt loam on large commercial fields owned by the Panola Corp. and on Sharkey clay at the Northeast Research Station near St. Joseph, La. These tests



Most of the cotton grown in Louisiana is grown in these colored areas. In addition, some cotton is grown just southeast of where the green and brown meet. The green area represents alluvial soils, which are optimal for cotton growth. The yellow area represents the geological formation known as the Macon Ridge. The brown diagonal line follows the Red River. In the last five years, cotton acreage has ranged from 610,000 to 849,000, with an average farm gate value of more than $270 million annually.

Figure 1. Gross revenue return per acre of cotton lint and number of irrigation applications from schedules on Sharkey clay in 2000 and 2001 at the Panola Corp., St., Joseph, La.



Steve Hague, former Assistant Professor and now with Bayer Cotton Seed in Leland, Miss., and Alphonse Coco, Research Associate, Northeast Research Station, St. Joseph, La.; and Donald J. Boquet, Professor, Macon Ridge Research Station, Winnsboro, La.

compared the effectiveness of several scheduling techniques.

One of the systems included the Arkansas Irrigation Scheduler (AIS), a computer program developed at the University of Arkansas. The program recommends irrigation when soil moisture reaches a water-budget deficit designated by the user. Irrigation treatments included a 2-inch (AIS 2.0) and 3-inch (AIS 3.0) deficit as well as a non-irrigated control. An AIS treatment (AIS 4.0) was tested in 2000, which allowed the soil moisture deficit to reach 4 inches before irrigation and then maintained a 2-inch deficit for the rest of the growing season.

A water-budgeting system developed at the LSU AgCenter was included in the trials. This system assumes daily 0.22-inch water use and recommends irrigation when the water budget deficit reaches 1.5 inches (1.5 WB). U.S. Department of Agriculture cotton loan schedules were used to calculate gross revenue from lint per acre based on yield and fiber properties from each treatment.

Photo by Robert L. Hutchinson

About 40 percent of the cotton grown in Louisiana is irrigated. Most irrigation is on the ground using these plastic tubes.

In 2000, less than 7 inches of rain fell in June, July and August, resulting in high irrigation demand. Responses to irrigation were observed (Figures 1 and 2) at Panola Corp. on both soil types. Performance of all irrigation schedules exceeded non-irrigated control treatments. Schedules that required the most frequent irrigation applications were slightly advantageous in terms of yield and fiber quality; however, high gross returns were realized from regimes with fewer applications.

In 2001 and 2002, timely rainfall occurred during the growing season. Damaging precipitation just before harvest caused severe yield and quality losses in both years. At the Panola Corp. in 2001, AIS 2.0 performed well on both soil types and cotton responded better to 1.5 WB on Sharkey clay than on Commerce silt loam. The on-station tests showed little to no economic benefit from irrigation in 2001 and 2002 (Figure 3). In fact, plants suffered from mild waterlogging because of irrigation in 2002.

Research findings suggest small yield advantages and no economic benefit from irrigating cotton on alluvial soils in years with normal to above-average rainfall. In a drought year, such as 2000, positive yield responses and economic benefits can be expected from irrigation. Scheduling methods affect the yearly number of irrigation applications and can influence yield significantly. While AIS 2.0 most often maximized gross returns, other schedules performed well and conserved more water. AIS may be a viable option for scheduling irrigation, but other options are needed for Louisiana that will account for local conditions and needs of growers. Efforts are being directed toward developing an irrigation scheduling system for Louisiana cotton producers that is user friendly, optimizes yield and fiber quality, conserves water and maximizes profit. Studies are under way to determine the correct time to initiate and terminate irrigation using crop growth monitoring and also to determine the interactions of irrigation with various management practices. ■

Figure 2. Gross revenue return per acre of cotton lint and number of irrigation applications from schedules on Commerce silt loam in 2000 and 2001 at the Panola Corp., St. Joseph, La.

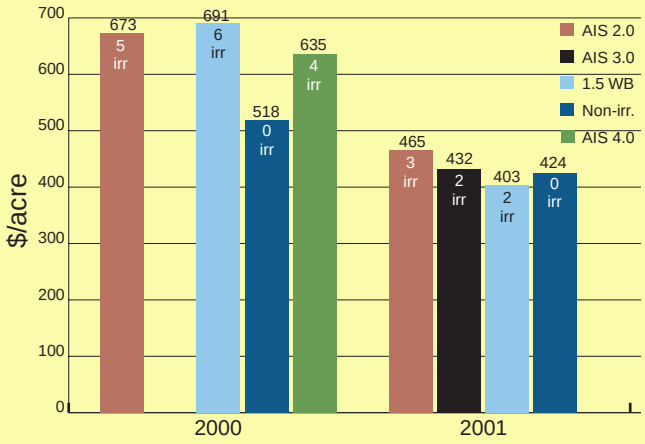
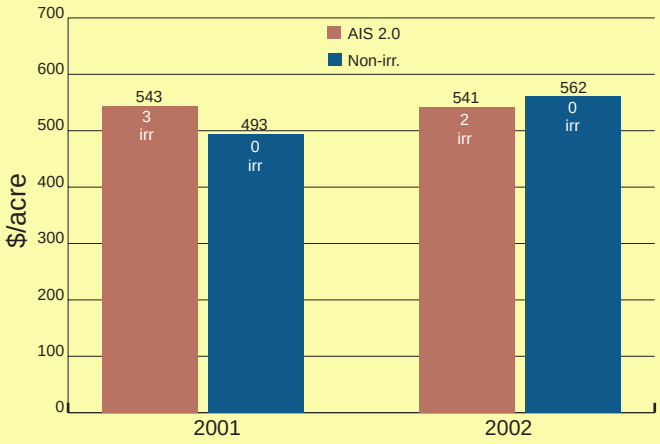


Figure 3. Gross revenue return per acre of cotton lint and number of irrigation applications from schedules on Sharkey clay in 2001 and 2002 at LSU AgCenter's Northeast Research Station, St. Joseph, La.



Conservation Tillage, Cover Crop BMPs for Cotton

Donald J. Boquet, Robert L. Hutchinson and Kenneth W. Paxton

Farming practices can affect environmental and agronomic sustainability as well as productivity. Traditional farming practices in the Mid-South typically use tillage and produce one crop each year, which exposes the soil to long periods with little or no protection from elements that cause sediment and nutrient losses. Multi-crop, year-round systems with summer crops of corn, cotton, soybean or grain sorghum combined with conservation tillage and winter crops of wheat, rye or vetch green-manure are considered best management practices (BMPs). They can substantially reduce farm contributions to nonpoint-source pollution of surface water bodies. BMPs also may benefit farm productivity, sustainability and profitability by improving soil characteristics and crop performance.

Two long-term field studies were conducted at the LSU AgCenter's Macon Ridge Research Station near Winnsboro between 1987 and 2002 on Gigger silt loam to determine the effects of tillage practices, cover crops and nitrogen rates on cotton growth and yield. Cotton was grown continuously without tillage (no-till) or with surface tillage following annual winter cover crops of wheat, hairy vetch and volunteer winter native vegetation and with fertilizer nitrogen rates of zero, 35, 70, 105 and 140 pounds per acre.

Seedbed preparation of no-till plots consisted only of herbicide treatments for vegetation control applied at least three weeks before planting. Seedbed preparation in surface tillage treatments consisted of four to five operations including disking, bedding and bed smoothing. No postplant cultivation was used in either tillage regime. One of the experiments was rain-fed, and one was irrigated as needed. Other than experimental treatments, varieties, planting methods and management practices were those normally used in the area and recommended by the LSU AgCenter. A list of the treatments for both experiments and the identified optimal N rates are shown in Tables 1 and 2.

An economic comparison of the above cotton production systems was performed using enterprise budgets. Physical input-output data from the experiments were used to develop an enterprise budget for each production system. Actual input levels (fertilizer, seed, herbicide) used were incorporated into the enterprise budgets. Equipment sizes representative of commercial cotton farming operations were used to estimate costs on a per acre basis. Yields were estimated for each system at the mean over the life of the experiment. Output prices used were essentially current loan rates under the 2002 Farm Bill. Input prices were current input prices used by the LSU AgCenter's Department of Agricultural Economics and Agribusiness to estimate 2002 enterprise budgets for Louisiana. Constant prices and average yields were used to compare the relative profitability of the various systems.

Table 1. Irrigated cotton lint yields, optimal N rates and costs and returns in selected tillage and winter cover crop regimes, 8-year average, 1995-2002.

Tillage and cover crop	Lint yield (lb/acre)	Optimal nitrogen rate (lb/acre)	Total production costs* ($/acre)	Returns above costs ($/acre)
No till, winter fallow vegetation	1116	80	418.32	162.00
No till, winter wheat cover crop	1113	90	435.45	143.31
No till, winter hairy vetch cover crop	1105	0	426.71	147.89
Surface till, winter fallow vegetation	997	70	417.21	100.78
Surface till, winter wheat cover crop	1058	120	470.66	79.85
Surface till, winter hairy vetch cover crop	1036	0	457.06	81.66

*Does not include land costs (rent) and general farm overhead costs.

Table 2. Rain-fed cotton lint yields, optimal N rates and costs and returns in selected tillage and winter cover crop regimes, 16-year average, 1987-2002.

Tillage and cover crop	Lint yield (lb/acre)	Optimal nitrogen rate (lb/acre)	Total production costs* ($/acre)	Returns above costs ($/acre)
No till, winter fallow vegetation	728	45	339.61	38.99
No till, winter wheat cover crop	815	90	370.99	52.81
No till, winter hairy vetch cover crop	780	0	361.42	44.18
Surface till, winter fallow vegetation	749	45	347.80	41.68
Surface till, winter wheat cover crop	763	90	374.14	22.62
Surface till, winter hairy vetch cover crop	740	0	391.94	-7.46

*Does not include land costs (rent) and general farm overhead costs.

Donald J. Boquet, Professor, Macon Ridge Research Station, Winnsboro, La.; Robert L. Hutchinson, Director, Northeast Region, Winnsboro, La.; and Kenneth W. Paxton, Professor, Department of Agricultural Economics and Agribusiness, LSU AgCenter, Baton Rouge, La.

Irrigated tillage, cover crop and N rate experiment, 1995-2002

Cover crop biomass and N content. Following a cotton crop and without additional fertilizer, the native, vetch and wheat cover crops produced an average 1054, 2054 and 4045 pounds above-ground biomass per acre, respectively. Nitrogen concentration of the cover crop vegetation averaged 2.0 percent in native, 4.0 percent in vetch and 1.5 percent in wheat. The total amount of nitrogen in the cover crop biomass averaged across year, tillage regime and nitrogen rate was 27, 90 and 38 pounds per acre in native, vetch and wheat, respectively. As indicated by the large amount of nitrogen present in the vegetation, the vetch cover crop provided sufficient nitrogen for production of two-bale per acre cotton without application of inorganic fertilizer nitrogen.

Cotton stand establishment. Seedling emergence and survival averaged about three plants per foot of row and was little affected by tillage practice or cover crop residue (data not shown). Although no-till cotton in the 1970s and 1980s often experienced reduced seedling emergence compared with tilled seedbeds, improvements in planting equipment have alleviated this problem. The results of this study and those of other researchers demonstrate that cover crop residue is not a major hindrance to obtaining near-ideal plant density in no-till cotton fields. With appropriate management and technology use, there is no longer an increase in the risk of production for no-till cotton following a winter cover crop.

Cotton yields in no-till vs. tilled and cover crop versus no cover crop. In the initial years of the study, cotton lint yields in surface-till and no-till regimes were similar but, after five years, no-till yields were higher. No-till increased cotton yield an average of 9 percent. The results demonstrate conclusively that, in the short and long term, cotton yields will not be reduced by no-till practices (Table1). The lowest yielding treatment was one in which no cover crop was planted and tillage was used. Further, the economic analyses of inputs and yield show that savings in equipment and labor costs contribute to increased returns for cotton grown with no-till practices (Table 1).

Interactions among cover crop, tillage and nitrogen rate. The optimal nitrogen rate for cotton depended on cover crop and tillage regime (Table 1). Cotton following vetch needed no fertilizer nitrogen, and cotton following wheat required high nitrogen rates for optimal yield. When the optimal nitrogen rate was applied, however, all tillage-cover crop regimes produced similar yields. There was a larger yield response in no-till than in surface-till for each pound of applied nitrogen. Because unfertilized yields were lower in no-till than in surface-till, adequate nitrogen fertilization was needed for cotton to benefit from no-till, especially following a wheat cover crop. The fertilizer nitrogen rate currently recommended for cotton following winter fallow-native cover on loess soils may be too low for no-till cotton. There was no yield response to fertilizer nitrogen following vetch and thus no need to apply nitrogen to cotton following vetch in either tillage regime.

Photo by Robert L. Hutchinson

This is a field of no-till cotton growing in wheat residue.

Rain-fed tillage, cover crop and N rate experiment, 1987-2002

Lint yields in the rain-fed study were lower than in the irrigated study, but the overall responses to cover crop and tillage were similar to the irrigated study in that both no-till and cover crop increased yield (Table 2). There were important differences, however. Because of the lower yields in most years with rain-fed cotton, potential profitability was much lower than with irrigated cotton. With the lower yield potential, the opportunity for cotton to use fertilizer nitrogen was lower and thus the optimal nitrogen rates were lower. The wheat cover crop was more beneficial to yield in rain-fed than in irrigated cotton, probably because the residue helped to conserve soil water. Highest yields and returns from rain-fed cotton were produced using a combination of a no-till seedbed and winter wheat cover crop.

No-till beats surface-till

No-till cotton produced yields similar to or higher than cotton planted in surface-till treatments. Economic analyses demonstrated that no-till benefits were augmented by lower investments in equipment and labor costs than surface till. Savings in tillage costs in no-till were partially negated by increase in chemical costs. The optimal nitrogen rate varied with tillage and cover crop from as low as zero pounds per acre to as much as 120 pounds per acre. The recommended fertilizer nitrogen rate should, therefore, be specific for each tillage and cover crop regime. Tillage, cover crop and nitrogen rate had significant but small effects on seedling emergence, yield components and plant growth variables, none of which were deleterious to yield production. We conclude that the adoption of no-till and winter cover crop BMPs to protect the soil and water quality will not decrease farm productivity or profitability. ■

Acknowledgment

The studies in this report were partially funded by Cotton Incorporated and the Louisiana Cotton Support Committee.

Nontransgenic Cotton Response to Off-target Herbicides

Donnie K. Miller, Robert G. Downer, Steve T. Kelly and P. Roy Vidrine

Transgenic technology, where genes conferring resistance to certain herbicides or protection against select insect species are transferred to plants, has had a dramatic effect on cotton production. According to National Cotton Council figures for 2002, more than 70 percent of Louisiana cotton acreage was planted to transgenic varieties. Cotton varieties resistant to herbicides glyphosate (Roundup Ready), bromoxynil (BXN) and glufosinate (Liberty Link) have been developed. Roundup Ready and BXN cotton have been commercially available for several years; Liberty Link varieties are to be available on a limited commercial basis in 2003. Use of this new technology creates the possibility for off-target movement, known as drift, onto nonherbicide-resistant cotton planted in close proximity or for misapplication from sprayer contamination.

To assess possible negative effects, research was conducted at the Northeast Research Station in St. Joseph, La., in 2000 and at the Macon Ridge Research Station in Winnsboro, La., in 1999 and 2000. The methodology involved testing reduced rates of glyphosate (Roundup Ultra formulation), bromoxynil (Buctril) and glufosinate (Liberty) on two different cotton varieties (Stoneville 474 at Macon Ridge and DP33B at Northeast) at three different growth stages (two-node, five-node and nine-node). Cotton response was assessed in seedcotton yield as well as in the following: injury 14 days after treatment, plant height 30 days after treatment, dry weight 30 days after treatment, nodes above white flower, percentage open bolls and final plant population.

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Roundup Ultra

Based on visual assessment, cotton was more tolerant to glyphosate at the nine-node growth stage. Plant dry weight was reduced with glyphosate rates of 2 ounces per acre or higher applied at the two- and five-node growth stages in two of three experiments. Weights were not affected by glyphosate at the nine-node stage. Plant height was also unaffected by lower rates, but reduction was noted for all growth stage by experiment combinations with the exception of nine-node for both experiments in 2000 with increase in herbicide rate of 2 ounces per acre or higher. Cotton maturity delay, as noted by increase in node above white flower (NAWF) number, was observed only at the highest glyphosate rate applied to two- and five-node cotton in one of three experiments. Percent open boll data analysis indicated a decrease in chance of observing an open boll with increasing glyphosate rate, and this effect was higher at the five-node stage compared to the two- and nine-node stages in two of three experiments. Although seedcotton yield was reduced 9 percent to 13 percent for the highest rate when compared to lower rates, yield following glyphosate application was equivalent to that for the nontreated control.

Buctril

Based on visual assessment, cotton response was reduced as application timing was delayed from two-to five-node in all experiments and from five- to nine-node in two of three experiments. Plant height reduction response decreased with increasing growth stage at time of application. Plant dry weight was most negatively affected following application at the two-node stage. Bromoxynil application, based on node above white flower number (NAWF), did not result in maturity delays but did promote earliness when applied at 4 ounces per acre to two- and five-node cotton in one of three experiments. Final plant population was reduced only at the two-and five-node timings, with response more pronounced at the initial timing. Seedcotton yield following bromoxynil application at the highest rate to two-leaf cotton was reduced 34 percent compared with other rates and the nontreated control, which were equal. Bromoxynil applied to five- or nine-node cotton did not reduce yield significantly.

Liberty

Based on observation, cotton response decreased as application timing was delayed in one of three experiments. Injury response was slightly increased with application at the five compared to two-node growth stage and was not significant for the latest application timing (nine-node) in two of three experiments. In two of three experiments, plant height reduction response was lowest at the five-node stage and highest at the nine-node timing. Regardless of application timing, plant dry weight was affected negatively only with the highest rate of glufosinate. Glufosinate application, based on node above white flower number and percent open boll, did not result in a maturity delay. Final plant population was reduced in all experiments at the two-node application and in one of three experiments at the five-node timing. Glufosinate application did not affect final plant population adversely when applied to nine-node cotton. Negative effects on cotton growth were not manifested in seedcotton yield reduction following glufosinate application.

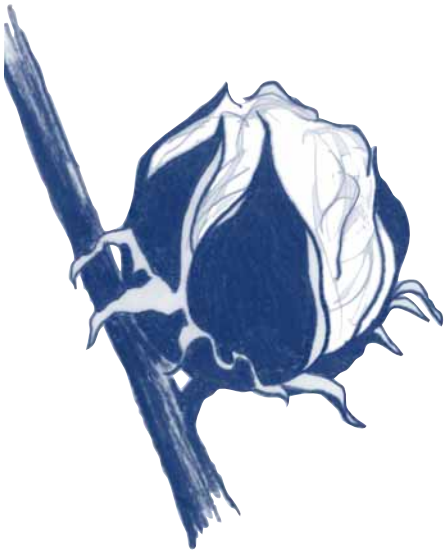
Prevention Is Best

Although various negative effects on growth were observed following application of Roundup Ultra, Buctril or Liberty herbicides at rates simulating those experienced with drift and sprayer contamination, cotton was able to recover and yields were equal to nontreated plants in almost every case. Yield reduction was observed only with Buctril at the highest rate (4 ounces per acre) applied to cotton in the least

advanced growth stage (2-node). Although the cotton was able to recover fully, it should be noted that late-season growing conditions were optimum at all locations because of supplemental irrigation at Winnsboro and adequate rainfall at St. Joseph. Cotton was managed for insect pests throughout the season. Had environmental conditions been less than optimal, the growing season shortened or insect damage more extensive, cotton may not have been able to recover fully, and detrimental effects from herbicide application may have caused yield reduction. In addition, rates observed in these studies are representative of those that would be expected in drift or sprayer contamination situations, and higher rates may result in more deleterious effects. Therefore, producers are cautioned to take all measures to avoid herbicide drift and sprayer contamination. ■

Acknowledgment

Donna R. Lee, A. Lawrence Perritt, C.F. Wilson and J.L. Milligan, Research Associates, Northeast Research Station, St. Joseph, La., for their work and Cotton Incorporated for providing funding.



Effects of Pre-plant Application of 2,4-D on Cotton

Conservation tillage systems, whether no-till or stale seedbed, require use of herbicides before crop planting to rid fields of native winter vegetation and planted cover crops. Elimination of competing vegetation, which is called burndown, helps improve soil moisture and assure crop stand establishment, rapid early season growth and efficient fertilizer use. The herbicide 2,4-D is used in burndown weed control because it eliminates a number of problem broadleaf winter weeds at a relatively low cost.

One problem with 2,4-D is that even though applied postemergence, it can stay in the soil long enough to injure sensitive crops such as cotton. The injury is more likely to occur if cotton is planted shortly after herbicide application. Unfortunately, most 2,4-D herbicide labels indicate no strict plant-back interval and include vague language such as "90 days or until dissipated from the soil." The LSU AgCenter is participating in a regional research collaboration to assess plant-back intervals to cotton following application of 2,4-D.

As part of this research, studies were conducted in 2001 and 2002 at the Northeast Research Station in St. Joseph, the Dean Lee Research Station in Alexandria and the Macon Ridge Research Station in Winnsboro to assess effects of 2,4-D applied at various preplant intervals on growth and yield of cotton. The 2,4-D was applied in two formulations, amine and ester. The two 2,4-D formulations were applied at the labeled rate and twice the labeled rate to rows undisturbed before application.

In 2001, each herbicide was applied seven, 14 and 21 days before planting. In 2002, application intervals were seven, 14 and 28 days before planting. A nontreated control was included for comparison. Cotton was planted and maintained weed free by hand-hoeing or postemergence herbicide. To determine possible negative effects, these assessments were made: visual injury, plant height, plant population about 30 days after planting and seedcotton yield.

Visual injury as high as 70 percent at St. Joseph in 2001 and 22 percent at Alexandria in 2002 was observed on cotton following a 2,4-D application before planting. For both locations, differences in injury could not be detected between herbicide formulations or rates, or among application intervals. Injury was either not observed or negligible at St. Joseph in 2002, Alexandria in 2001 and Winnsboro in 2001. Differing injury response among experiments could not be explained by rainfall patterns before or after 2,4-D application.

Although significant injury was observed in two of five experiments, plant height and population and seed-cotton yield were not reduced at any location when compared to cotton receiving no preplant application of 2,4-D. At St. Joseph in 2001, extreme variability in the data may have reduced the ability to detect differences on cotton growth and yield. Results indicate that 2,4-D can be applied seven days before cotton planting without having negative effects on growth and yield. Cotton was able to recover from this early season injury and compensate because of a full growing season and intensive scouting and management of weeds and insects. Under different growing conditions, cotton may not have been able to recover fully.

Although results of this study support 2,4-D label changes, such changes must be initiated by the herbicide manufacturer and approved by the U.S. Environmental Protection Agency. Producers are cautioned to follow current label restrictions for planting cotton following 2,4-D application. ■

Acknowledgment

Donna R. Lee and A. Lawrence Perritt, Research Associates, Northeast Research Station; Derek Scroggs, Research Associate, Dean Lee Research Station; and Barrett McKnight, Extension Associate, Scott Research, Extension and Education Center, for their work and Helena Chemical Company for providing funding.

Donnie K. Miller, Associate Professor, Northeast Research Station, St. Joseph, La.; P. Roy Vidrine, Professor, Dean Lee Research Station, Alexandria, La.; Steve T. Kelly, Assistant Specialist (Weed Science), Scott Research, Extension and Education Center, Winnsboro, La.; and Rebecca G. Frederick, Research Associate, Department of Experimental Statistics, Baton Rouge, La.

Photo by Mark Claesgens

Gene Burris (standing in striped shirt), a professor at the LSU AgCenter's Northeast Research Station at St. Joseph, La., explains to farmers gathered for a field day about the research he is conducting to determine how to use technology to better control nematodes. The research involves using a Veris mapping cart, the wheeled device at right, to measure soil conductivity. See more explanation of the research on page 11. Others in the photo are, left to right, Richard Costello, post-doctoral researcher, and Libby Byrnes and Mirandy Lee, both student summer workers. Maurice Walcott, research associate, is standing under the umbrella.

Inside:

- *For more than 100 years, cotton has been the most important crop grown in Northeast Louisiana. Read a perspective on cotton's role in the state's economy.* *Page 4*
- *LSU AgCenter research has played a significant role in making it possible to grow cotton profitably in this state.* *Page 6*
- *Scientists are learning more about precision agriculture by studying remote sensing images.* *Page 9*
- *Conservation tillage in cotton improves water quality.* *Page 32*

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