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ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY

HIGHLIGHTS OF AGRICULTURAL RESEARCH

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ON THE COVER: This harmless imperial caterpillar is among several "furry" caterpillars found in Alabama. Some, however, are not so harmless. See related story on page 8.

from the Director

In the last issue of Highlights, we mentioned the support provided to the Alabama Agricultural Experiment Station (AAES) by tax dollars, gifts, grants, contracts, and income from sale of products. These sources of income allow the AAES to continue research programs by scientists in the different schools and colleges within Auburn University (AU).

AAES research programs have historically been based on partnerships that allow more to be done with less. The original partnership was between the federal and state governments to jointly sponsor research at the state level. This partnership continues today, but is supplemented by other equally important working relationships.

AAES has evolved into an organization that partners with five different schools and colleges on the AU campus. These are the colleges of Agriculture, Sciences and Mathematics, and Veterinary Medicine plus the Schools of Forestry and Human Sciences. Scientists supported by AAES in these five schools/colleges work across administrative divisions to jointly conduct research needed by AAES clientele.

Under a federal court order of two years ago, AAES is now sponsoring joint research with Alabama A&M University (AAMU). Scientists from both campuses are utilizing AAES facilities across the state to conduct research on both the AU and AAMU campuses. While some cooperative research was already underway between our scientists, this legal action spurred us to support needed research in areas where both of our faculties have expertise.

Other partnerships are being strengthened within the state and across state lines. We have gene transfer work in swine being conducted by animal scientists at AU and molecular biologists at the University of Alabama in Birmingham. Across state lines, we are doing regional research in a number of areas with other state universities.

After all the above working relationships are considered, our most important partner is still the user of AAES-generated information. This partner may be a producer, processor, agribusiness person, or consumer of products covered by AAES research. To you, that partner, we pledge our best efforts in service to you, your family, and your business.

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Consumer Choice of U.S. Brands in Foreign Markets: Opportunities for Alabama Textile and Apparel Manufacturers

Christie Caine and Sandra Forsythe

Future success in the global marketplace requires accurate response to consumer demands in international markets. Successful firms must identify customers' needs and expectations so they can develop product and marketing strategies that will enhance success in international markets. An AAES study is helping Alabama textile and apparel producers identify their customers' needs around the world.

AAES researchers developed a model of the consumer choice process and tested it with consumers from Korea, China, Mexico, and the United States. This model provides a framework for understanding customer needs and demonstrates the interrelationship between product attributes, the customer's perception of product attributes, and resulting evaluations of the product's quality and value.

Purchase decisions are based on consumers' perceptions, and those perceptions may vary by country since culture is a powerful force shaping perceptions and, thus, product choices. That is why careful examination of customer demographics, purchase behaviors, and attitudes toward U.S. products and brands is critical.

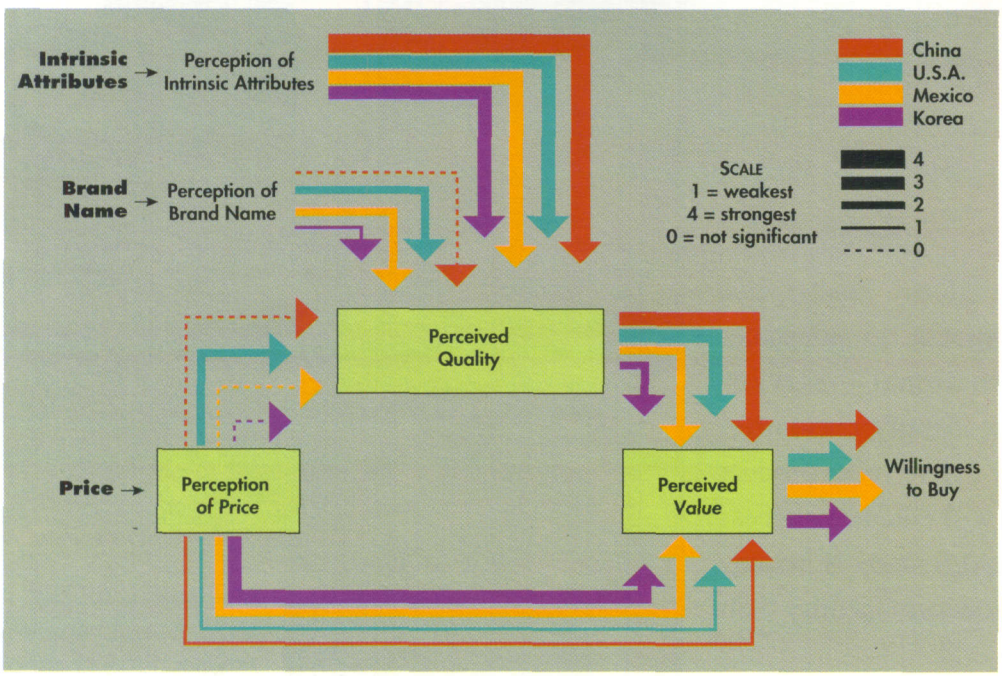
Mall intercept studies of consumers in four countries were conducted to examine the effect of product attributes on consumers' perceptions of quality, value, and willingness to buy a U.S. brand apparel product. Product attributes important to the consumer for apparel products include physical attributes of the product, such as the style, fabric quality, and workmanship, as well as brand name and price.

In examining consumer attitudes and purchase behaviors in international markets we can see how the individual markets differ. China, South Korea, and Mexico represent diverse emerging markets with a growing middle class and growing potential for U.S. textile and apparel products. The U.S. market was used as a benchmark to compare Asian and Latin American markets.

Foreign Markets, continued on page 4

Consumer segments were compared on a number of variables to better understand how market segments differed and what was necessary to satisfy customers in each market. For example, consumers who are most likely to purchase U.S. brands are typically younger, more highly educated, more affluent, and more fashion and brand conscious than the average consumer in those markets. Most bought U.S. brands because they represent the American lifestyle or image.

Statistical analysis was used to test the effect of physical attributes, U.S. brand name, and price on perceptions of quality, value, and willingness to buy among customers in each of the four countries. The model (see the figure) shows color coded country paths: red-China, orange-Mexico, purple-Korea, and green-USA. The width of the line indicates the strength of the relationship.



Model of consumer choice for U.S. products in four countries.

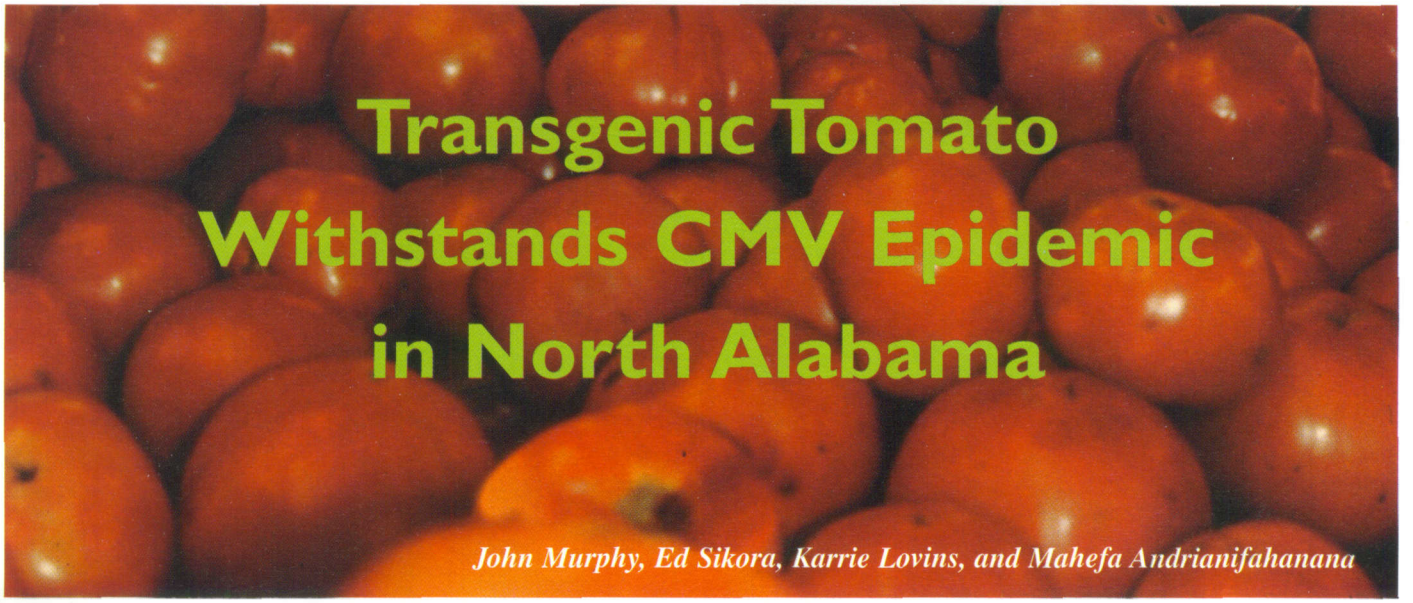
Consumer perception of physical attributes had a strong impact on perceived quality. Brand was also important, but the effect of price on perceived quality was less important than intrinsic attributes or brand (except for U.S. customers, who have been conditioned to look for sales). U.S. brand name did affect quality perceptions in all countries except China; however, most respondents did not examine the country-of-origin label when evaluating garments. They appeared to base their evaluations on their perception of U.S. brands rather than actual country of origin. That is, consumers appeared to use U.S. brand names as an indicator of product quality, fashionability, etc. The direct effect of price on perceived value is significant in all markets. There is a strong relationship between perceived quality, value, and willingness to buy in all markets.

Understanding customers' needs, expectations, and motivations for purchase allows companies to develop more effective product and marketing strategies to maximize customer satisfaction. For example, among Mexican apparel customers, image and status are very important; thus, high status brand names are very popular. Furthermore, high quality apparel is desired to convey a high status and image. Mexican customers are willing to pay higher prices for apparel than Korean, Chinese, or U.S. consumers. They seldom purchase apparel products that are on "sale" because they believe it denotes inferior quality. Therefore, marketing strategies that build a strong brand image consistent with the status-oriented attitudes and values of Mexican customers will be most successful in that market.

By comparison, customers in South Korea are more price and value conscious and more prone to purchase apparel products on sale than are Mexican consumers. Thus, strategies of value-oriented promotion, advertising, pricing, and sourcing are necessary to maximize customer satisfaction in South Korea. Positioning a U.S. brand/product near the high end of the market was typically the most successful positioning strategy in Mexico. In Korea, positioning products toward the top with emphasis on competitive prices was the best strategy.

This research can benefit the Alabama apparel and textile industry by providing better forecasting of potential customer response to changes in product quality, offerings, and service levels for each market; enhancing customer satisfaction (and sales and profitability) by more effectively identifying and responding to customer needs and expectations; reducing risk associated with errors in developing and positioning a product for specific international markets; and anticipating potential effects of advertising, promotion, pricing, or other positioning strategies on consumer perceptions of the brand/product.

Caine is a Technology Specialist for the Center for Textile and Apparel Technology and Forsythe is Wrangler Professor of Consumer Affairs.



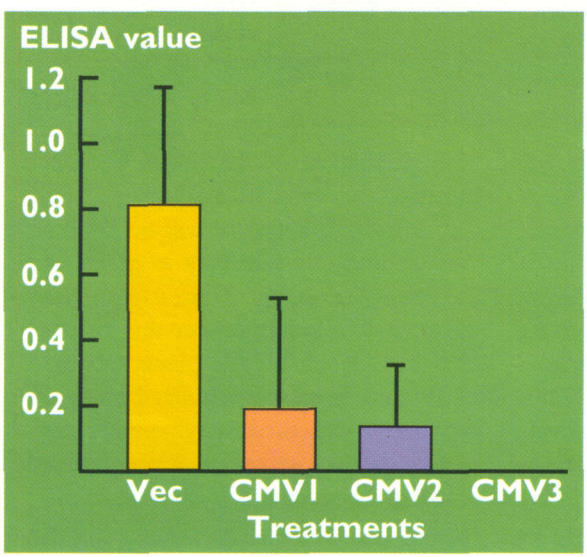
Transgenic Tomato Withstands CMV Epidemic in North Alabama

John Murphy, Ed Sikora, Karrie Lovins, and Mahefa Andrianifahanana

A large proportion of Alabama's fresh market tomato production occurs in Blount and St. Clair counties in North Alabama and each year since 1992 tomato growers in these and surrounding counties have suffered severe losses due to an epidemic of the plant virus cucumber mosaic virus (CMV). Recent AAES and Alabama Cooperative Extension System (ACES) research indicates that genetically engineered tomato plants are less susceptible to CMV, giving growers a viable management option.

Tomatoes are typically transplanted to the field at two-week intervals beginning in April and continuing through July. The severity of disease caused from infection by CMV varies with the age of the plant at the time of infection. The younger the plant at the time of infection, the more severe the disease and the greater the loss in production of marketable fruit. Cultural practices used by growers in North Alabama, such as introduction of young tomato transplants every two weeks, provides a continuous supply of young, highly susceptible plants. As a result, each new setting of tomato plants becomes severely affected by disease, produces little or no marketable fruit, and provides CMV inoculum for subsequent plantings.

CMV is a difficult plant pathogen to manage under natural conditions because this virus can infect more than 800 plant species and is transmitted from plant to plant by any one of 75 different aphid species. These two factors make CMV widespread in nature, particularly in Alabama's mild climate. To make matters worse, an aphid can acquire the virus by simply probing an infected cell with its stylet (as briefly as five seconds) and in a similar manner transmit the virus to another plant. This type of transmission of a virus by its aphid vector makes it impossible to manage the virus with aphid-controlling insecticides. In fact, research has shown that insecticides make aphids hyperactive, thereby enhancing plant-to-plant spread of virus.



The amount of CMV in tomato samples as determined by ELISA (a maximum value for ELISA is 2.0). Treatments include the susceptible control, Vec, and the three CMV transgenic tomato lines: CMV1, CMV2, and CMV3.

Management strategies for CMV depend on availability of commercially acceptable, genetically resistant varieties. Unfortunately, there are no fresh market tomato varieties available to growers that are genetically resistant to CMV. AAES and ACES scientists pursued an alternative approach to manage the extreme levels of CMV that occur in North Alabama. Tomato plants genetically engineered to express the capsid

CMV, continued on page 6

protein gene of CMV (referred to as transgenic plants) were evaluated in a grower's field in Blount County in 1995 and 1996 for their ability to withstand the extreme levels of disease that occur in North Alabama.

Four genetically engineered tomato lines–CMV1, CMV2, CMV3, and Vec–were evaluated. The three CMV lines expressed the capsid protein gene of CMV, while Vec represented an engineered susceptible control line. Experiments were carried out twice in 1995, early and late in the season, and once in 1996.

CMV3 plant (top) free of symptoms and a Vec plant with severe CMV symptoms.

In each experiment, plants were evaluated at one, two, and four weeks after trans-planting for development of CMV-like symptoms (stunting, yellowing of leaves, and deformation of young leaves). All plants were tested for the presence of CMV by an enzyme-linked immunosorbent assay (ELISA) test at the time of transplant and at four weeks after transplant (see the table). A similar trend was observed between experiments regarding development of CMV symptoms and accumulation of virus in plants. The data presented is representative of each of the trials.

Evaluation of Virus-Like Symptoms at One, Two, and Four Weeks After Transplanting

Treatment	Percentage of plants showing CMV symptoms		
	Week 1	Week 2	Week 4
Vec	15	69	96
CMV1	0	0	9
CMV2	0	0	0
CMV3	0	0	0

Within the susceptible control treatment, Vec, 15% of the plants developed symptoms one week after transplanting with almost all plants (96%) showing symptoms by four weeks. In striking contrast to Vec plants, none of the CMV2 and CMV3 plants developed symptoms and only 9% of CMV1 plants showed symptoms after four weeks.

Evaluation of CMV infection correlated well with symptom data in Vec plants; however, this was not the case for CMV1, CMV2, or CMV3 plants. All Vec plants were infected with CMV while 42%, 68%, and 67% of the plants in treatments CMV1, CMV2, and CMV3, respectively, were shown to be infected even though they were free of symptoms. Interestingly, even though many of the plants in treatments CMV1-3 were infected, the amount of CMV in these plants was significantly less than in Vec plants (see the figure), which might explain their apparent lack of symptoms.

These results show that infection of tomato with CMV under natural conditions of extreme disease pressure can be reduced through the use of genetically engineered plants. The transgenic plants apparently were not fully resistant to infection by CMV since a fairly high percentage of the plants became infected. However, the amount of CMV that accumulated in the transgenic plants was significantly less than in plants in the control treatment. Thus, even under the extreme disease pressure that occurs in North Alabama, these plants resisted CMV and generally remained free of symptoms. Genetically engineered virus resistance may serve as an alternative practical approach to tomato production.

Murphy is an Assistant Professor, Sikora is an Associate Professor, Lovins is a Research Associate, and Andrianifahanana is a Graduate Research Assistant of Plant Pathology.

WHEN WATER TEMPERATURE DROPS below about 68°F, channel catfish don't gain weight economically; therefore, winter feeding is expensive and inconvenient. Conventional wisdom has advocated feeding catfish through winter months to keep the fish healthy and prevent weight loss. The return on investment from winter feeding is difficult to identify because of a lack of data on weight changes and feed efficiency with various feeding schedules. An AAES study suggests that partial winter feeding– where the fish are not fed during December, January and February–will yield fish of almost

Should Catfish in Ponds be Fed Over Winter?

Tom Lovell and M.K. Kim

equal harvest size in the spring as continuous feeding throughout the winter.

The study was designed at the AAES to evaluate effects of three winter management regimens with two sizes (fingerlings and harvestable size) of catfish on weight change over winter and rate of gain by the fish the following grow-out season. The two sizes were stocked separately in earthen ponds on Nov. 1, 1995, and managed until April 23, 1996, on three feeding regimes: (1) no feeding; (2) restricted feeding, which meant no feeding during the months of December, January, and February; and (3) continuous feeding by a prescribed winter feeding schedule based on water temperature.

The fish were removed from the ponds the following spring and weight change, feed conversion, body composition, and processing yield were determined. Subsequently, fish from each of the over-winter treatments were placed back into the ponds and fed for the following six-month growing season to determine effects of the previous over-winter management scheme on fish performance during the next grow-out period.

The large fish on restricted feeding increased their weight by 41% over winter (Table 1), which was only slightly less than that of the continuously-fed large fish (48% increase). The large fish without winter feed lost 10% of their initial weight. The relative weight changes for the small fish showed a similar trend. Feed conversions were 1.6 for fish on restricted feeding and over 2.0 for continuously-fed fish in both size groups. Dressing yield for the food-size fish was not different between the fed groups, but was significantly lower for the non-fed fish. There were no significant losses to disease in any of the treatments.

At the end of the subsequent grow-out season, the large fish overwintered under the restricted feeding regime were slightly larger than those that had been continuously fed; the fish not fed during winter gained faster but did not quite reach the harvest weight of the other fish (Table 2). The smaller fish showed essentially the same responses as the large fish in relative weight changes. Feed conversions and dressing yields were not statistically different among treatments within both size groups.

These results indicate that a partial winter feeding program, where channel catfish are not fed during December, January, and February, will yield fish of almost equal harvest size at the end of winter and at the end of the next grow-out period as full-feeding over winter in Alabama. Fish not fed for a six-month winter period will lose 8 to 10% of weight during winter; however the fish will grow faster during the following grow-out season and will reach a harvest weight only slightly less than that of winter-fed fish.

Lovell is a Distinguished University Professor and Kim is a former Doctoral Graduate Research Assistant of Fisheries and Allied Aquacultures.

Table 1. Responses of Large and Small Channel Catfish to Three Feeding Regimens During Six-month Winter Period

	Large fish			Small fish		
	Full fed	Partial fed	Not fed	Full fed	Partial fed	Not fed
Weight, Nov. 1 (g)	420	420	420	21	21	21
Weight, Apr. 30 (g)	624	595	379	35	32	19
Feed fed (g/fish)	473	281	—	30	18	—
Feed conversion	2.3	0.6	—	2.1	1.6	—
Visceral fat (%)	1.2	0.9	0.4	0.5	0.4	0.3
Dress-out (%)	61.0	61.6	58.7	—	—	—

Table 2. Responses of Large and Small Catfish During Grow-out Following Three Overwinter Feeding Regimens

	Large fish			Small fish		
	Full fed	Partial fed	Not fed	Full fed	Partial fed	Not fed
Weight, May 6 (g)	624	595	379	36	32	19
Weight, Sept. 8(g)	1,568	1,611	1,393	597	627	580
Wt. gain (%)	251	270	367	1,540	1,830	2,840
Feed conversion	1.80	1.90	1.97	1.32	1.38	1.41
Visceral fat (%)	2.7	3.3	3.8	1.2	1.6	1.8
Dress-out (%)	68.6	69.1	68.9	61.2	61.6	61.5

Some Stinging Shade and

The imperial caterpillar is a "horned," hairy, spined, dangerous-looking, but harmless larva; it possesses no urticating structures. This specimen is about 3 1/2 inches long.

Caterpillars, the larvae of moths and butterflies, constitute the largest and most important group of defoliators of deciduous trees in Alabama, including shade and ornamental trees in urban landscapes. Within the group are some unique, somewhat lesser known caterpillars that, while they damage tree foliage, are sometimes of more concern as pests of humans than as pests of trees. This is because these caterpillars "sting." AAES studies are providing information that may help humans avoid the sting.

Stinging caterpillars do not sting in the manner of bees, yellowjackets, and wasps. Females of the bee-wasp group (only the females sting) have stingers with which they penetrate skin and inject venom. Stinging caterpillars have no such stinger, but bear instead specialized nettling or urticating setae (hairs) or spines. These structures are hollow and contain toxins produced by poison-gland cells to which they are connected. The sting of the caterpillar results from contact, usually inadvertent, with toxin-bearing setae or spines.

Many species of caterpillars bear conspicuous "horns," hairs, and/or spines, but not all so armed are "dangerous." Only a few of these possess structures that are venomous and urticaceous. Consequently, "stingers" and "non-stingers" are often similar in appearance, and distinguishing one from the other is difficult. Identification of stingers by personal exposure, while fool-proof, may be painful and fool-hardy. Therefore, results of AAES research on tree insects may be helpful.

During studies on identification and habits of insects attacking foliage of Alabama trees, several species of stinging caterpillars have been encountered and identified. The following is a pictorial guide to recognition of some species found on ornamental trees and shrubs.

Saddleback Caterpillar

Puss Caterpillar

(Megalopyge opercularis)

The puss caterpillar is the most "dangerous" stinger. It is densely clothed with long, fine, tan or grayish to brown hairs, and appears docile and harmless. However, concealed within its furry coat are venomous setae which, on contact with skin, produce severe

Caterpillars on Ornamental Trees

Lacy L. Hyche

reactions: intense burning or nettling; inflammation and development of pustules and lesions; numbness and swelling; intense pain; and nausea. Victims of puss caterpillar stings sometimes require medical attention.

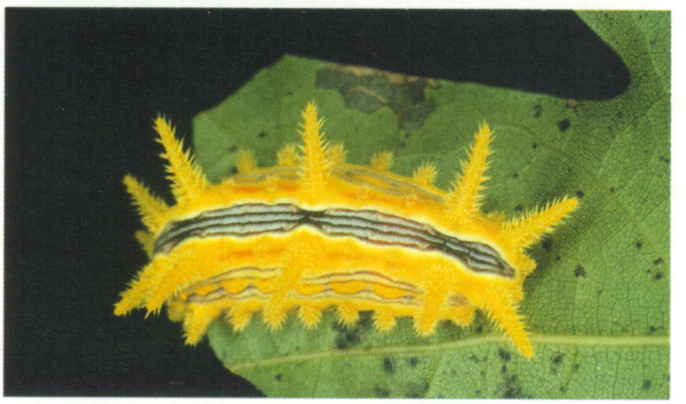
Puss caterpillars feed on a variety of broadleaf shrubs and trees. Common tree hosts include apple, elm, hackberry, maple, oak, pecan, and sycamore. The caterpillar is most commonly encountered in late summer and fall.

Puss Caterpillar (length to tip of "tail" is about 1 1/2 inches).

Saddleback Caterpillar

(Sibine stimulea)

The saddleback, sometimes called packsaddle, is probably the most familiar "stinger." The full-grown caterpillar is about one inch long. Its prominent "horns," form, and markings make it easy to identify. The green midsection with large brown spot gives the appearance of a saddle and blanket, thus the common name. The full-grown caterpillar is generally a solitary feeder, but younger larvae may tend to be gregarious. The saddleback occurs on a wide variety of trees, shrubs, and other plants, including corn. Common tree hosts are apple, basswood, cherry, dogwood, maple, and oak. Larvae are most often found in late summer and fall. The sting of the saddleback is painful, but the reaction is usually less severe than that of the puss caterpillar.



Stinging Rose Caterpillar

Buck Moth Caterpillar

(Hemileuca maia)

The full-grown buck moth caterpillar is 2 to 2 3/8 inches long. The head is reddish brown to black; the body brown to grayish black with numerous small yellowish dots. Young larvae are solid black. A double row of short, tannish tufts of spines is present down its

Caterpillars, continued on page 10

Buck Moth Caterpillar

White Flannel Moth Caterpillar

back; longer, bristled spines occur along the sides. In Alabama, the caterpillar has been found only on oak; post oak seems to be preferred. Larvae are generally present during May and the first half of June. Severity of sting is generally considered to be about equal to that of the saddleback.

White Flannel Moth Caterpillar *(Norape ovina)*

The caterpillar of the white flannel moth is 1 to 1 1/4 inches long when fully grown. Coloration and markings are as pictured. Redbud is the primary host in Alabama, but larvae also feed on honeylocust, mimosa, and hackberry. Caterpillars begin to appear in late July and August and are present into October. Larvae are sometimes abundant on ornamental redbud.

Stinging Rose Caterpillar

(Parasa indetermina)

The full-grown stinging rose larva is 3/4 to 7/8 inch long. The body is armed with conspicuous horn-like, bristled spines. Coloration and markings are as pictured. Hosts include apple, cottonwood, dogwood, hickory, oak, redbud, sycamore, and rose. Caterpillars are generally present in August and early September but are not usually abundant.

Hag Moth Caterpillar

(Phobetron pithecium)

The distinctive form of the hag moth caterpillar makes it easy to identify. Fully grown larvae are brown, hairy and 1/2 to 5/8 inch long. The lateral extensions of the body bear urticating setae. Tree hosts include apple, ash, birch, dogwood, hickory, oak, and willow. Larvae are generally solitary feeders, and are usually present in August and September.

Knowledge that some larvae possess urticating structures should not generate undue fear of caterpillars. Only a relative few species have stinging capabilities, and these are not often abundant. Of the species reviewed, the puss caterpillar, saddleback, and buck moth are the most troublesome "stingers." Reactions produced by these are somewhat similar and may sometimes be severe (see puss caterpillar). The remaining species are definitely "stingers," but reactions produced are less painful and often short-lived. However, the severity of reaction depends on the species of caterpillar, degree of contact, and susceptibility of the individual. Reactions may be particularly severe for allergy sufferers or individuals with sensitive skin. In case of severe reaction, victims (often children) should promptly seek medical attention.

Hyche is an Associate Professor of Entomology.

More details on stinging insects will be available in AAES Bulletin 632, "Stinging Insects of Alabama," which will be published later this year.

Hag Moth Caterpillar

A one-foot H flume and Coshocton type runoff sampler used in the study.

Runoff, Erosion, and Water Quality Detriment Evaluated in Grazing Studies

Eric Pitts, Kyung Yoo, Mary Miller-Goodman, and William de los Santos

AS ANIMALS GRAZE FORAGES, they alter the vegetative cover and soil physical properties of pastureland. These alterations may decrease infiltration of water through the soil which, in turn, increases the amount of surface runoff. On lands where poultry waste has been used as a fertilizer for perennial pastures, this increased runoff can deposit high concentrations of nitrogen into water bodies adjacent to pastures, which can be detrimental to the ecology of the water sources. The potential for negative effects to the environment surrounding the areas where the waste is applied increases the need for sound management practices. A recent AAES study was conducted to help define best management practices in these situations.

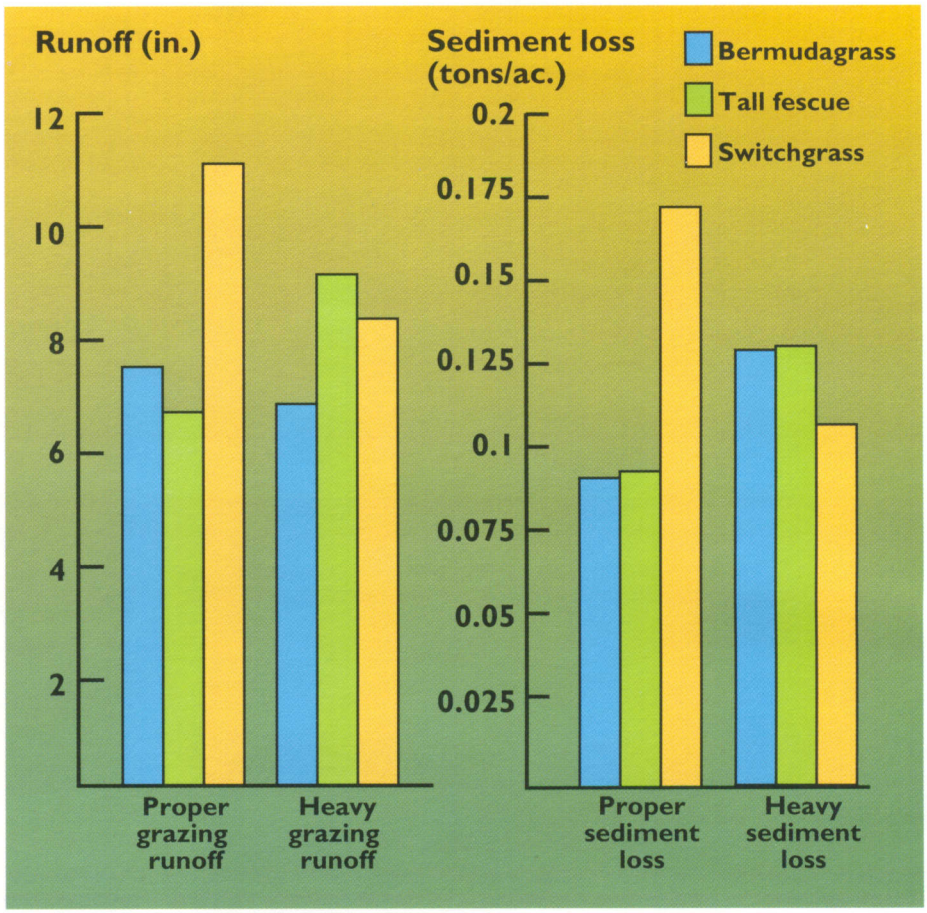
Grazing Studies, continued on page 12

Grazing Studies, continued from page 11

The study related grazing pressure to surface erosion, runoff, and runoff water quality comparing two grazing pressures on three pasture vegetation types (switchgrass, bermudagrass, and tall fescue) in the Tennessee Valley region of Alabama.

Runoff, sediment loss, and water quality data were recorded at the Tennessee Valley site from November 1994 through September 1996. Data gathered in the field are being compared to trends predicted by two non-point source computer simulation models (GLEAMS and WEPP).

WEPP is the USDA Water Erosion Prediction Project and was initiated in 1985 to develop a new generation of water erosion prediction technology. The model is designed for use in soil and water conservation planning and environmental assessment. It is capable of estimating spatial variability in topography, surface roughness, soil properties, hydrology, and land use capabilities. GLEAMS is a field-scale model that consists of hydrology, erosion, nutrient, and pesticide simulation components. The latest version of GLEAMS (version 2.1) has been updated to make it more user friendly and comprehensive. Mainly, changes have been made to streamline the input to reduce user dependence and allow more internal estimation of parameters.



Observed average cumulative runoff and average cumulative sediment loss by grazing pressure for bermudagrass, tall fescue, and switchgrass plots, Tennessee Valley Substation, Belle Mina.

The study was conducted at the Tennessee Valley Substation in Belle Mina on 12 0.25-acre rectangular runoff plots. Each plot was equipped with a flume for measuring surface runoff and a runoff sampler. Plots were fenced so that cattle were restricted to certain plots according to the type of management practice the plot was under. Grazing could take place only in plot area or in the travel area between plots.

Observed and GLEAMS Predicted Average Sediment Loss and Runoff by Grazing Pressure for Bermudagrass, Tall Fescue, and Switchgrass Plots, January through August, 1996, Tennessee Valley Substation, Belle Mina

	Proper grazing regime		Heavy grazing regime	
	Observed	Predicted	Observed	Predicted
Sediment loss (tons per acre)				
Bermudagrass	0.039	0.045	0.037	0.050
Tall fescue	0.020	0.055	0.022	0.060
Switchgrass	0.066	0.085	0.049	0.075
Runoff (inches)				
Bermudagrass	2.32	1.72	2.46	1.72
Tall fescue	2.17	1.72	2.43	1.72
Switchgrass	3.48	1.72	3.13	1.72

The plots were divided into proper (recommended) and heavy (twice the recommended rate) grazing treatments. Grass height was used to determine the grazing pressure. Control heights of four inches for bermuda, six inches for tall fescue, and eight inches for switchgrass were used for the proper grazing treatment. Control heights of two inches, three inches, and four inches for bermudagrass, tall fescue, and switchgrass, respectively, were used for the heavy grazing treatment. Once a grass was grazed to the control height, the cattle were removed from the plot until the grass recovered enough for grazing to resume. A combination of cow-calf pairs and single cows were used throughout the grazing period.

Broiler litter was applied to the site in split applications at a rate of 3.02 tons per acre each in spring and summer for bermudagrass and switchgrass and 2.52 tons per acre each in spring and fall for tall fescue. Runoff from the plot areas was sampled after each runoff producing rainfall event and weather data was monitored at the site.

Data suggest that there is a significant interaction between forage species and grazing pressure (see the figure). Under proper grazing management, the bermudagrass plots contributed the least amount of sediment (0.088 ton per acre), followed by tall fescue (0.089 ton per acre). Switchgrass lost the most, 0.17 ton per acre. Under heavy grazing management, the bermudagrass and tall fescue plots were very close, losing 0.131 and 0.132 ton per acre respectively. Switchgrass lost the least sediment, 0.11 ton acre, when grazed heavily.

Runoff amounts observed also varied. Under proper grazing management, bermudagrass had 7.21 inches of runoff, while tall fescue had 6.91 inches, and switchgrass 11.12 inches. When grazed heavily, the bermudagrass contributed the least amount of runoff, 6.93 inches. Switchgrass was next with 8.43 inches, followed by tall fescue, which contributed 9.24 inches. The total rainfall amount recorded for the 23-month study was 92.8 inches.

Although the switchgrass plots produced significantly more cumulative runoff and sediment than the other plots under proper grazing management, nutrient analysis for total nitrogen indicated that tall fescue pasture lost significantly more than both bermudagrass and switchgrass regardless of the grazing pressure. Dissolved phosphorus and sediment phosphorus in the runoff water showed similar patterns of loss.

In the context of surface water quality, this trend becomes critical considering the influence of phosphorus on eutrophication, the extensive use of tall fescue as a winter pasture grass, and the wide use of poultry litter as a nutrient source for tall fescue pastures in areas where poultry is produced in Alabama.

The collected data was compared to the GLEAMS and WEPP models, and showed that in all cases except for switchgrass heavy grazing pressure contributed to increased amounts of sediment when compared to the proper grazing pressure. The GLEAMS model overpredicted amounts of sediment loss in all cases, while underpredicting runoff amounts. Using site-specific input parameters and observed weather data for the same time period, the WEPP model has predicted no sediment losses, yet very large amounts of runoff for all of the plots.

Compared to observed data, these predictions were not on target, and more work will be needed to make sure that adequate documentation is provided and the models perform well enough to develop reliable decisions on pasture management practices. This is especially important in the Southeast, where very little research such as described here has been done.

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Organic Sprays Effective for Worm Control in Cabbage and Lettuce

This broccoli field (above) in Baldwin County may attract several damaging caterpillar species. Inset: (left) cabbage looper;(center) imported cabbage worm; (right) diamond-back moth adult, cocoon, and larvae.

VEGETABLES IN ALABAMA are often plagued by insects, particularly caterpillars that can cause severe feeding damage to the marketable parts of the plant. While synthetic insecticides are available, recent AAES studies have shown that garlic, red pepper, and other organic materials also provide effective control of these pests on lettuce and cabbage.

Some of the more damaging of the lepidopterous species include the diamondback moth, the cabbage looper, and the imported cabbage worm. These pests primarily feed on cruciferous crops (cabbage, collards, broccoli, kale, etc.). Several armyworm species also may occasionally attack crucifers and other Alabama vegetable crops, including lettuce.

Adult female moths lay eggs on the cabbage and lettuce plants, and the hatching caterpillars, or "worms," feed on the outer leaves and heads causing defoliation and reducing the grade or marketability of the crop. Application of synthetic insecticides is one method that growers can use to protect vegetable crops against insect attack. However, organic growers or growers interested in adopting integrated pest management (IPM) practices are interested in alternative methods of insect management.

Organic insecticides and insect repellents, usually derived from plants or microbes, have a long history in agriculture and reports (many are anecdotal) vary as to their effectiveness. Unfortunately, few formal studies have been done to compare these materials, particularly the organic insect repellents, with standard, synthetic insecticides.

A two-year AAES study was conducted to compare commonly used, synthetic insecticides with some readily available organic materials, including

garlic juice and red pepper powder, for control of worm pests in cabbage and lettuce. The study demonstrated that application of garlic and other organic materials provided levels of worm control sufficient to protect cabbage and lettuce heads from insect attack.

Separate experiments were conducted with Atlantis variety cabbage transplanted on March 25, 1997, at the E.V. Smith Horticulture Substation in Shorter and Salinas 88 Supreme variety head lettuce transplanted on June 6, 1997, at the Sand Mountain Substation in Crossville. Cabbage treatment plots consisted of a single, 25-foot-long treatment row bordered on each side by an nontreated or buffer row, and lettuce treatment plots consisted of two-row plots with 40 plants per plot. Cabbage treatments were sprayed on a weekly schedule beginning on April 25 until harvest using a spray volume of 55 gallons per acre. Ivory Snow™ liquid laundry soap (six drops per two-liter bottle) was added to the spray mixture in all spray treatments to ensure the cabbage leaves were evenly covered.

Karate ™, applied at the rate of 0.75 ml per two-liter bottle, was used as the standard synthetic pyrethroid insecticide in the cabbage trial. This amount was equivalent to the recommended field rate of 2.6 fluid ounces of Karate per acre applied in 55 gallons of water. (Note: a gallon is 3.8 liters and a fluid ounce is 29 ml.) Commonly used by commercial growers to control caterpillars in vegetables and other crops, this product contains 13.1% lambda-cyhalothrin, the active ingredient. The organic materials under study in the cabbage trial included the following: Garlic Barrier™, Align™, Javelin WG™, and McCormick™ ground red pepper.

The garlic mixture, which is 100% garlic juice mixed with water, was applied as a foliar spray; 1% garlic, 1% fish oil, 98% water. This product is advertised as an insect repellent that enters the plants through stomata and moves systemically through the plant.

The McCormick ground red pepper, obtained at a local super market, has also been reported as an insect repellent. Align is a botanical insecticide containing 3.0% azadirachtin, a natural insecticide obtained from the tropical neem tree. Azadirachtin is reported to have activity against a wide variety of insect species, including lepidopterous pests. The active ingredient in Javelin WG is a toxin obtained from a bacterium, *Bacillus thuringiensis* variety *kurstaki*. The toxin is active only against caterpillar pests, and acts as a stomach poison that must be consumed by the worms to be effective.

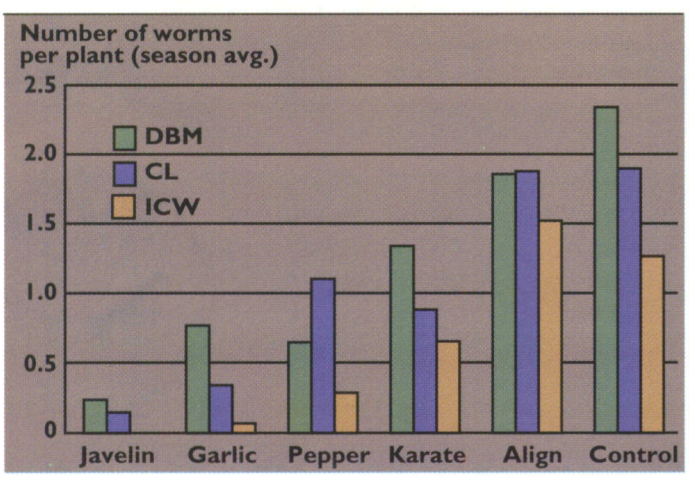

Fig. 1. Average number of cabbage worms per plant in the different cabbage spray treatments. DBM=diamondback moth larvae; CL= cabbage looper; ICW=imported cabbageworm.

Lettuce spray treatments, applied approximately weekly beginning on June 12 through July 18, were made using 36 gallons per acre spray volume. In the lettuce experiments Garlic Barrier was evaluated as a foliar spray using the same formulation of garlic, fish oil, and water, and as a foliar spray plus a transplant drench application. A combination of Sevin XLR™ insecticide (at a one-pint-per-acre rate) plus Kocide DF™ bactericide (at a two-pounds-per-acre rate) was used as the chemical standard treatment in the lettuce trial.

In the cabbage test, worm counts were recorded weekly on five cabbage plants per plot, and a visual damage rating was assigned to five plants per plot at harvest on May 28. Plants in the lettuce trial were evaluated at harvest using a 0 (no insect or disease damage) to 5 (severe insect feeding damage and disease symptoms) visual damage rating scale to assess insect damage and foliar disease incidence. Caterpillar larvae were not identified by species in the lettuce trial.

Worm counts taken in the different cabbage treatment plots indicated that the Javelin biological insecticide, Garlic Barrier, and red pepper treatments resulted in equivalent or better control of cabbage worms than the Karate synthetic insecticide treatment (Figure 1). All these treatments resulted in significantly lower num-

Organic Sprays, continued on page 16

Growers interested in these alternative controls might consider performing their own evaluation by comparing the efficacy of various materials in a small portion of their vegetable plantings. Contact Geoff Zehnder at 334-844-6388 for additional information on design of an "on farm" experiment to evaluate various insect control treatments.

bers of worms than in the nontreated control. Align provided the least effective worm control of all the spray treatments. Insect damage ratings taken at harvest indicated that cabbage plants in the Javelin treatment exhibited the least worm damage, followed by red pepper, Karate, Garlic Barrier, Align, and the nontreated control, in order of increasing damage (Figure 2). The average worm damage ratings in all organic treatments except for Align were below 4, indicating that most of the damage occurred on the outer wrapper leaves and did not affect marketability of the cabbage heads.

In the lettuce experiment, differences in insect feeding damage among treatments also were evident (Figure 3). Treatments in order of increasing insect feeding damage were: Garlic Barrier applied as a transplant drench and foliar spray, the chemical standard, Garlic Barrier applied only as a foliar spray, and the water control. In the garlic treatments, insect feeding damage was limited to the wrapper leaves and did not affect marketability of the lettuce heads. No garlic odor was detected from the lettuce or cabbage plants at harvest.

This study indicates that all the organic insecticides and insect repellents evaluated in these studies, except for Align, were effective in reducing caterpillar populations and insect feeding damage in cabbage and lettuce. Surprisingly, application of the organic materials resulted in equivalent or lower insect feeding damage than the chemical standard treatment. This did not occur in the 1996 cabbage trial, where the organic materials provided acceptable insect control and marketable cabbage heads, but were not superior to the chemical standard Karate (*Highlights of Agricultural Research*, Volume 43, No. 3, Fall, 1996). Variability in results between years could be due to various factors, including level of insect infestation and environmental conditions. However, these results demonstrated that application of Javelin WG, Garlic Barrier, and red pepper reduce caterpillar feeding damage sufficient to result in marketable yields of cabbage and lettuce. These materials have not been evaluated for control of insect pests of other vegetable crops. Although treatments may prove efficacious in these experiments, pest, crop, and environmental conditions may be different on individual farms or gardens.

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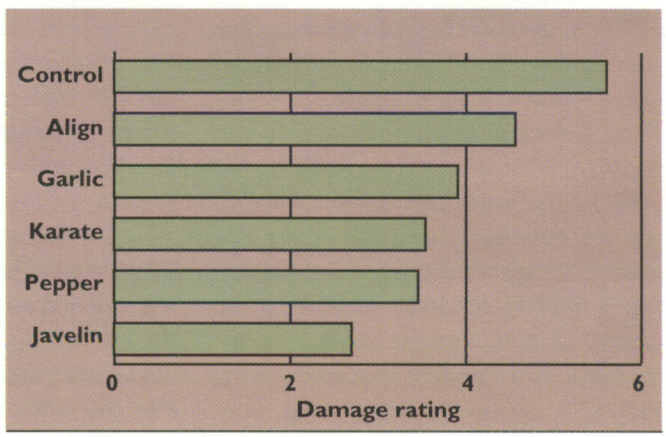


Fig. 2. Insect feeding damage ratings in the different cabbage spray treatments: 1=no apparent insect feeding; 2=minor feeding on wrapper leaves; 3=moderate feeding on wrapper leaves with no head damage; 4=moderate feeding on wrapper leaves with minor feeding on head. A rating of 4 and above is considered unmarketable because even slight damage to the head is not acceptable.

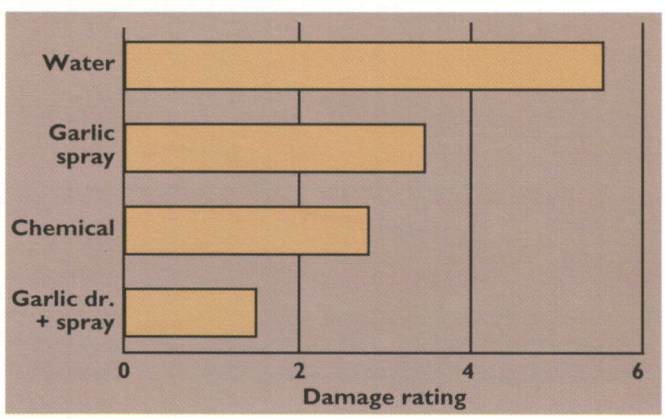
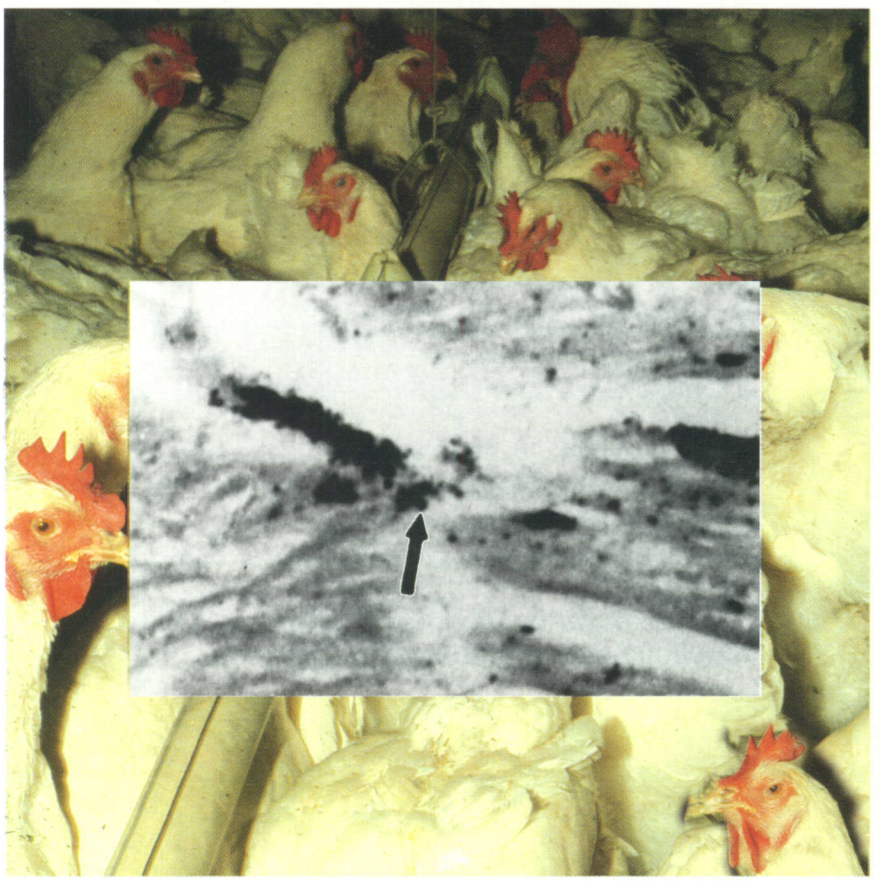


Fig 3. Insect feeding and disease damage ratings in the different lettuce spray treatments (0=no damage; 5=most severe damage).

AAES Develops Fast, Efficient Test for Diagnosis of Viral Disease of Chickens

Joseph J. Giambrone and Hung Jen Liu

Avian reoviruses cause a number of economically important, debilitating diseases of commercial chicken and turkey flocks worldwide. Reovirus is an abbreviation for respiratory, enteric orphan virus. These viruses got their names because they were originally isolated from the enteric and respiratory tract of clinically normal children some 40 years ago.



Detection of avian reovirus RNA in the heart of an infected broiler by in situ *hybridization using a digoxigenin-labeled cDNA. Positive viral RNA particles are indicated by an arrow, which points to small, dark round particles.*

In susceptible chickens, reoviruses can cause lameness and suboptimal weight gain and feed conversion, as well as immunosuppression. Immunosuppression results in poor vaccine responses and renders the birds more susceptible to other infectious agents.

Reoviruses can also result in increased mortality and high processing plant condemnation, which will increase the cost of production. Other economic loses come from the cost of medications to treat the disease as well as for diagnostic procedures and vaccines to prevent infection.

Despite new vaccines and treatments, losses due to reovirus infections still occur. The virus has the ability to mutate and evade the chicken's immune response. Diagnosis of reovirus-induced diseases is difficult, because they are clinically indistinguishable from a number of other common problems. Therefore, a rapid laboratory diagnostic test for reovirus infections in poultry is needed. Researchers in the AAES have developed a rapid sensitive laboratory test for the diagnosis of avian reoviruses. The test uses the very latest molecular biological procedures for the detection of the presence of reovirus nucleic acid in the tissues of infected chickens. *In situ* (in the tissue) hybridization (the union of two strands of nucleic acid) was used to detect viral genes in infected tissue sections, that had been fixed in formalin and paraffin-embed-

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Viral Disease, continued from page 19

ded. This histologic procedure of formalin fixing and paraffin embedding is common in the poultry diagnostic laboratory for the microscopic observation of lesions (abnormalities) in the tissues of sick chickens.

The *in situ* hybridization (ISH) procedure can assess infection in a small percentage of the total number of chicken cells, without loss of sensitivity due to large numbers of cellular nucleic acids. This allows for early detection (24 hours after infection) with only a small number of viral particles. The ISH test has been widely used for the detection of viral infections. A clinically unapparent viral state in which a particular viral marker is synthesized at levels below the threshold of detection by serology (antibody detection) or immunohistochemistry can be detected using ISH.

The AAES ISH test used a nonradioactive, cloned cDNA (copy of deoxyribonucleic acid) probe amplified in *E. coli* bacteria for the safe and rapid (one day of processing) detection of viral nucleic acid.

The probe was labeled with the nonradioactive chemical digoxigenin (DIG). The DIG labeled probe is safe, sensitive, and stable for more than one year in the refrigerator. DIG labeled probes accurately define viral nucleic particles and show less nonspecific (background) staining than with other nonradioactive probes. With this test the viral RNA (ribonucleic acid) can be seen in close proximity to the microscopic lesions indicating that the reovirus caused the lesions. The figure shows an arrow, which indicates a positive ISH signal (presence of reovirus RNA). This is a heart tissue showing microscopic lesions from a reovirus infected chicken. With this test, viral containing particles could be localized in the liver, pancreas, and synovial membrane of the tendon of infected chickens. These tissues also had macroscopic and microscopic lesions indicative of reovirus infection. The microscopic lesions were in close proximity with the positive ISH particles indicating that the reovirus caused the lesions. Tissues showing the most amount of microscopic lesions had the most amount of positively stained particles, which further showed that reoviral replication was responsible for the microscopic lesions. In addition, tissues from noninfected chickens or chickens infected with nonrelated poultry viruses did not show positive stained particles. This indicated the specificity and reliability of the test for routine diagnosis of reovirus infections.

The ISH test can be adapted to many other poultry viruses by simply making specific probes for each piece of viral nucleic acid. Therefore, this test represents a major breakthrough for the diagnosis of all viral diseases of poultry where the disease cannot be diagnosed based solely on the clinical picture.

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