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Patents provide additional funding source

Patents are becoming increasingly important to the LSU Agricultural Center and similar institutions across the country as the cost of research increases and public financial support faces competition from other segments of society.

The Ag Center has been patenting discoveries for many years. Several of the more recent patents hold promise of both improving society's well-being and contributing funds to sustain the research mission of the Louisiana Agricultural Experiment Station:

Gene transfer procedure. Richard Cooper, a microbiologist in the Veterinary Science Department , has patented a new, more efficient way to transfer genes from one species to another. An early application of the procedure was used to move a gene from a silk moth into a catfish, causing the catfish to be immune to *Edwardsiella ictaluri*, the No. 1 disease-causing bacteria in catfish. He worked with Terrence Tiersch of the Aquaculture Research Station. The gene transfer procedure has the potential to be used in both human and veterinary medicine.

Herbicide-resistant rice. Two new rice breeding lines discovered by Tim Croughan, a researcher at the Rice Research Station, are resistant to imidazolinones, a family of herbicides that can now be used to control major weed problems in rice, including difficult-to-control weeds such as red rice. Red rice, because it belongs to the same species as cultivated strains of rice, has historically been particularly difficult to control. Improved weed control will increase yields and give farmers greater flexibility in crop rotations, herbicide timing, planting practices and water management.

Photo by John Wozniak

A new bait system that holds promise of controlling the Formosan subterranean termite

Vaccine for more chickens. EggMax is a vaccine that can be injected into chickens before puberty to inactivate a hormone called inhibin, which inhibits egg production. The patented product was developed by Ag Center scientists Dan Satterlee of the Department of Poultry Science and Konstantin Kousoulas of the Department of Veterinary Science in conjunction with William Fioretti, president of AgriTech Labs of Coppell, Texas. The vaccine is targeted at meat-producing chickens, called broiler breeders, which are poor layers in comparison to egg-type chickens that produce the eggs we eat. After injections of EggMax, broiler-breeder hens can lay as many as three dozen more eggs during their reproductive lives. Producers will save money in feed costs, because fewer hens will produce the same amount of chicks, and the feeding of hens accounts for about 70 percent of the cost of chick production.

Termite bait. A new bait system that holds promise of controlling the Formosan subterranean termite was developed by Gregg Henderson and Jian Chen of the Entomology Department. The system lures termites into a feeding chamber, then entices them into a second chamber that contains toxin-laced material the invaders carry back to their nest to kill the entire colony. Made from a plastic cylinder about 8 inches long and 4 inches in diameter, the apparatus is divided into two chambers with a small hole between them. **– Rick Bogren**

LOUISIANA AGRICULTURE

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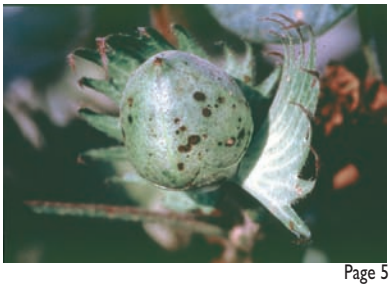

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***Cover**:*
Acrylic on paper by Frankie Gould, Project Leader, LSU Agricultural Center Communications

Louisiana's equine industry contributed an estimated $41 million in gross farm income and an additional $89 million in value-added and related activities to the state's $1.5 billion animal industry in 1998. Of 10 recognized Louisiana animal commodities, the equine industry ranked fourth in total value, following poultry, milk and cattle. Including horse production, the race horse industry, horse shows, youth programs and all activities that add value, the direct impact of the equine industry approaches $1 billion in Louisiana. See page 10.

Photos by Roger Leonard

Two tarnished plant bug adults were placed into a nylon mesh bag, which was then placed over an individual boll. The opening of the bag was tightly closed around the stalk of the boll with a drawstring.

Tarnished plant bug adult and late instar nymph on a cotton square (flower bud).

Cotton Boll Susceptibility to Tarnished Plant Bug

James S. Russell and B. Roger Leonard

The tarnished plant bug is becoming a major cotton pest in the mid-South states of Arkansas, Mississippi and Louisiana. In 1998, the tarnished plant bug caused a loss of more than 14,000 bales of cotton in Louisiana, even though more than $5.5 million was spent to control it.

The tarnished plant bug has become a problem in Louisiana for several reasons. The use of transgenic Bt cotton on considerable acreage has reduced insecticide application frequency for tobacco budworm, which would otherwise control tarnished plant bugs. The development of insecticide-resistant populations of this pest has made control with insecticides more variable. An increase in native host plants along field borders provides an untreated refuge for tarnished plant bugs to reproduce throughout the production season.

Tarnished plant bug injury has been primarily associated with early season pre-flowering cotton and can result in delayed crop maturity and yield reductions. Recently, tarnished plant bugs have been observed at high densities later in the season during the flowering and boll-development stages of cotton. Because of the lack of knowledge about the effects of tarnished plant bug feeding on bolls, this study was undertaken to examine the susceptibility of cotton bolls to tarnished plant bug- induced abscission (premature boll loss).

All experiments were conducted at the Macon Ridge location of the Northeast Research Station near Winnsboro. These studies were done in plots of transgenic Bt cotton (NuCOTN 33^{B}) containing the Bollgard gene. The test areas consisted of 16 rows by 250 feet and were managed according to crop production practices recommended by the Louisiana Cooperative Extension Service.

Collecting insects

Tarnished plant bugs were collected from cotton and native hosts in northeast Louisiana using a standard 15-inch diameter sweep net. They were held in a wire mesh cage in the laboratory for 24 hours to reduce mortality from physical injury and disease and were fed washed green beans and sugar water to maintain health. They were then placed in glass vials and transported to the field in a chilled ice cooler to eliminate mortality from heat stress.

Boll infestation

Cotton plants were monitored twice a week until the first week of flowering. First-position white flowers (flower located on the first fruiting node of a fruiting branch from the main stem of the plant) were marked with a yellow tag on the fruiting branch between the petiole of the flower and the main stem of the plant. The date of anthesis (flower opening) was

James S. Russell, Graduate Assistant, Department of Entomology, LSU Agricultural Center, Baton Rouge, La.; and B. Roger Leonard, Associate Professor, Macon Ridge Location of the Northeast Research Station, Winnsboro, La.

Tarnished plant bug injury to immature anthers. Damaged anthers are seen as a brown discoloration compared to undamaged anthers on the right.

Dark, necrotic spots indicate the tarnished plant bug feeding on a cotton boll.

recorded on the tag in permanent ink to ascertain boll age at the time of infestation. Boll age was calculated using accumulated heat units beginning at anthesis. A heat unit (HU) is the maximum daily temperature minus the minimum daily temperature divided by two and subtracted from 60 (the minimum critical temperature for cotton plant development).

Two tarnished plant bug adults were placed into a nylon mesh bag, which was then placed over an individual boll. The opening of the bag was tightly closed around the stalk of the boll with a drawstring. The date of the infestation was also recorded on the tag for each individual boll. The non-infested bolls were also covered with bags that contained no tarnished plant bugs.

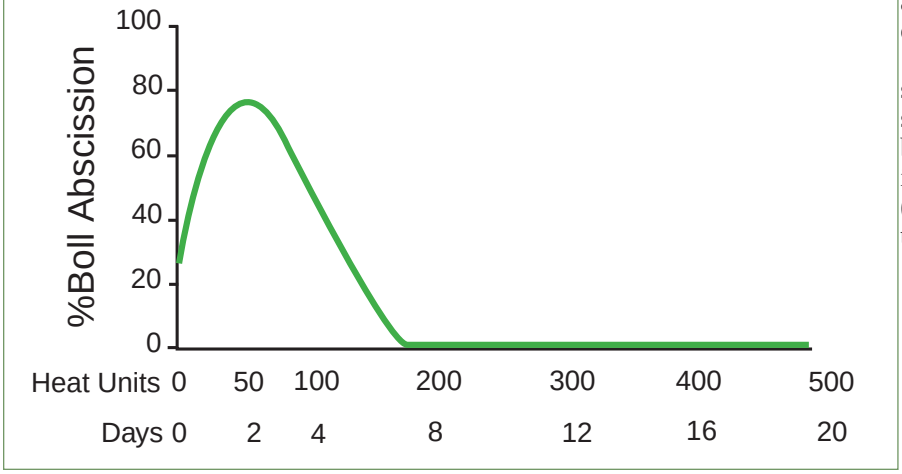
Tarnished plant bug infestations began at white flower (zero HU) and continued until bolls had accumulated 487 HU beyond anthesis. Fifty-nine different levels of accumulated HU were used within this range. The sample size for each individual HU varied from nine to 85 flowers or bolls. At 72 hours after infestation, the cages and tarnished plant bug adults were removed. The number of abscised bolls was recorded at seven days after infestation.

Boll abscission

Boll abscission appeared to peak (76.6 percent) at 50 HU or two days after anthesis and decreased to zero at 189 HU or 7.5 days after anthesis (Figure 1). A lower incidence of boll abscission was observed for bolls that had accumulated less than 30 HU as compared to bolls that had accumulated 30 to 100 HU. On bolls with less than 30 accumulated HU, tarnished plant bugs are probably concentrating their feeding on petals and anthers before the flower naturally separates from the boll. The cotton flower normally separates at its base during the second day after anthesis and will generally fall off in a few days. Young bolls (less than 1 day old) are not exposed, and tarnished plant bugs appear to be unable to feed on these bolls and cause abscission. On older bolls, tarnished plant bugs pierce the outside skin of the boll and cause sufficient damage to result in abscission of that boll. Essentially no boll abscission was observed for bolls that had accumulated at least 189 HU.

Our study indicates that cotton bolls are safe from tarnished plant bug-induced abscission 7.5 days after anthesis. These data will be important in designing and implementing late-season integrated pest management (IPM) programs for the tarnished plant bug in the mid-South region. ■

Figure 1. Boll abscission appeared to peak (76.6 percent) at 50 HU or 2 days after anthesis and decreased to zero at 189 HU or 7.5 days after anthesis.



Effects of Tillage and Herbicide Treatments on Itchgrass Seedling Emergence and Seed Survival

Ronald E. Strahan, James L. Griffin and Kathy R. LeJeune

Itchgrass, often referred to as Raoulgrass, is a major weed problem in south Louisiana. Yield reductions attributed to itchgrass competition have been as high as 43 percent in sugarcane and 30 percent in corn and soybeans. The spread of itchgrass has been linked to birds, flood water, rodents and contaminated farm equipment. Itchgrass infested south Louisiana rapidly during the 1970s and 1980s when road matting materials were used in oil exploration. The detrimental effects of itchgrass were not known at that time. Consequently, the weed was generally ignored until it had infested much of the area.

Itchgrass is pale green with brace roots that descend from lower nodes, much like what is present on corn, and hairs on the leaf sheath that cause an itching sensation. The weed is aggressive and may reach a height of 8 feet at maturity.

Seed regeneration

Unlike the perennial weeds johnsongrass and bermudagrass, itchgrass depends solely on seed production for regeneration. A single itchgrass plant can produce more than 2,000 seeds. Weed seeds have a built-in dormancy or survival mechanism. Dormant seeds do not germinate, even when environmental conditions are favorable for germination. Seed dormancy assures that weeds will be a problem year after year, even if new seeds are not produced every year.

Weed seeds can have strong or weak dormancy characteristics. Seeds with a strong dormancy mechanism can remain viable in soil for many years, sometimes as long as 40 years. In contrast, seeds with weak dormancy either germinate within a few years or deteriorate. Weeds with weak seed dormancy would be easier to eliminate from fields, if plants are not allowed to set seed to replenish the soil reservoir. An understanding of seed dormancy of itchgrass would be useful in developing long-term management programs. Our research was conducted to determine the effect of weed management programs over a single growing season on reducing the itchgrass seed reservoir in soil.

The seeds of the itchgrass plant are quite distinctive and can help identify the weed.

Two-year study

The study was conducted over two years in fallowed fields where itchgrass had set seed for the two previous years. Treatments included monthly tillage to a 4-inch depth, monthly application of Roundup at 1.5 quarts per acre and no weed removal (undisturbed control). The rationale was that tillage would stimulate seedling emergence, resulting in more rapid depletion of the seed soil reservoir when compared with the herbicide-only treatment. Experiments began in May. Tillage and herbicide treatments were continued through October.

Before each tillage or herbicide application, the itchgrass seedling population was determined in selected subplots. The itchgrass seed population was determind from soil core samples collected at a zero to 4-inch depth in mid-May and in late November. A full seed was one that was solid and hard to the touch. Itchgrass seed viability was not determined. Rainfall was monitored each year.

Initial itchgrass seed population in soil at the zero to 4-inch depth was similar for the tillage, herbicide-only and undisturbed control each year, indicating that seeds were uniformly distributed within the experimental areas. Soil seed population when experiments were initiated was calculated to be 8.3 million and 3.1 million seeds per acre for the first and second year, respectively. Total itchgrass seedling emergence across the entire growing season was stimulated by tillage in one of two years.

Rainfall

Itchgrass seedling emergence closely followed rainfall. When drier conditions prevailed, seedling emergence was reduced, and no advantage was observed for the tillage treatment over that of the Roundup-only treatment. Previous observations have shown itchgrass emergence to be enhanced by successive periods of soil wetting and drying. When itchgrass was not allowed to produce seed over a single growing season (May - November), itchgrass seed reserves were depleted 91 percent to 95 percent with tillage and 88 percent to 89 percent with Roundup, suggesting that itchgrass seeds possess weak dormancy. The fact that seed depletion was equivalent for the tillage and Roundup-only treatments indicates that seed loss was caused not only by germination and emergence, but also by seed rot.

Ronald E. Strahan, Extension Associate in Plant Pathology; James L. Griffin, Professor; and Kathy R. LeJeune, former Graduate Research Assistant, Department of Plant Pathology and Crop Physiology, LSU Agricultural Center, Baton Rouge, La.

Photos by Jim Griffin

The itchgrass plant has profuse tillering. Hairs on the leaf sheath can cause an itching sensation, hence the name itchgrass.

Other research has shown that approximately half the itchgrass seeds present in soil were lost each year because of rotting. In the present study, when itchgrass was not disturbed throughout the growing season and allowed to set seed, seed reserves increased by almost twofold in the first year and fourfold the second year.

Tillage, herbicides

Results clearly show that timely herbicide application and frequent tillage, both of which destroy emerged plants and prevent seed production, are equally effective in reducing the itchgrass soil seed reserve over time in fallowed fields. The use of Roundup would be especially effective when field conditions preclude tillage operations. An intense management program can reduce the itchgrass soil seed reserve in a single growing season by around 90 percent. Even so, a significant quantity of itchgrass seed would remain in the soil to cause problems the next year. It would be imperative that control methods be implemented in crops planted in successive years to prevent seed production. Successful efforts over time would further reduce the itchgrass seed reservoir and could eventually eliminate itchgrass as a problem weed. ■

Itchgrass is a problem in cane fields. The seedlings are usually light green to yellow green.

Acknowledgment

The authors are appreciative of the Louisiana Soybean and Grain Research and Promotion Board and the American Sugar Cane League for providing funds to support this research.

Warp in Overlaid Furniture Panels

Qinglin Wu

The furniture industry uses overlaid panels as flat, straight elements in furniture and cabinet construction. The panels are often in 3-ply or 5-ply construction with a thick core and thin overlays. Occasionally, 2-ply overlaid panels, which are particleboard or medium density fiberboard overlaid on the visible face only, are used for economical reasons.

These panels sometimes warp unexpectedly and severely after being assembled, even though they left the manufacturing plant in a perfectly flat condition. Such warping cannot be easily corrected because the forces that cause the warping are of considerable magnitude. Often the entire panel or the entire product must be replaced with no guarantee that the replacement will perform better than the original. Severe warping of finished products may well damage a company's reputation and even lead to lawsuits.

The potential to warp is often built into the panel during manufacture. This potential may be triggered by changes in the moisture content of the panel components in response to long-term variations of the relative humidity of the air.

The process of bringing moisture content of a material or a panel to a desired level is called conditioning. If raw materials, such as veneers or particleboard, used in the manufacture of panels are conditioned before they are assembled, the process is called preconditioning. During manufacturing, all raw materials are normally preconditioned to ensure that they all have a similar moisture content. After a panel is made, manufacturers normally condition the panel again, called reconditioning, to ensure that the panel's moisture content is similar to those at the places where the panel will be used.

This article highlights the relative importance of the various factors involved and the development of a computer-aid tool that the manufacturer can use for analysis in design and manufacture. It is hoped that the effort will foster a better understanding of the technology of furniture panel design and reduce panel warping.

Warping causes

Warping in overlaid panels is almost always caused by differences in shrinkage or swelling from one side of the panel to the other. This imbalance in shrinkage or swelling can be caused by panel structure imbalance, which means a panel was constructed with different face and back materials. It also can be caused by moisture penetrating into the panel unevenly from the panel face and back. Sometimes a combination of both is found. These two examples illustrate how these imbalances occur.

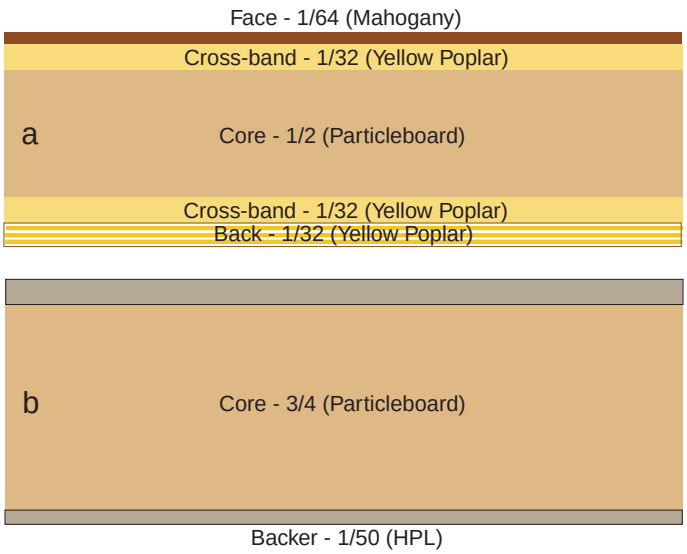
- Figure 1a shows a typical veneered 5-ply furniture panel. It consists of a 1/64-inch thick mahogany veneer face, a 1/32-inch thick yellow poplar cross-band, a 1/2-inch particleboard core, a 1/32-inch yellow poplar cross-band and a 1/32-inch yellow poplar veneer back.
- Figure 1b shows a typical 3-ply overlaid panel. This panel consists of a high pressure laminate (HPL) face overlay (1/20-inch thick), a particleboard core (3/4-inch thick) and a thin HPL back (1/50-inch thick).

Both panels have two imbalances: 1) differences in wood species (Figure 1a) or materials (Figure 1b) between face and back and 2) differences in veneer or overlay thickness between face and back.

In addition, different face and back materials cause different moisture sorption rates from the face and the back. This causes the third imbalance: moisture gradient across panel thickness. As a result, both panels will warp after being exposed to high or low humidity conditions.

For veneered panels, a difference in grain angle, or grain deviation, from one side of the panel to the other also leads to warping, even if both face and back veneers are from the same type of wood.

Figure 1. Typical veneered (a) or overlaid (b) panels used in the furniture industry.

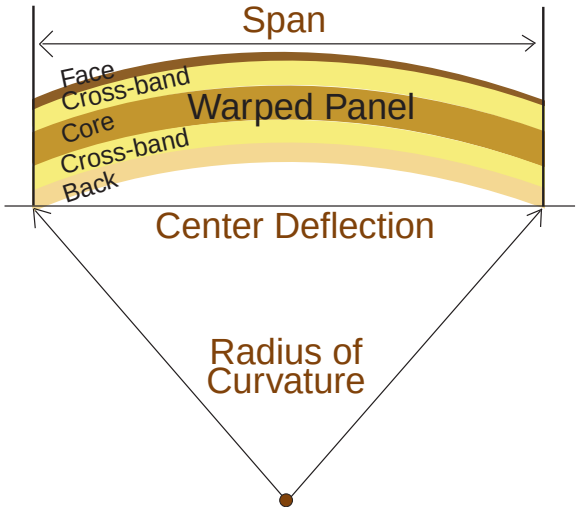


Qinglin Wu, Assistant Professor, Louisiana Forest Products Laboratory, LSU Agricultural Center, Baton Rouge, La.

Warping Analysis

The magnitude of warping of a laminated panel is a relatively complex function of layer thickness, stiffness, moisture expansion and relative position of the layer in the panel. Under swelling or shrinking conditions, these variables interact and result in a complex pattern of warping for a given panel. To facilitate the calculation of the warping of a multi-layer panel, the author developed a computer program named WARP. The program is based on one-dimensional beam bending equations and predicts center deflection or radius of curvature (Figure 2) of a multi-layer laminated beam over a given span. The center deflection is used to indicate the degree of warping in the panel. The program takes input information on material properties including material type (solid wood, particleboard, medium density fiberboard or overlay), moisture expansion, stiffness, grain angle for solid wood, layer thickness and moisture content change of individual layers forming the panel. Most of the variables can be either measured directly or estimated from published data. The panel can be re-analyzed by changing the construction parameters without exiting the program. The program can be run in any IBM-compatible system.

Figure 2. Definition of center deflection and radius of curvature of a warped panel over a given span.



Case study

The following analysis uses the panel shown in Figure 1a to illustrate the importance of various factors in controlling the warping of the panel. Two cases of moisture content change are considered:

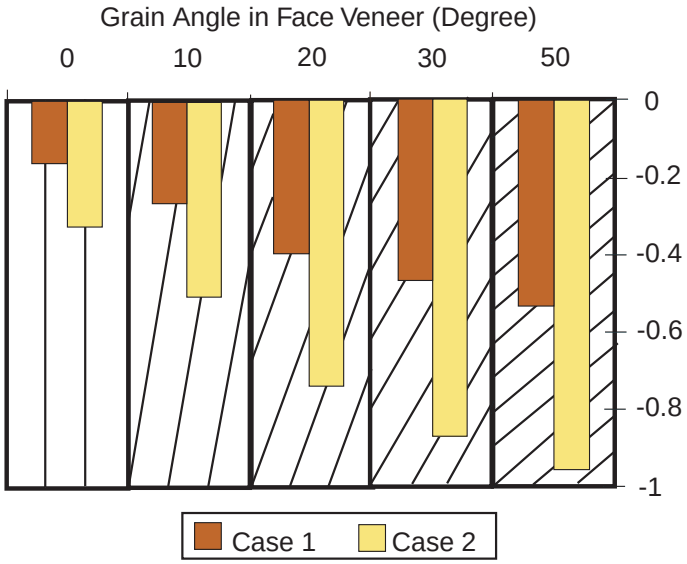
- Case 1: Moisture content change is +3.0 percent in all veneers and +2.0 percent in panel core
- Case 2: Moisture content change is +3.0 percent in all veneers and +4.0 percent in panel core

Case 1 corresponds to a relative humidity change from 30 percent to 65 percent where the moisture content of the veneers increases about 3 percent and the particleboard core by 2 percent. Case 2 corresponds to a condition where all materials are preconditioned at 30 percent relative humidity, and the finished panel is then reconditioned at 65 percent relative humidity. This gives a 3 percent moisture content increase in veneers and a 4 percent moisture content increase of the particleboard core.

The WARP program was used to predict the warping behavior of the above panel. With straight-grained mahogany face veneer (grain angle = 0 degrees), significant warp develops in the panel (Figure 3) because of its imbalanced structure. This indicates the importance of panel construction on its warp behavior. For economical reasons, expensive hardwood veneers, such as mahogany veneers, will usually not be used in the back side of a panel. Under such circumstances, the effect of material differences can be compensated by varying veneer thickness at the front and back faces. A computer simulation program such as WARP is a useful tool in determining the appropriate thickness for a given panel structure.

To show the effect of grain deviation in the mahogany face veneer on panel warp, the WARP program was run at various grain angles. Figure 3 shows the warping of the panel under the two prescribed exposure conditions. As the grain angle of the face veneer deviates from 0 degrees (grain angle = 10, 20, 30 and 50 degrees), severe warp develops in the panel. For example, at a grain angle of 50 degrees in the mahogany veneer, about 0.5- and 1-inch deflections (over a 48-inch span) develop under Case 1 and Case 2, respectively. The large amount of panel deflection will significantly affect the performance of the product. Case 2, with a larger core moisture content change, has a more severe problem than Case 1. Thus, both panel construction and extent of moisture content change affect the warping of the panel significantly.

Figure 3. Predicted center deflection of a veneered panel as a function of face veneer grain angle deviation.



Manufacturers need to pay close attention to the moisture content of panel components. They need to look for consistency of moisture content in the materials they use. The WARP program can help them determine if different materials will behave in the same manner. This will help in controlling warp problems. The WARP program is available to manufacturers through the Louisiana Forest Products Laboratory, a division of the LSU Agricultural Center. ■

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The author wishes to thank Otto Suchsland, Department of Forestry, Michigan State University, for his cooperative work in this field.

Economic and Geographic Impact of Equine Infectious Anemia in Louisiana

Gary A. Kennedy, William H. Green and Mark W. Murphey

In 1998, the equine industry contributed an estimated $41 million in gross farm income and an additional $89 million in value-added and related activities to Louisiana's $1.5 billion animal industry. Of 10 recognized Louisiana animal commodities, the equine industry ranked fourth in 1998 in total value, following poultry, milk and cattle. Including horse production, the race horse industry, horse shows, youth programs and all activities that add value, the direct impact of the equine industry approaches $1 billion in Louisiana.

Equine Infectious Anemia (EIA or "Swamp Fever") is a contagious viral disease of horses, mules and donkeys and is related to the human immunodeficiency (AIDS) virus. As with AIDS, no specific treatment or vaccine is available for EIA. Prevention and control of the disease is by testing, quarantine and destruction of infected animals. Insects may transmit EIA, and outbreaks tend to be geographic in nature. Louisiana has historically reported a high incidence of EIA. For example, in 1994, Louisiana had the highest per capita incidence of EIA in the nation with 326 positive animals from approximately 41,000 animals tested. The purpose of this study was to estimate the economic impact of this disease on the Louisiana economy and to examine its geographic incidence throughout the state.

EIA regulations vary

EIA regulations vary from state to state. Animals testing positive for EIA in Louisiana must be euthanized or sold for slaughter only. All animals located within 200 yards of an animal testing positive for EIA require a minimum 30-day negative test before a quarantine release is issued. Louisiana requires permanent identification in the form of a tattoo, an electronic chip, or a hot or cold brand and a mandatory annual test for every horse. In addition, animals changing ownership must have a negative test within six months.

Data on 673 animals testing positive for EIA from January 1995 through June 1998 were collected from the Louisiana Equine Infectious Anemia Test Program, maintained by the Louisiana Department of Agriculture and Forestry. Data collected included the owner's name and address and the species, age, gender and origin of each infected animal identified during the time period. Data used in this study on animals testing positive for EIA represent approximately 94 percent of the population of EIA-positive animals for the study period. Data were not available on animals testing negative for EIA during the time period.

No statistical difference was found in the incidence of EIA between mares (314 reactors) and geldings (306 reactors). Stallions represent a much smaller segment of the population, and only 49 stallions tested positive for EIA during the study period.

Horses represented 93 percent of all EIA reactors in the data collected. The data included eight EIA-positive donkeys and 40 EIA-positive mules.

While EIA may infect an animal of any age, those between 2 and 20 years of age accounted for the majority of animals in this study.

Geographic impact of EIA

To determine a geographic impact of EIA in Louisiana, the state was divided into nine areas (Figure 1). Each area is relatively homogeneous with respect to climatic conditions and types of agricultural commodities produced. Animals testing positive for EIA were divided into categories by area and by the year of

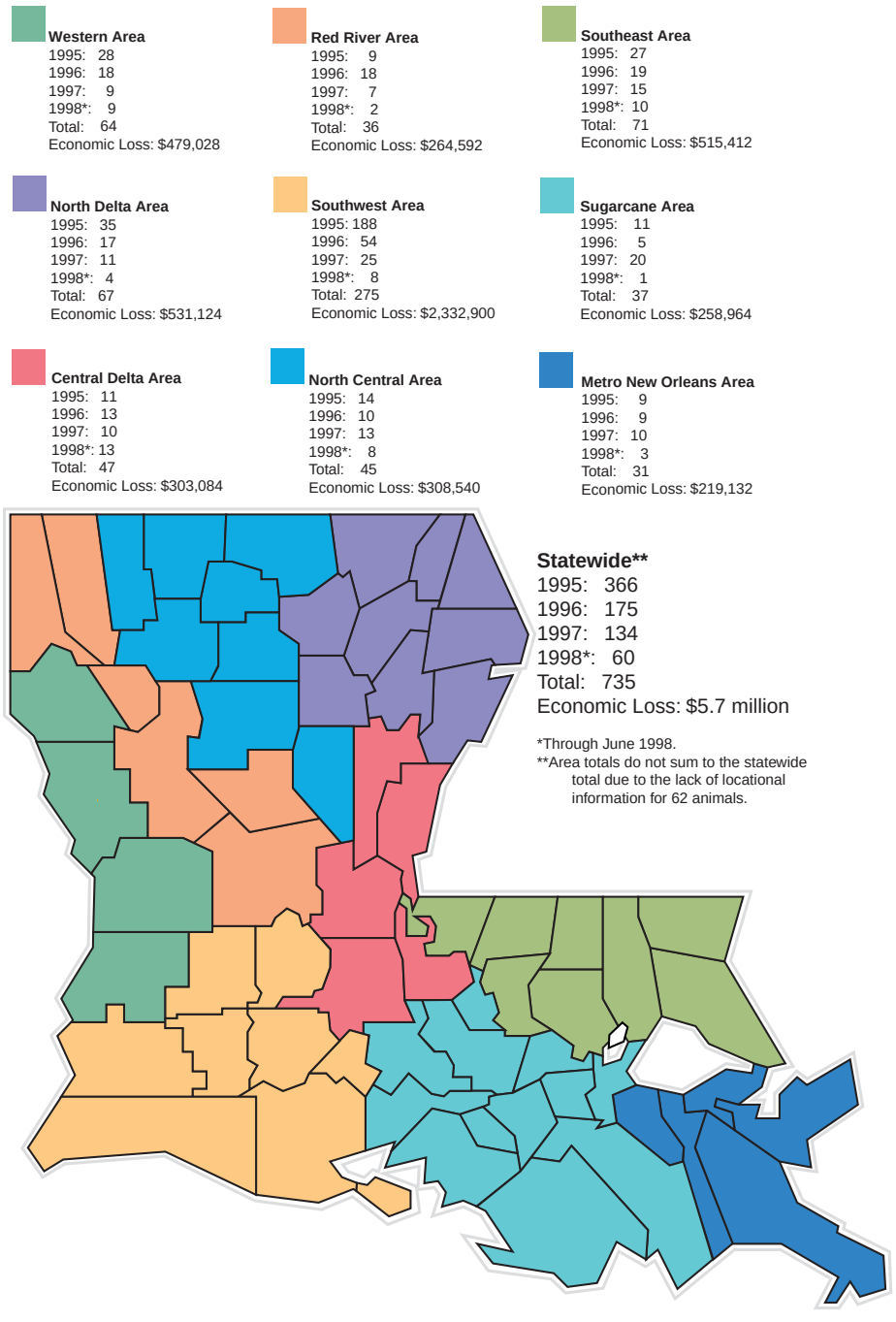
Table 1. Estimated animal value before EIA infection and slaughter value received after EIA Infection, January 1995 through June 1998.

	Estimated Value Prior to Infection	Slaughter Value Received
Mean	$ 1,745	$373
Median	$ 1,200	$375
Standard Deviation	$ 2,486	$200
Minimum	$ 50	$ 5
Maximum	$30,000	$900
No. of Animals	209	181

Gary A. Kennedy, Assistant Professor; William H. Green, Associate Professor and Resident Veterinarian; and Mark W. Murphey, Assistant Professor, Department of Agricultural Sciences, Louisiana Tech University, Ruston, La. Kennedy is also Adjunct Assistant Professor, Department of Agricultural Economics and Agribusiness, LSU Agricultural Center, Baton Rouge, La.

test. Results indicated that the Southwest Area accounted for 275 of the 673 EIA-positive animals for which location information was verified. However, the number of EIA-positive animals in the Southwest Area declined from 188 in 1995 to 25 in 1997, a decrease of 87 percent. Annual totals in Figure 1 indicate that the statewide incidence of EIA in Louisiana is also declining each year. In 1995, there were 366 reactors statewide as compared to 134 in 1997, a decrease of 63 percent.

Figure 1. Numbers of EIA reactors and estimated economic loss in animal value and value added in Louisiana by area, January 1995 through June 1998. Data were collected in July 1998 from the State Veterinarian's Office, Louisiana Department of Agriculture and Forestry. The authors then surveyed owners of EIA reactors in late summer and early fall of 1998 to estimate the economic impact.



Economic impact of EIA

To estimate an economic impact, a mail survey was sent to owners who had animals infected with EIA between Jan. 1, 1995, and June 30, 1998, requesting information on use of the animal, method of disposal and an estimated value before and after infection. Survey results and data provided by the LSU Agricultural Center were used to estimate area and statewide average economic loss in the value of infected animals and the related value-added loss in feed, equipment and veterinary supplies and services resulting from the destruction of infected animals. Information was returned on 220 of the 673 EIA-positive animals in the data set.

An animal value before infection was indicated for 209 EIA-positive animals (Table 1). Nearly 90 percent (188) of EIA-positive horses reported in the survey were sold for slaughter. The remainder were euthanized.

Owners reported using about half the EIA reactors for pleasure purposes. Other uses included ranch work (24 percent), performance events (15 percent) and breeding (11 percent).

The average loss in value per animal was estimated to be $1,372 (mean value before infection minus mean slaughter value received). Considering that a total of 735 animals were infected with EIA over the study period, the estimated total loss in animal value was $1,008,420. Data obtained from the LSU Agricultural Center indicated that equine owners spent an average of $2,000 per animal per year in 1995 and 1996 and an average of $2,200 per animal in 1997 on feed, equipment, tack and veterinary supplies and services. This translates into an estimated value added and related loss of $4,699,600.

Combined with the loss in animal value, the total statewide loss was estimated to be $5,708,020. Continued emphasis on mandatory testing and regulation enforcement in all areas of the state is needed to ensure a continued decline in the incidence of EIA in Louisiana. ■

Acknowledgment

The authors express appreciation to Dr. Maxwell Lea, state veterinarian, Louisiana Department of Agriculture and Forestry, for providing the data that made this research possible.

Site-Specific Application of Fertilizer in Soybeans

Steven H. Moore, Amos I. Bechtel, Robert G. Downer,
Maurice C. Wolcott and Michael L. Tarpley

Illustration by Elma Sue McCallum

New technology using computers and satellites has made it possible to measure the variability of nutrients within a field and vary the rate of applied fertilizer based on need. A two-year study of site-specific application of fertilizer in a soybean field at the LSU Agricultural Center's Dean Lee Research Station in Alexandria involved three tools: a global positioning system (GPS), geographic information systems (GIS) and variable rate technology (VRT).

The global positioning system is operated by the U.S. Department of Defense and involves 24 satellites that transmit radio signals to earth. Receivers on the ground collect these signals to determine longitudinal and latitudinal coordinates. Most receiving systems used in agriculture can calculate location within a few feet. Vehicles, tractors and combines outfitted with receivers are able to determine location at any point in a field.

Geographic information systems are computer software programs used to map and analyze geographic data, such as nutrient concentration in a production field. GIS software matches data with exact coordinates to create a map. The maps provide useful information to producers, such as how organic matter, phosphorus concentration or yield may vary within a production field. A prescription map may be constructed from a soil nutrient map to show the amount of input needed at any site.

Variable rate technology combines GPS and GIS with application hardware to vary the rate of input according to the prescription map. For example, a fertilizer spreader with VRT capability includes a receiver to collect signals from satellites, a computer equipped with GIS and a prescription map of the amount of fertilizer needed at specific sites in the field, and a series of controllers that operate according to computer instructions.

Mapping soil fertility

The study was conducted in 1997 and 1998 on a predominantly Norwood silt loam soil. The test area was about 162 acres. Plot sizes were either 8 or 11 acres. The three treatments in the tests were: fertilizer applied at a uniform rate, fertilizer applied at a variable rate based on a 1-acre grid sampling pattern and fertilizer applied at a variable rate based on a 2.5-acre grid sampling pattern. Soybeans were planted both years in 38-inch rows.

Pettiet Ag Services of Leland, Miss., did soil nutrient maps in the spring of 1997. At the time, no company in Louisiana had begun mapping soils for nutrient content. Samples were collected using both a 1.0-acre and a 2.5-acre grid. A composite sample for the field was collected also. The cost for mapping the test using a 2.5-acre grid pattern was $8 per acre, and the cost for the 1.0-acre grid pattern was $20 per acre.

The boundaries of the field were first determined by driving the perimeter of a field in an ATV equipped with a receiver and GIS. A grid pattern was then overlaid on the field, and a sampling point within each grid was randomly assigned. Samples were collected by driving to each point on the map and pulling soil cores.

Samples were analyzed for phosphorus, potassium, magnesium, calcium, sulphur, zinc, boron, cation exchange capacity, organic matter and pH. Nitrogen is almost never tested for in fields planted in soybeans. Soil test values were entered into the computer, and the data were extrapolated to construct color-coded soil nutrient maps for each grid sampling scheme. Since phosphorus, potassium and sulphur were found deficient, the prescription maps were constructed to show the amount of fertilizer needed at every location in the field to bring these nutrients to desired levels.

Variable rate application

Phosphorus, potassium and sulphur fertilizers were applied at variable and uniform rates using a Terra-Gator (Model 1903) manufactured by Ag Chem Equipment Company, Inc. The Terra-Gator was equipped with a GPS receiver and a Falcon control system (GIS and VRT controllers). The Terra-Gator had four fertilizer bins and applied the three fertilizers in one pass. The spread width was about 20 rows, and the truck ran at about 19 miles per hour, allowing an application time of about an acre a minute. Fertilizer was applied to overwintering beds on April 15, followed by lifting the middles to cover the fertilizer material.

Crop culture

A John Deere vacuum planter was used to plant Asgrow A5885 in 1997 and Pioneer P9611 in 1998. The soybeans were harvested with a John Deere 9400 field combine equipped with a Green Star Yield Monitoring System. Yields were recorded using scales at the elevator where the grain was sold.

Soil nutrient maps for phosphorus and potassium showed the nutrient concentration generally increased from west to east. Finer differences in nutrient concentration were observed in the maps using a 1.0-acre grid sampling pattern, compared to the 2.5-acre grid sampling pattern. More "islands" appeared in the maps based on 1.0-acre grid sampling patterns, but both grids showed similar patterns indicating that the 2.5-acre grid sampling pattern was able to depict soil nutrient variability. Overall, the prescription maps called for less fertilizer in the variable-rate applications than in the conventional uniform application treatment.

Little yield difference

Yield data from the two-year study indicated no significant differences among the three fertilizer application methods. The yield response of soybeans to potassium and phosphorus fertilizers at this location is historically minimal or nonexistent. Assuming no difference in yield, the economic analysis comes down to application costs. Fertilizer costs used in the economic analysis here are $160 per ton for 0-0-60, $230 per ton 0-46-0 and $330 per ton for Sulf90. The soil mapping and testing cost was $20 per sample, and one sample was required for the entire field when uniform fertilization was practiced.

One sample and soil test was required for each 1.0-acre and 2.5-acre grid. Soil sampling is generally done once every three years, so the cost of sampling and soil testing is allocated over a three-year period using a 9 percent cost of capital. Since no significant differences in crop yields were found among the three treatments, total revenue per acre is the same for all. Differing profitability among treatments is reflected solely by the difference in cost associated with the sampling grid size, quantity of fertilizer applied and fertilizer application. These costs are shown in Table 1.

For the two years of this study, uniform or whole field

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sampling and fertilizing was the lowest cost system, with annual fertilizer, sampling, testing and application costs of $30.20 per acre. The costs for the 2.5-acre and 1-acre grid systems were $32.03 and $34.51 per acre, respectively. In this case, uniform fertilizer application increased profitability by $4.31 per acre over the 1-acre grid and by $1.83 per acre over the 2.5-acre grid. Note that in this study only fertilizer cost is being examined. Additional benefits resulting from the information gained through more intensive soil sampling have not been considered. These benefits might include reduced soil-applied herbicide costs made possible by varying application rates to match soil properties or by variable seeding rates that could potentially increase crop yields or reduce seed costs. Note, also, that greater benefits to grid sampling may be achieved when used on crops requiring larger fertilizer applications such as corn or cotton. More research is needed. ■

Acknowledgments

Appreciation is acknowledged to the following agencies that contributed to making this research possible: Louisiana Soybean and Grain Research and Promotion Board, International Teaching and Research Foundation, Ag Chem Equipment Company, Inc., and Potash and Phosphate Institute.

Table 1. Fertilizer and application costs for conventional and variable rate systems.

Input	Soil sample grid size		
	162 acres	1 acre	2.5 acres
0-0-60 Potash ($/acre)	14.27	13.55	13.72
0-46-0 Phosphate ($/acre)	10.05	6.19	8.21
Sulfur 90 ($/acre)	1.83	0.87	0.94
Fertilizer application ($/acre)	4.00	6.00	6.00
Mapping and soil testing ($/acre)	0.05	7.90	3.16
Cost per acre	30.20	34.51	32.03

Mapping Yield in Soybeans

Steven H. Moore, Maurice C. Wolcott and Michael L. Tarpley

Row crop producers have always had an idea of how yield varied in different parts of their fields. By looking at the crop before harvest and visually monitoring yield during harvest, they could see general yield patterns and speculate on why they occurred. But, because of new technology combining satellites and computers, the ability to picture yield patterns in a field and make diagnoses of the causes have been greatly advanced. A two-year study was undertaken at the LSU Agricultural Center's Dean Lee Research Station to assess how this new technology can be used as a diagnostic and management tool.

Yield monitoring system

Yields were mapped in this study with a John Deere GreenStar Yield Monitoring System installed on a John Deere 9400 field combine equipped with a six-row header. The John Deere GreenStar Yield Monitoring System has five principal components:

- a GPS system that receives radio signals from satellites to determine longitudinal and latitudinal location
- a mass flow sensor at the top of the clean grain elevator to measure the force exerted by grain exiting the elevator
- a moisture sensor mounted on the return clean grain elevator
- an auger speed sensor
- a computer, located behind the operator's seat in the cab of the combine, to synthesize data from the other four components.

A yield measurement is made every 2 seconds when the header of the combine is down and engaged with the system turned on. The combine may operate for 250 hours before data need to be dumped from a PCMCIA card onto the hard drive of a desktop computer equipped with JD Map software. Instructions are in a manual that comes with the software to make yield maps.

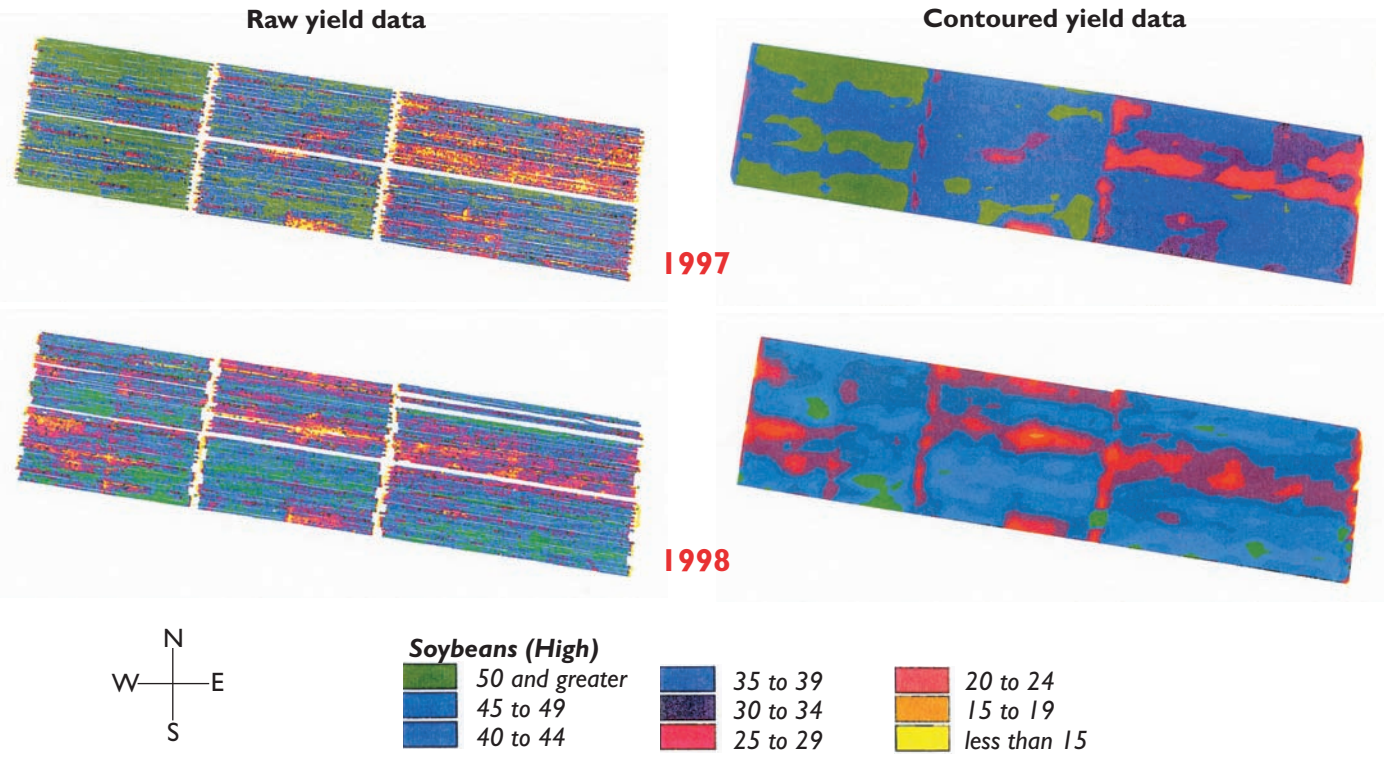
Mapping yield

Soybean yields were mapped in a 162-acre soybean field in 1997 and 1998. The soil type is predominantly Norwood silt loam and is traditionally cropped to cotton. Asgrow A5885 was planted the first year and Pioneer P9611 the second. The soybeans were produced in 38-inch rows on raised beds. The first season was cool at the beginning but fairly normal afterward. The second season was extremely hot and dry for the region.

Raw yield data for 1997 are color coded in Figure 1. The average yield for the field in 1997 was 41 bushels per acre, according to elevator scales. The white gaps in the yield map are turn rows and a drainage ditch. The highest yields occurred mostly in the western portion of the field. Lowest yields were in the eastern part, and trouble spots are easily distinguished.

Steven H. Moore, Professor; Maurice C. Wolcott, Research Associate; and Michael L. Tarpley, former Research Associate, Dean Lee Research Station, Alexandria, La.

Figure 1. This shows the difference between the raw yield data and contoured yield data for both 1997 and 1998. The white gaps in the yield map are turn rows and a drainage ditch. Trouble spots are easily distinguished. The four rectangular cuts in the western two-thirds of the field are 24 acres each. The other two are 33 acres each. The contoured yield maps help distinguish management zones. A trend in precision agriculture is to define management zones for individual treatment.



The four rectangular cuts in the western two-thirds of the field are 24 acres each. The other two are 33 acres each.

Raw yield data may be contoured using extrapolation procedures to show broad yield patterns. This is a helpful procedure for distinguishing management zones. A trend in precision agriculture is to define management zones for individual treatment.

Yield patterns from the 1998 soybean harvest were similar to those in 1997 but showed additional features as well. In 1998, the average yield for the entire field was 40 bushels per acre, according to elevator scales. Temperature exceeded 105 degrees F during the season, which was relatively dry. The hot and dry conditions seemed to bring out new areas of the field where yield was markedly low.

Comparing yields

Twelve plots were harvested in 1997 where comparisons could be made between elevator totals and the yield monitoring system (Table 1). The calibration coefficient used to transcribe mass flow data into yield was periodically updated in the same field. In 1997, the difference in yield measurements between the GreenStar system and the elevator varied by up to 21 bushels per acre, although a difference of this magnitude was rare. All other differences were less than 10 bushels per acre. There was a difference of only three bushels per acre when measuring yield for the entire field.

Seventeen comparisons were made in 1998 (Table 2). One

Table 1. Yield measurements recorded by the John Deere GreenStar Yield Monitoring System in 1997 without periodically stopping to calibrate compared to weights recorded on grain elevator scales.

Plot	Acreage	GreenStar	Elevator	Difference
			Bu/Acre	
1	8	43	38	+5
2	8	41	34	+7
3	11	37	34	+3
4	11	33	34	-1
5	11	27	35	-8
6	24	44	37	+7
7	8	54	45	+9
8	8	45	42	+3
9	8	62	41	+21
10	11	45	44	+1
11	11	40	43	-3
12	11	37	42	-5
Average	—	42	39	+3

calibration coefficient was used for the entire field. The largest difference was 13 bushels per acre, with all others being 10 bushels or less. There was a six-bushel difference between the two measurements when considering the entire field.

The differences in yield measurements point to the need to use large, representative acreage when calibrating the yield monitor. It is a good practice to continually update the calibration, perhaps at the end of each day when elevator totals and acreage are known.

Table 2. Yield measurements recorded by the John Deere GreenStar Yield Monitoring System in 1998 without periodically stopping to calibrate compared to weights recorded on grain elevator scales.

Plot	Acreage	GreenStar	Elevator	Difference
			Bu/Acre	
1	8	39	35	+4
2	8	40	40	0
3	8	38	31	+7
4	8	41	38	+3
5	8	40	30	+10
6	8	36	34	+2
7	8	37	34	+3
8	8	42	29	+13
9	8	37	27	+10
10	8	45	40	+5
11	8	42	32	+10
12	8	44	39	+5
13	11	36	26	+10
14	22	39	34	+5
15	11	42	36	+6
16	11	41	35	+6
17	11	42	41	+1
Average	—	40	34	+6

Using yield maps

Yield maps may be used as both diagnostic and management tools. Studying a yield map may help diagnose the cause of a particularly low or high yielding area by linking the information on the map with what is known about the field.

Sometimes the cause of a low-yielding area is unknown. For example, the low-yielding area in the bottom center of the field is believed to be caused by compaction; the cause of the low-yielding strip in the northeast section of the field is unknown. There are at least two approaches to determine the cause for low yield in this strip. One is to sample soil inside and outside of the low-yielding area. Comparison of these data may provide a reason for the yield difference. Another approach is to map other parameters affecting yield for the entire field, such as soil compaction or micro-topography related to drainage.

Additional parameters have been mapped for the field, including tissue nutrients in 1997, DRIS indices (nutrient balance) in 1997 and electrical conductivity in 1998. Correlation between yield and these parameters revealed how each was related to yield (Table 3). For example, 29 percent of the variability in yield could be accounted for by the variability of electrical conductivity (first column in Table 3). Furthermore, yield went up as electrical conductivity went down.

The correlation between phosphorus and yield was low. This does not mean phosphorus was unimportant, only that it was not a very high limiting factor. One-third or more of the variability in yield could be accounted for by the variability in potassium, suggesting that this nutrient often may have been a limiting factor.

The ability to correlate yield data with factors affecting production in individual fields provides a tremendous advancement in diagnostic ability for correcting yield-limiting factors. A second major economic advantage is that the solution need be applied only in the problem portion of the field. One caution in using correlation coefficients is that sometimes a parameter may not directly affect yield, but only be highly associated with a parameter that does.

Spatial stability of yield

Yield maps may provide an excellent tool to diagnose what happened last year. Their use for making management decisions, such as fertilizer recommendations, will be determined largely by the spatial stability of yield. Spatial stability measures the relative consistency in yield ranking of one location of a field with another from one season to the next. If there is no spatial stability, then yield maps provide no information for the future. If spatial stability is high, yield maps provide much information.

A limiting factor in soil grid sampling for site-specific fertilizer application is the cost. In addition, only one sample is usually collected for every 2.5 acres, which leads to the likelihood of missing variability in Louisiana soils. Yield maps often contain 200 or more measurements of variability at a relatively inexpensive cost per sample. If an input can be prorated according to yield, then yield maps may be useful for making variable-rate application.

Fertilizers are often recommended based on yield goal. If the yield goal in a field varies, then the fertilizer recommendation should vary. A cropping systems study to determine the spatial stability of yield in corn, cotton and soybeans (and rotations) was established at Alexandria in 1998. Field experiments to apply nitrogen on corn and cotton based on yield maps from a previous season also were initiated. ■

Table 3. Correlations between yield and selected nutrient concentrations.

	Nutrients									
		Soil			Tissue			DRIS Indices		
	EC*	P	K	Na	P	K	Na	P	K	Ca
Yield	-0.29	0.08	-0.38	0.32	-0.03	-0.33	-0.06	0.16	-0.33	-0.14

*electrical conductivity

Photos by Ed Bush

A typical container nursery operation using an overhead sprinkler irrigation system requires 0.5 to 2.0 inches of water per acre per day.

Cyclic irrigation improves nursery crop efficiency

Nursery crop production in Louisiana and across the southeastern United States has experienced unprecedented growth in the past decade. In 1998, Louisiana ranked 17th nationwide in wholesale sales of nursery crops with more than $107 million and 20th nationwide in retail sales of lawn and garden products with $1.4 billion.

The most important consideration in commercial nursery production is availability of large quantities of high quality water for irrigation. A typical container nursery operation using an overhead sprinkler irrigation system requires 0.5 to 2.0 inches of water per acre per day. This is equivalent to between 12,500 and 50,000 gallons of water per acre per day or 5 to 10 acre-feet of water per production season. These amounts vary from one nursery to another. The upper end of this range is typically considered excessive, while the lower end can produce desirable quality plants only under a properly designed irrigation system maintained under ideal environmental conditions.

Nursery managers are exploring how to reduce water requirements by converting to alternative irrigation methods. This has included installation of drip irrigation systems, especially for larger containers, and use of a cyclic irrigation schedule. Cyclic irrigation dispenses the daily water allotment in more than one application with timed intervals between each one. Most nurseries previously irrigated on a daily basis, applying the daily water allotment in a single application, which is called continuous irrigation. The use of a cyclic irrigation system significantly decreases the amount of irrigation water applied and reduces the amount of nutrients leached from the container medium, thus increasing fertilizer efficiency. Compared to continuous irrigation, cyclic

Cyclic irrigation can be used with spray (micro-irrigation) systems.

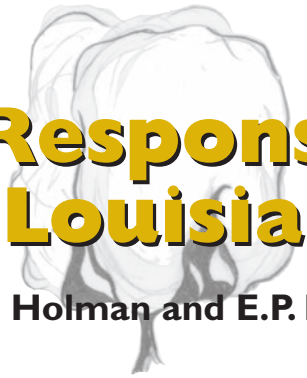
Photo by Ed Bush

This lined ditch collects the runoff for re-use.

irrigation has been shown to reduce the volume of water runoff by as much as 30 percent and the amount of nitrate leached from the containers by more than 40 percent. Cyclic irrigation can be used with overhead and drip (micro-irrigation) systems.

One objective of LSU Agricultural Center studies has been to determine the efficiency of cyclic irrigation by measuring container leachate volume or effluent (excess water). Results indicate that cyclic irrigation reduces effluent, while improving water and fertilizer efficiency. ■

Edward Bush, Assistant Professor, Department of Horticulture; Allen Owings, Associate Specialist, and Ann Gray, Research Associate, Department of Horticulture, LSU Agricultural Center, Baton Rouge, La.



Cotton Response to Pix in Louisiana

E. Merritt Holman and E.P. Millhollon

Cotton is a perennial that continues to grow vegetatively during reproductive development. A consequence of this characteristic can be excessive vegetative growth under conditions of above-optimum soil moisture and fertility, thereby delaying maturity and increasing the incidence of lodging. The excessive foliage can create an environment favorable for boll rot and can decrease picker harvest efficiency. In an attempt to limit excessive vegetative growth in cotton, several growth retardants have been tested over the past 25 years. One that has been investigated extensively is 1,1-dimethylpiperidinium (mepiquat chloride).

In 1980, BASF Corporation began marketing a formulation of mepiquat chloride under the trade name Pix, the first widely marketed plant growth retardant for cotton. Currently, several formulations of mepiquat chloride are marketed and sold in Louisiana as Pix, Pix Plus, Mepex, MepPlus and Mepichlor. Although plant growth regulation using Pix has been under investigation since the mid 1970s in Louisiana and other cotton-producing states, results concerning the economic benefits have been contradictory. Determining where Pix belongs in a cotton production program in Louisiana necessitates a closer examination of the research and the underlying physiological effect of Pix on cotton growth and development.

Pix and plant growth

Once inside the plant, Pix reduces the synthesis of a class of plant hormones referred to as gibberellins. One of the major effects of this hormone class is to promote cell expansion in plant tissues. As some cell expansion is obviously needed, complete inhibition of gibberellin is not desirable; therefore, the rate of Pix applied to plants is critical to achieve the desired plant growth response. Pix concentration in the plant is a function of the rate applied and the plant size at application. Following application, the concentration of Pix in the plant is diluted by plant growth. Thus, Pix applied when plants are small can result in a significant plant response, whereas the same amount applied when plants are larger can result in little or no response.

Research conducted in Louisiana and other states has shown that Pix applications reduce internode elongation, resulting in a reduction in overall plant height and length of vegetative branches. Pix also causes smaller, thicker leaves, resulting in a characteristic dark-green color. Pix does not reduce existing plant tissue but limits further expansion following application. In theory, because Pix-treated cotton requires less energy and nutrients for leaf expansion and stem elongation, more energy should be available for boll production and, consequently, higher lint yields. In practice, however, the effect of Pix on yield has been highly inconsistent and in some cases negative.

Louisiana research results

Plant height. The effect of Pix on cotton plant height has been well documented under a multitude of environments, rates and timings by several researchers at the Northeast Research Station near St. Joseph since 1975. In the late 1970s, Steve Crawford demonstrated in small and large plot research that Pix consistently reduced height by 15 percent. Don Boquet, in the early 1990s, found that Pix reduced height by an average of 13 percent across two row spacings, five varieties and two soil types. More recently, Holman observed a 12 percent decrease in final plant height with Pix applied when the average of the upper five internodes was longer than 1.8 inches. Height reductions have been the most stable response to Pix measured in Louisiana research.

Crop maturity. Research in other states has suggested that Pix results in earlier crop maturity. Early maturity could help lower a farmer's production costs by avoiding late populations of insect pests. In Louisiana, only two of the nine studies reviewed showed an increase in earliness associated with Pix. Most of the studies conducted in Louisiana have been non-irrigated, which could allow a dry period during the summer to negate any differences in crop maturity as a result of using Pix. On the other hand, in the situations where earlier maturity was observed with Pix, the difference in days to harvest was rather small: less than or equal to five days.

Lint yield. The most important economic response, lint yield, has also been the most inconsistent, ranging from a 24 percent increase to a 19 percent decrease. In Crawford's studies in northeast Louisiana, yield increases or decreases with Pix were closely associated with differences in soil moisture. Thus, in dry conditions, Pix limited plant growth to the extent that yield was negatively affected (two of seven years), whereas yield increases with Pix occurred only under high-rainfall conditions (two of seven years) where excessive plant growth and boll rot were noted.

Cotton boll rot. About 10 percent of the Louisiana cotton crop is lost each year to cotton boll rot. The reduction in plant growth with Pix could allow more sunlight penetration and air circulation around lower bolls and create an unfavorable climate for the fungi that cause boll rot. Snow and colleagues initiated a study at the Dean Lee Research Station near Alexandria in 1978 to determine the effect of Pix on boll rot and yield. The incidence of boll rot was reduced indirectly by Pix in all three years of the study with yield increases up to 24 percent occurring during years with high rainfall, vigorous plant growth and a high incidence of boll rot in untreated plants. Thus, some of the variability in yield response to Pix can be explained by conditions (high rainfall and excessive plant growth) conducive to boll-rotting fungi.

Different varieties. There is also some evidence that varieties respond differently to Pix. Jones and Dickson in Baton Rouge found a yield increase from Pix in one of two studies in 1987.

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The yield increase from Pix occurred with experimental strains (okra-leaf shape) when soil moisture was adequate to excessive, but there was a larger yield increase in the more vigorous strains. However, Millhollon and colleagues at the Red River Research Station in Bossier City found no yield differences in three normal-leaf varieties and one okra-leaf variety in response to Pix. Boquet and Coco also found no difference in yield response among five varieties of varying growth habit. Thus, the evidence supporting a Pix-by-variety interaction is not conclusive. However, it is reasonable to expect some degree of variety interaction with Pix because boll rot can be more severe in large, vigorous varieties.

Row spacing. Row spacing and loss of early squares are other factors that have also been investigated for interaction with Pix. Boquet and Coco found no interaction between Pix applications and row spacing. In addition, Cook and Kennedy in 1992 observed that Pix application following early square loss improved yield. However, they concluded that the interaction between Pix rate and timing and the amount of square loss would make it difficult to estimate the appropriate rate and timing for maximum benefit.

New product with *bacillus cereus*

In 1998, Micro Flo Company (Lakeland, Fla.) introduced a new plant growth regulator under the trade name Mep Plus, which contains mepiquat chloride and *bacillus cereus*. Researchers in several states are currently investigating the effect of *bacillus cereus* on plant growth. Testing by Holman in 1997-98 indicated that Mep Plus applications resulted in similar plant responses in height reduction and yield as the same rate of Pix.

What it means to Louisiana cotton producers

- Pix and similar growth regulators can reduce plant height by 10 percent to 15 percent. However, late applications, even at a high rate, have little effect on final height and will lower net return.
- The effect of Pix on crop maturity is small to none with only modest increases in earliness at best.
- Pix applications can increase, decrease or have no affect on lint yield, depending on application timing, rate and environmental conditions.
- Yield increases from Pix were most often associated with situations such as high rainfall and excessive vegetative growth that favored boll-rotting fungi.
- Yield decreases from Pix were most often associated with drought conditions that occurred some time during the fruiting period.
- Producers must avoid yield decreases to break even with Pix priced at 70 cents to 80 cents per fluid ounce. To increase net return, producers must be conservative and apply Pix only when conditions warrant.

The shorter, more consistent plant height and dark green color associated with Pix-treated cotton are highly attractive to producers. However, Pix should be used only in fields with a prior history of excessive growth and adequate soil moisture. Producers should consider soil type, irrigation and previous rainfall. If it is determined a Pix application is justified, multiple applications at low rates will reduce the risk of a yield decrease if drought conditions ensue.

The recent interest in ultra-narrow-row cotton may establish a new niche for Pix in Louisiana. This cotton production system requires substantially shorter cotton plants with greatly reduced vegetative growth. Research on ultra-narrow-row cotton in Louisiana is limited but will be an area of future research. ■

Table 1. Pix Research at the LSU Agricultural Center.

Location and Date	Agricultural Center Scientist	Factors Investigated	Summary of Major Findings
St. Joseph 1975-1981	S. H. Crawford	Rates and timings	Pix reduced plant height 15% and did not affect maturity. Yield response was inconsistent (+14% to –19%).
1992-1995	D. J. Boquet and A. B. Coco	Row spacing, varieties, and soil type	Pix resulted in 13% height reduction, 3-7% earlier maturity, and no effect on yield. There was no interaction with row spacing, varieties or soil type.
1996-1998	E. M. Holman	Rates and timings	Pix applied using a growth indicator to determine timing resulted in 12% height reduction, 0-10% earlier maturity and no effect on yield. Mep Plus applications produced similar plant responses to Pix.
Alexandria 1978-1980	J. P. Snow, S. H. Crawford, G.T. Berggren and J. G. Marshall	Boll rot	Pix resulted in 28-46% reduction in boll rot and from 0-24% yield increase.
Baton Rouge 1987	J. E. Jones and J. I. Dickson	Varieties	Pix had no effect on yield in one study among normal-leaf strains and up to a 17% increase in another with two okra-leaf strains. The increase was greater with the larger, more vigorous strain. There was no difference in crop maturity in either study.
1988-1992	C. W. Kennedy	Varieties and early fruit retention	Pix increased the yield (14%) of a normal-leaf cotton strain one of two years but resulted in no differences in yield for a similar okra-leaf strain. Pix application following early square loss improved yield, but interactions with the amount of square loss, rate and timing would make it difficult to select appropriate rate and timing.
Bossier City 1992	E. P. Millhollon	Varieties	Found no yield differences among varieties.

Photo by Mark Claesgens

The black cow is a Brangus-sired cow, and the red cow on the right is a Gelbvieh-sired cow. Both are being evaluated as brood cows. The two calves are both Simmental-sired.

Preweaning Performance of Angus-, Gelbvieh-, Brangus- and Gelbray-Sired Crossbred Calves

Sidney M. DeRouen and J. Michael Turpin

Most commercial cow-calf herds in Louisiana and in the southeastern United States include fewer than 100 animals and consist of crossbred combinations of Brahman, British, Continental and possibly dairy breeds. The first-cross Brahman has been recognized as one of the more productive brood cows throughout the southern United States because of superior adaptability and productivity in hot, humid weather.

Crossbreeding is widely recognized as an excellent management tool for improving productivity because of heterosis. Heterosis is the superiority exhibited by crossbred individuals for a particular trait, such as weaning weight, compared to the average of straightbred animals. The effects of crossbreeding can accumulate. Even though only a small level of heterosis may be realized for a single trait, the effects tend to be additive

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so that an increase in overall productivity can range from 9 percent to 28 percent.

A major disadvantage of traditional crossbreeding systems is that the producer must use several breeding pastures or artificial insemination. For producers with cow herds of fewer than 100 animals, this is not feasible. Another limitation is the difficulty of producing suitable replacement females of the desired breed composition. It is almost impossible to produce the optimum market steer calf and the ideal replacement heifer from the same mating system because carcass characteristics and maternal traits are antagonistic.

In this crossbreeding study, the main objective was to compare straightbred- and composite-sired progeny that vary in percentage of Brahman inheritance. In addition, British (Angus) and Continental (Gelbvieh) sire breeds were evaluated along with their Brahman derivative counterparts, which are Brangus (5/8 Angus-3/8 Brahman) and Gelbray (5/8 Gelbvieh-3/8 Brahman). In this report, progeny produced from these matings were evaluated for potential as market calves.

Mating systems, preweaning management

A total of 503 calves were weaned from both spring and fall calving seasons over a four-year period. First cross (F_1) Brahman x Hereford cows were sorted by cow age and were randomly allotted each year to one of eight breeding groups. Groups of cows were exposed each year to either Angus, Gelbvieh, Brangus or Gelbray sires. All together, 29 sires were used — nine Angus, seven Gelbvieh, six Brangus and seven Gelbray. The Angus- and Gelbvieh-sired offspring had 1/4 Brahman inheritance, whereas Brangus- and Gelbray-sired offspring had 7/16 Brahman inheritance.

Spring-calving cows were exposed to bulls from May 1 through June 30. Calves were born from early February through mid April in 1993 through 1996, with weaning occurring in late September of each year. Cows and calves were placed on bermudagrass pastures during the preweaning period. Before bermudagrass became available for grazing, cows were fed bermudagrass hay and an energy supplement (3 to 5 pounds per head per day of ground corn).

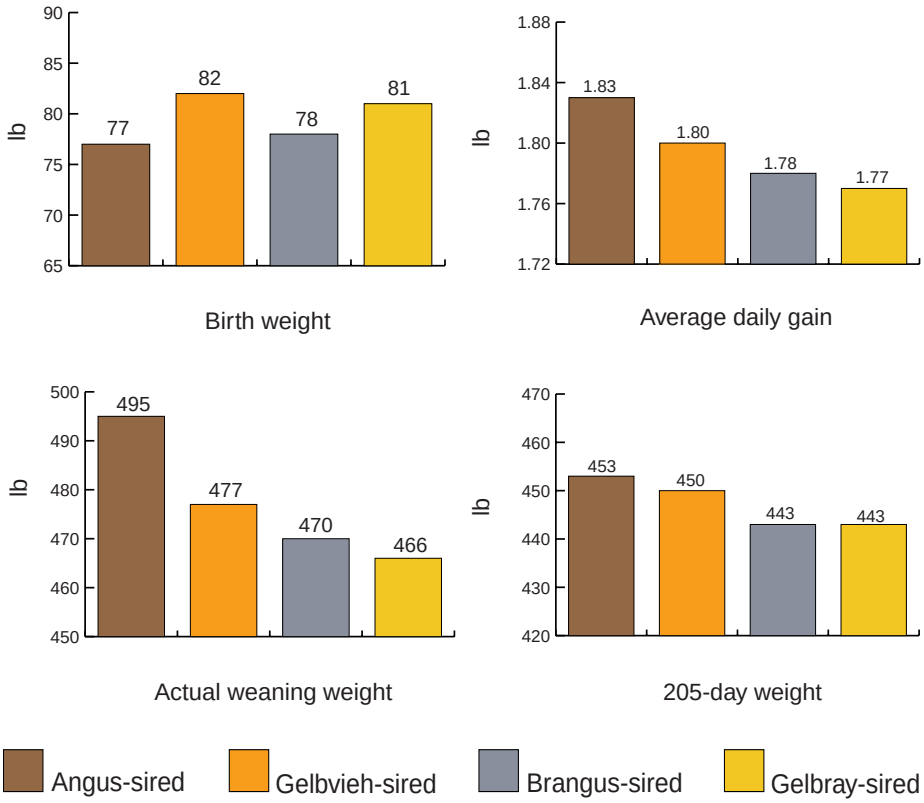
Fall and late-summer calving cows were exposed to bulls from October 15 through December 14. Calves were born from late July through early October 1993 through 1996, with weaning occurring in mid April of the subsequent year. Calves were weaned at this time so that they could be placed into a stocker grazing program on bermudagrass pastures in late April. During the preweaning period, cows and calves grazed bermudagrass until it became dormant. Thereafter, cows were fed with bermudagrass hay and an energy supplement (3 to 5 pounds per head per day of ground corn). No grazing of cool-season annuals, such as ryegrass, was employed for either calving system during the preweaning period.

Cows were tested for pregnancy about 60 days after the end of the breeding season, and open cows were reassigned to the alternate calving season to allow the production of as many calves as possible. Cows that were open after a second consecutive breeding season were culled. All male calves were castrated at birth. Creep-feeding was not practiced. Recommended health and management practices were followed on the cows and calves.

Calving season and calf sex effects

Fall-born calves were 2 pounds heavier at birth than spring-born calves. Average daily gain for spring-born calves, however, was 0.45 pound greater than for fall-born calves. This resulted in a 14-pound-heavier actual weaning weight and a 90-pound-heavier adjusted 205-day weight for spring-born calves. It is important to note that the majority of the preweaning period for the fall-born calves occurred when the bermudagrass was dormant. Cows and calves in this calving system were provided free-choice bermudagrass hay and 3 to 5 pounds of ground corn per cow. Under this type of nutritional program, the growth potential of fall-born calves was apparently hindered, resulting in substantially lower preweaning weight gains compared to spring-born calves. Male calves were 3 pounds heavier at birth and 22 pounds heavier at weaning and had greater preweaning gains than female calves.

Figure 1. Birth weight did not vary among sire breeds. Rate of average daily gain and actual weaning weight were similar among sire breeds. When weaning weight was adjusted to an age-constant basis (205-day weight), the variation among sire breeds was reduced.



Sire breed effects

Figure 1 shows the performance of preweaning traits of crossbred calves by sire breed. There was no change in rank of sire breed between the two calving seasons. The range in birth weight – from 77 pounds for Angus-sired calves to 82 pounds for Gelbvieh-sired calves – did not vary among sire breeds. Rate of average daily gain was similar among sire breeds (1.77 to 1.83 pounds per day). Actual weaning weight ranged from 495 pounds for Angus-sired calves to 466 pounds for Gelbray-sired calves and was similar among sire breeds. When weaning weight was adjusted to an age-constant basis (205-day weight), the variation among sire breeds was reduced (443 to 453 pounds).

Estimated market value (at 75 cents per pound) of calves, if sold at weaning, would be $371 for Angus-, $358 for Gelbvieh-, $352 for Brangus- and $350 for Gelbray-sired calves based on actual weaning weight. The Brangus- and Gelbray-sired calves may possibly be discounted because of level of Brahman inheritance. A possible explanation for the lack of variation in preweaning performance due to sire breed could be that the maternal ability of the F_1 Brahman x Hereford cow tended to mask any differences in growth potential among these breeds.

In this study, an attempt was made to sample individual sires of each breed that would be representative of the type of bulls used by commercial cattle producers in this state. However, because only 29 bulls were sampled, true representation of the average of each respective sire breed may not have been attained.

In conclusion, calf performance was statistically similar among straightbred and Brahman-composite bulls when mated to F_1 Brahman x Hereford cows. Angus- and Gelbvieh-sired calves were numerically heavier at weaning, resulting in increased market value compared to Brangus- and Gelbray-sired calves.

A long-term objective of this study includes evaluation of female productivity. Brangus and Gelbray bulls producing calves with 7/16 Brahman inheritance would not be ideal sire breed types when marketing at weaning but would be suitable sires to consider for producing replacement heifers. These calves will be evaluated for potential as replacement heifers, stockers, feeders and for carcass merit. ■

Horn flies and mastitis development in dairy heifers

Dairy heifers are at risk for mastitis long before parturition. Recent studies document that these animals can become infected with a variety of mastitis pathogens. If undetected and untreated, these infections can often persist through calving and into the first lactation.

Staphylococcus aureus, a major mastitis pathogen, is often present as a cause of heifer mastitis, and, in some herds, this microorganism infects more than a third of the heifers. How and when these infections become established is unknown. Studies suggest flies may be involved in this disease, but no direct data implicating flies exist.

In this preliminary study, two heifers were exposed to horn flies fed blood that contained *Staph. aureus* to determine if mastitis could be induced by fly bites. Results indicate that the horn fly (*Haematobia irritans*) can be colonized with *Staph. aureus* during feeding and can remain colonized for up to four days, with substantial numbers of organisms present. When colonized horn flies were allowed to feed on teats of uninfected dairy heifers, mastitis with the same *Staph. aureus* strain resulted. This indicates that the horn fly can transmit *Staph. aureus* to heifers' teats if a source of organisms is present. That source was shown to be present in the existing scabs on the teat ends of heifers. High concentrations of *Staph. aureus* were found in scab material present on heifers' teats. When uncolonized flies were allowed to feed on this material, they became colonized with *Staph. aureus* just as readily as flies that had fed on experimentally infected blood. Thus, a vector capable of transmitting the infection is readily present, and when a source of *Staph. aureus* exists, such as scabs on heifer teats, the potential for dissemination of mastitis from heifer to heifer via horn flies exists.

The threshold number of flies required to be present to transmit mastitis is unknown. Because fly populations can rapidly increase to several thousand per animal under favorable conditions, however, the need for early fly control on dairy heifers in herds with a *Staph. aureus* problem is apparent. Once scabs are obvious and fly populations are high, spread of new infections is highly likely. ■

William E. Owens, Professor, Hill Farm Research Station, Homer, La.; Lane D. Foil, Professor, Entomology Department, LSU Agricultural Center, Baton Rouge, La.; C.H. Ray, Research Associate, and Stephen C. Nickerson, Professor, Hill Farm Research Station

Hill Farm researcher wins national dairy award

An LSU Agricultural Center professor received the 1999 Dean Foods Award at the American Dairy Science Association's Annual Meeting in Memphis, Tenn.

Stephen C. Nickerson, a professor and researcher at the Hill Farm Research Station at Homer, was recognized for his scientific contributions – including research on the structure and function of the mammary gland's resistance to mastitis.

"Dr. Nickerson is one of the premier researchers in the country," said R. Larry Rogers, vice chancellor of the Ag Center and director of the Louisiana Agricultural Experiment Station. "His research has made a significant contribution toward the control of mastitis, which is the most costly disease in the dairy industry."

The Hill Farm Research Station has one of the premier mastitis laboratories in the country, Rogers said. The lab was established in 1968 and expanded in 1985, and Nickerson has been a researcher there since 1981. ■

Post-Molting Time and Consumer Acceptability of Fried Soft Crawfish

Viacheslav L. Sereda, Witoon Prinyawiwatkul, Mohamed Ahmedna, Ramu M. Rao, Alfred F. Trappey II and Douglas L. Park

Soft-shelled crawfish, often referred to as soft crawfish, have been consumed in Louisiana for many years. Commercial production of soft crawfish follows the annual molt cycle. Soft crawfish are produced by holding and feeding large numbers of the immature, hard (intermolt) crawfish in culture trays until they molt.

The quality of soft crawfish is critically affected by post-molting calcification and time. Calcium that initially hardens the soft exoskeleton is obtained from the dissolving gastroliths (calcium stones in the stomach), hepatopancreas (liver and pancreas), blood (so-called hemolymph), and water and food when feeding resumes. Shell hardening normally takes 72 hours. Crawfish should be harvested immediately after molting to ensure the best quality.

The longer the post-molting time, the more calcium is dissolved from gastroliths and deposited in the shell. As the new shell gets harder, the less marketable the crawfish becomes as a premium product. To obtain the best quality for consumption, soft crawfish must be collected within two to eight hours, depending on the water temperature. Ninety percent of crawfish molt during the midday hours (10 a.m. to 3 p.m.). If the newly molted crawfish are left overnight, some may harden to the point that they are not marketable as a premium product.

Post-molting time

No research has been done to identify the allowable post-molting time that still yields consumer-acceptable fried soft crawfish. Increasing allowable post-molting time would enable producers to harvest more marketable soft crawfish. The objective of this study was to determine color and textural qualities and consumer acceptability of non-breaded fried soft crawfish as affected by post-molting calcification and time (6, 12, 18 and 24 hours).

Collection and sample preparation. For each different post-molting time of 6, 12, 18 and 24 hours, 70 crawfish were collected from the premolt tray and placed in separate molting trays for 6, 12, 18 and 24 hours, respectively. All crawfish were soaked in 1 percent salt solution for three hours at 42.8 degrees F and then placed in freezer bags. The bags were filled with tap water to cover all crawfish and stored at minus 4 degrees F. Ten hours before consumer sensory evaluation, all soft crawfish were thawed in the refrigerator and fried unbreaded in soybean oil at 350 degrees F for three minutes. Freshly fried crawfish were used for consumer sensory and physical property evaluation.

Color and texture measurements. Color measurements were determined using a spectrophotometer on the tail part of the fried soft crawfish. Colors were expressed as L* (brightness), +a* (redness), +b* (yellowness), hue angle (actual color) and chroma (intensity) values. Texture measurements were made on the third ring of the tail part and expressed as maximum force (Kg) required to shear an individual fried crawfish.

Consumer sensory evaluation. Fifty-eight consumers were randomly recruited from the Baton Rouge area. These consumers were between 18 and 65 years of age and not allergic to crawfish and soybean oil used for frying. One whole piece of freshly fried soft crawfish from each of the different post-molting times was presented to consumers on a white plastic plate coded with a three-digit random number. Consumers evaluated the acceptability for appearance, color, flavor, crispness of shell, overall texture and overall liking of four samples using a 9-point scale (1 = dislike extremely, 5 = neither dislike nor like, and 9 = like extremely). Consumers also classified each fried soft crawfish product as "acceptable" and "unacceptable" and indicated whether they would buy or not buy the product.

Results and discussion

Color. The purple, blue and red colors of live crawfish are attributed mainly to the carotenoid and carotenoprotein pigments. The carotenoproteins get denatured upon heating, causing the color changes from purple and blue to reddish-orange. Color brightness (L*) and yellowness (b*) of fried soft crawfish generally increased with increased post-molting time (Table 1). Color redness (a*) was not drastically affected by post-molting time. The 24-hour fried soft crawfish had more intense orange color than did other samples as indicated by the hue angle and chroma values.

Texture. Maximum peak force (Kg) of fried soft crawfish decreased with increased post-molting time. The six-hour fried crawfish required more force to shear than did the 24-hour

Table 1. Changes in color of fried soft crawfish as affected by post-molting time.

	Post-molting time (hours)			
Color	6	12	18	24
L*	33.9	33.7	44.9	51.8
a*	28.8	31.9	28.2	30.1
b*	18.6	19.6	35.4	45.3
Hue angle	33.0	31.5	50.3	56.3
Chroma	34.3	37.5	45.9	54.4

Viacheslav L. Sereda, Research Assistant; Witoon Prinyawiwatkul, Assistant Professor; Mohamed Ahmedna, Research Assistant; Ramu M. Rao, Professor; Alfred F. Trappey II, Instructor; and Douglas L. Park, Professor, all with the Department of Food Science, LSU Agricultural Center, Baton Rouge, La.

Table 2. Mean consumer acceptability scores of fried soft crawfish as affected by post-molting time.

	Post-molting time (hours)			
Acceptability	**6**	**12**	**18**	**24**
Appearance	6.3	6.3	6.0	6.3
Color	7.1	7.2	6.4	6.0
Flavor	6.7	6.8	6.2	6.6
Shell crispness	6.5	6.4	5.7	6.2
Overall texture	6.8	6.8	6.0	6.6
Overall liking	6.6	6.7	5.9	6.3

sample. This was likely due to the very elastic, thin layer of newly synthesized skin as opposed to the crispy, crushable shell of the 24-hour fried soft crawfish.

Product acceptability. Mean acceptability scores for appearance of fried soft crawfish were least influenced by post-molting time (Table 2). Color acceptability score of the 24-hour fried crawfish was less than that of the six-hour sample. Based on the color values (Table 1) and the sensory data (Table 2), consumers may prefer fried soft crawfish with darker red color over those with lighter orange color.

Texture quality of fried soft crawfish is critical to consumer acceptability. The shell crispness and overall texture of the 24-hour fried sample were as acceptable as the six-hour sample. This indicates that consumers may prefer fried crawfish with either a soft/elastic or crispy/crushable shell. Color, overall texture, shell crispness and, to a lesser extent, flavor and appearance, affected overall liking, but they did not cause the products to be unacceptable. Acceptability scores for appearance, flavor, shell crispness and texture of six- and 24-hour samples were slightly different. The 24-hour fried soft crawfish was as acceptable as the six-hour sample.

Purchase intent. The acceptability rating was highly related to the purchase intent rating. More than 82 percent of the consumers said the 24-hour fried soft crawfish were acceptable. More than 60 percent of consumers indicated the tendency to purchase this product if it were commercially available.

24-hour acceptability

Changes in texture and color of fried soft crawfish were distinctively observed as a result of post-molting time and calcification, but these changes did not cause the products to be unacceptable. Comparisons of consumer acceptability scores for appearance, flavor, shell crispness, overall texture and overall liking of six-hour versus 24-hour post-molt fried crawfish showed no significant differences. Without exception, sensory acceptability scores for the 24-hour post-molt fried crawfish were equal to or higher than 6.0 (“slightly like” on a 9-point scale).

It is commonly believed that, to obtain the best quality for consumption, soft crawfish must be collected within two (at 80 degrees F) to eight (at 68-70 degrees F) hours after molting, depending on the water temperature. In this study, all crawfish were held in the trays at approximately 70-75 degrees F. Results from the consumer study showed that crawfish held for up to 24 hours after molting were still acceptable to consumers if served as a nonbreaded deep-fried product. Maximizing the harvesting time for soft crawfish would allow producers to harvest more marketable soft crawfish and thus perhaps increase revenue. ■

Photo by John Wozniak

Medicinal plants from China

Researchers look at growth and CPT concentrations in 18 seed sources

Camptotheca acuminata, a deciduous tree native to southern China, contains camptothecin (CPT). In 1996, the FDA approved two CPT derivatives for treating ovarian and colorectal cancer. In addition, other derivatives of CPT are being tested in clinical trials against other types of cancer in the United States. Manufacturing of the two anti-cancer drugs continues to rely on extraction from plant materials harvested mainly from naturally grown trees. There is no known plantation production in an agricultural setting in the United States or in China to supply the plant materials.

The medicinal plant research program at the LSU Agricultural Center initiated a study using *Camptotheca acuminata* to develop a production system. Cultivation of *C. acuminata* not only presents cropping opportunities but also allows the input of effective production management that offers superior quality raw materials to the now available natural sources. Since 1993, plantations of *C. acuminata* have been grown in southern Louisiana, and extensive growth studies have been done to find cultural practices to enhance the levels of CPT. The plantations, however, were established with propagules from a single tree that is perhaps the offspring of an earlier introduction program of the U.S. Department of Agriculture. Therefore, the genetic base is narrow. *C. acuminata,* however, has a broad range of natural distribution in China, covering almost all areas south of the Yangtze River.

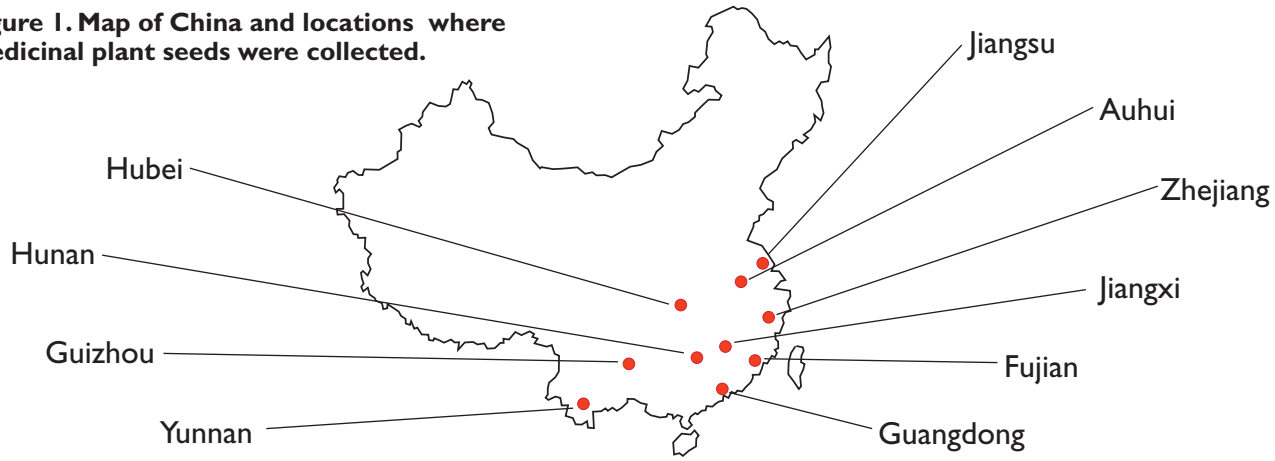
The vast distribution area led the researchers to believe that natural variations in terms of growth and camptothecin

Zhijun Liu examines seedlings in Huzhou City, Zhejiang Province, China. Eighteen seed sources of C. acuminata *were collected from 10 provinces south of the Yangtze River.*

Table 1. CPT yields as a product of leaf biomass and CPT concentration in 18 *Camptotheca acuminata* seed sources collected in southern China.

Seed source	Biomass (Rank) g	CPT concentration (Rank) % dry wt.	CPT content (Rank) mg/seedling
1	11.19 (11)	**0.114 (2)**	12.76 (7)
2	7.96 (18)	0.034 (17)	2.71 (18)
3	8.96 (16)	0.072 (14)	6.45 (17)
4	**15.50 (5)**	0.081 (13)	12.56 (9)
5	9.97 (15)	0.076 (14)	7.58 (16)
6	10.86 (14)	0.090 (10)	9.77 (14)
7	10.91 (13)	0.095 (7)	10.36 (13)
8	**19.33 (1)**	0.086 (11)	**16.62 (1)**
9	**16.04 (4)**	0.069 (16)	11.07 (11)
10	11.96 (10)	0.092 (8)	11.00 (12)
11	**16.71 (3)**	0.083 (12)	**13.87 (5)**
12	**16.81 (2)**	0.086 (11)	**14.46 (3)**
13	13.61 (7)	**0.102 (5)**	**13.88 (4)**
14	11.08 (12)	**0.112 (3)**	12.41 (10)
15	12.71 (8)	**0.119 (1)**	**15.12 (2)**
16	14.45 (6)	0.091 (9)	13.15 (6)
17	8.27 (17)	0.097 (6)	8.02 (15)
18	12.41 (9)	**0.103 (4)**	12.78 (8)

Figure 1. Map of China and locations where medicinal plant seeds were collected.



concentrations exist. Consequently, cooperative research between the LSU Agricultural Center and Zhejiang Forestry College was conducted to find these variations and to lay the foundation for clonal line development. Once the clonal lines are developed, specific cultivation practices using these clonal lines can be developed for high quality raw plant material production. This provenance study, which means an investigation of variations associated with geographical source of *C. acuminata*, is the first step in the effort to cultivate *C. acuminata* in both Louisiana and Zhejiang of China.

Within its natural distribution, 18 seed sources were collected from 10 provinces south of the Yangtze River (Figure 1). Trees 20 to 29 years old bearing seeds were selected from a large local area in November. In Huzhou City, Zhejiang, China, nursery beds were prepared for the study.

Results showed significant variations among the 18 seed sources in growth rate and leaf CPT concentrations. Since leaves are the target plant materials, based on the findings of this study, the top five seed sources were identified. These seed sources warrant further growth studies to determine the optimal growth conditions for accumulating CPT. ■

Zhijun Liu, Assistant Professor, School of Forestry, Wildlife and Fisheries, LSU Agricultural Center, Baton Rouge, La.; Guomo Zhou, Associate Professor, and Shaoyuan Xu, Professor, both at Zhejiang Forestry College, Lin'an, Zhejiang, People's Republic of China.

Zhijun Liu, left, and Shaoyuan Xu in Huzhou City, Zhejiang Province, China.

Research looks at drainage in sugarcane fields for economic, environmental benefits

The U.S. Department of Agriculture and the LSU Agricultural Center are beginning a 5- to 10-year project involving drainage systems for sugarcane production that could result in environmental and economic benefits.

Goals of the joint research and demonstration project, which involves pump-enhanced underground drainage for fields, are to determine if the systems can reduce the losses of fertilizers and pesticides carried in surface runoff from the cropland, keep sugarcane growers' equipment out of muddy situations and increase farm profits.

The project will be coordinated by the USDA's Agricultural Research Service (ARS) on a 16-acre site at the Sugar Research Station at St. Gabriel. It will compare traditional sugarcane production methods with those using the subsurface drainage system to determine any economic and environmental benefits of the enhanced system.

"Sugarcane growers are coming under increasing pressure to reduce the amount of chemicals leaving their fields and entering streams and lakes," said agricultural engineer James L. Fouss, who heads the project for the ARS's Soil and Water Research Unit in Baton Rouge. "A controlled subsurface drainage system allows rainwater to infiltrate the soil and thus reduces runoff from the land, so chemicals and topsoil stay in the field where they belong."

The drainage system involves a crisscrossed field of buried corrugated plastic pipe, which helps to remove excess water from the soil but also allows for the return of water to the soil through irrigation.

In preliminary tests, the drainage system appeared to increase yields as much as 25 percent and to extend the productive life of the sugarcane stubble crop, according to Fouss and project engineer Ted S. Kornecki, also of the ARS unit Baton Rouge.

As an additional benefit, by removing excess moisture from the field, the subsurface drainage system means farmers are less likely to spend time and money freeing equipment that gets stuck in the mud.

The economic and environmental returns will be studied by installing the drainage system on two-thirds of the St. Gabriel research plot and comparing results of sugarcane production on that area to the remaining third, which will be farmed using traditional production methods for the area.

The cost of installing such drainage systems is about $450 per acre – although an agricultural economist who will be part of the project's team will be exploring ways to make its use more cost effective. – **Tom Merrill**

This piece of equipment, called a trencher, was brought in to lay the plastic pipe in the sugarcane field at the Sugar Research Station. Guided by laser, the trencher lays the pipe 4 feet underground. The trencher digs and threads the pipe simultaneously.

Photos by Mark Claesgens

LSU Ag Center scientists expect a field full of underground pipe will prevent surface runoff, protect the environment and improve profits for cane growers.

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