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# HIGHLIGHTS

OF AGRICULTURAL RESEARCH



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**ON THE COVER.** A researcher samples ozone damage to trees in the Talladega National Forest; see story on page 9.

## U P C O M I N G E V E N T S

April 7 _____	Farm-City Week Awards Luncheon, Birmingham
April 26 _____	Beef-Forage Field Day, Upper Coastal Plain Substation, Winfield
May 17 _____	Livestock-Forage Field Day, Black Belt Substation, Marion Junction
June 16 _____	Vegetable Field Day, Sand Mountain Substation, Crossville
June 19 _____	Horticulture Field Day, E.V. Smith Research Center, Shorter

## G U E S T C O M M E N T S

There is an historic alliance between agriculture and veterinary medicine that traces its origins to antiquity. In the animals of the New World, 17th and 18th century concerns focused on public health and sanitation, rabies, tetanus, and various diseases of horses, cattle, sheep, and hogs.

The current hysteria over *E. coli* and salmonella contamination of our food supply is a replay of early 19th century human and animal plagues in the colonies due to brucellosis, tuberculosis, and other food-borne diseases. No modern day trade war is more threatening to animal agriculture than was the embargo of 1878 imposed on U.S. cattle and hogs by West European nations due to an unchecked outbreak of bovine pleuro-pneumonia and a high incidence of porcine trichinosis.

In repeated instances, since antebellum days, American agriculture and veterinary medicine have worked together for the benefit of human health and well-being and for stability of the nation's economy. This is expressed today in cooperative research on such animal diseases as tibial dyschondroplasia and mycoplasmosis in broilers, enteric septicemia and viral infections in channel catfish, the shipping fever complex and reproductive disorders of cattle, and parasitisms of all domestic species.

At Auburn University, agriculture and veterinary medicine have grown from the same rootstock for more than a century. Perpetuation and enhancement of that relationship is in the best interest of the public trust and deserves the unified support of government and industry in partnership with the land grant university.

J.T. Vaughan, Dean  
College of Veterinary Medicine

S p r i n g 1 9 9 4 V o l u m e 4 1 N u m b e r 1

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# BOLL WEEVIL ERADICATION PROGRAM BENEFITS ALABAMA COTTON FARMERS

Cotton farmers in the southern third of Alabama will vote in a 1994 referendum to determine whether to continue participation in the federal Boll Weevil Eradication (BWE) program, which has been active in that area since 1987. AAES research indicates that the BWE program was likely responsible for dramatic cotton yield increases, significant enough to cause farmers to shift acreage away from alternative crops into cotton.

Farmers in Alabama, Georgia, and Florida were surveyed from 1986-90 to assess the impacts of BWE. Statistical analysis of the data, accounting for weather conditions and other factors affecting cotton yields, revealed that the BWE program has resulted in yield increases of roughly 100 pounds per acre. The average number of insecticide applications for boll weevils fell over the study period, and the average number of cotton acres per farm increased. The most dramatic increases have occurred in Southwest Alabama, where acreage has nearly doubled.

To assess the full economic impact of the program, AAES researchers used a whole-farm computer model to develop a five-year profit-maximizing plan for a representative cotton farm in Southwest Alabama. Crops on the hypothetical 1,692-acre farm included cotton, soybeans, and winter wheat. Information on yields, prices, and costs of production was taken from Alabama Cooperative Extension Service (ACES) budgets. Information on the appropriate structure of a representative farm was obtained from the Alabama Farm Analysis Association. The model included full representation of 1990 Farm Bill provisions.

Cotton acreage "base," or acreage eligible for enrollment in the Farm Bill commodity program, is calculated as a moving average of acres planted or "considered planted" in cotton for the previous three years. If a farmer elects to participate in the commodity program in any year, cotton planting must be limited to a portion of the base. In return, the farmer receives a deficiency payment if market price falls below the legislatively set target price. The representative cotton farm used in this study was assumed to have cotton base on half its acres.

The farm planning model was first used on a "no eradication" scenario. For this

simulation, budgeted ACES yields were decreased by 100 pounds per acre — the amount of the increase attributed to BWE. A \$12 per acre charge for the confirmation phase of the BWE program was also removed from variable production costs. The optimal crop-mix for this scenario involves commodity program participation for cotton every year, with the remainder of the farm planted in wheat and soybeans double cropped (see table).

To reflect the actual situation after implementation of BWE, the cotton yield was returned to current ACES levels — 100 pounds higher than in the no-eradication scenario. With this change, the farm shifts heavily into cotton production, staying out of the program for two years in order to build base for the future. In years three through five, cotton is planted within program limits with some cropland planted in the alternative crops. Results indicate that the BWE program was the probable cause of the increased cotton acreage in Southwest Alabama.

Profits for the entire farm also rose after BWE. Because BWE start-up costs — which are not considered explicitly in the models — depended on acreage planted in cotton during the early program years, the net benefit to individual producers varied considerably.

Results of this study should not be generalized to other areas of Alabama, where different growing conditions may result in different outcomes of the program. Northeast Alabama cotton farmers voted to participate in the program in 1992, and farmers in central and West Alabama joined in 1993. Since insect pressures are not as great in North Alabama, the BWE program will probably result in lower yield gains. Even so, expected gains will most likely far outweigh the producer costs of the program.

Duffy and Young are Associate Professors of Agricultural Economics. Wetzstein is a Professor of Agricultural and Applied Economics at the University of Georgia. Cain is a County Extension Agent and former Graduate Research Assistant.

CROP-MIX AND RETURNS FOR SOUTH ALABAMA FARM<sup>1</sup>

	No Boll Weevil Eradication Objective Function: \$155,970 <sup>2</sup>		
	Cotton	Wheat-Soybeans	Soybeans
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Year 1	846 <sup>3</sup>	846	0
Year 2	846 <sup>3</sup>	846	0
Year 3	846 <sup>3</sup>	846	0
Year 4	846 <sup>3</sup>	846	0
Year 5	846 <sup>3</sup>	846	0
	Boll Weevil Eradication Objective Function: \$431,653		
	Cotton	Wheat-Soybeans	Soybeans
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Year 1	1,692	0	0
Year 2	1,692	0	0
Year 3	1,410 <sup>3</sup>	282	0
Year 4	1,598 <sup>3</sup>	94	0
Year 5	1,567 <sup>3</sup>	125	0

<sup>1</sup>This hypothetical farm has 1,692 acres of cropland with 50% initial cotton base. Cotton base is calculated as a three-year moving average of acreage planted or considered planted in cotton. The farm is assumed to have 846 acres planted or considered planted in each of the three years preceding this computer model analysis.

<sup>2</sup>Objective function is defined as five-year discounted returns above variable costs and machinery depreciation costs.

<sup>3</sup>Total acres enrolled in commodity program for cotton, including land set aside under the Acres Reserved Program.

# GRAZING INTENSITY DOES NOT ALWAYS CHANGE PERSISTENCE OF TALL FESCUE

Common wisdom dictates that grazing intensity changes the persistence of tall fescue, but a two-year AAES study found this belief to be only partially true. Alabama has more than 1.1 million acres of tall fescue, which form the forage base for the beef cattle industry in the northern part of the state. For several decades, virtually all the fescue acreage in Alabama was Kentucky 31, a hardy cultivar often infected with a toxic endophytic fungus.

AU Triumph, developed at Auburn University, was the first of numerous endophyte-free cultivars marketed following the identification of the *Acremonium* endophyte as the causal agent of health disorders in cattle grazing tall fescue. Unfortunately, there have been continual reports that all of these new endophyte-free cultivars have problems with stand persistence.

AAES researchers are committed to determining the precise cause of these stand declines. A recent study, conducted at the Sand Mountain, Black Belt, and Gulf Coast substations, investigated factors influencing stand percentage over time. The plant material consisted of three pairs of endophyte-infected and endophyte-free fescue experimental populations. To exclude all unrelated effects on the outcome of the trial, the seed for the three pairs was produced at a common location, the seed was genetically identical except for the presence or absence of the fungus, and seeding rates were adjusted for differences in germination. Stands were established in autumn 1990. Grazing at two intensities began in March 1991.

Within one year of seeding, the heavily grazed pasture had all but disappeared at the Gulf Coast Substation in Fairhope (see figure) regardless of population or endophyte level. Less than 50% of the stand remained in the leniently grazed pasture,

and endophyte-infected cultivars had approximately 10% more stand than the endophyte-free populations. The trial was discontinued at this location in early 1992 due to the dramatic decline in stand.

The best stand percentage after two years of grazing remained at the Black Belt Substation in Marion Junction, where stands exceeded 80%. There, endophyte-infected populations had 7-10% stand advantages over endophyte-free populations. This confirms observations from a previous study at that location, where the endophyte-infected cultivar had approximately 10% more plants than the endophyte-free population, regardless of grazing intensity. This difference was observed during the first year and did not change throughout the four-year duration of that study.

Endophyte-infected and endophyte-free populations had virtually identical stand percentages at the Sand Mountain Substation in Crossville. Stand percentages under heavy grazing were 25% less than under lenient grazing. The heavily grazed pasture was slowly converted to a mixture of white clover, Kentucky bluegrass, bermudagrass, and some orchardgrass.



Ground cover ratings of endophyte-free (left) and endophyte-infected (right) tall fescue were evaluated under grazing at three locations in Alabama. The trial at Fairhope was discontinued after one year.

Three conclusions may be reached from this study: (1) intensive grazing does not necessarily lead to stand decline; (2) even high-endophyte varieties may not persist in South Alabama; and (3) for the remainder of the state, particularly the Black Belt and Sand Mountain areas, endophyte-free varieties offer producers the chance to take advantage of better animal performance using endophyte-free populations.

van Santen is an Associate Professor of Agronomy and Soils, Eason is Superintendent of the Sand Mountain Substation, Holliman is Superintendent of the Black Belt Substation, Pegues is Assistant Superintendent of the Gulf Coast Substation, and Ball is a Professor of Agronomy and Soils.



# AERIAL NITROGEN FERTILIZATION OF CORN

**H**eavy spring rainfall can cause a loss of nitrogen (N) fertilizer through leaching and other processes. Wet soil conditions may force corn growers into considering expensive, aerial application of fertilizers to salvage the crops, but there are many uncertainties about this practice. An experiment at E.V. Smith Research Center in Shorter was designed to help corn producers decide how to respond to wet weather problems.

Researchers simulated the effects of excessive rainfall by using frequent irrigations to keep the soil relatively wet. An aerial application was simulated using ammonium nitrate (34-0-0), urea (46-0-0), and a liquid urea-ammonium nitrate (UAN) solution. Materials were applied at rates of 80 and 160 pounds of nitrogen per acre. The various treatments were applied over the

grew out of it. However, when UAN was applied at silking, yields were almost half that of plots not supplemented with N.

Ammonium nitrate applied at the V8 stage resulted in 40% leaf burn. At early silking, the damage from ammonium nitrate was less because leaves were fully expanded and not likely to collect the falling fertilizer pellets.

Dry urea, the material of choice for aerial application, resulted in little or no leaf burn regardless of when it was applied.

The source of N, the time of application, and the rate used had dramatic effects on grain yield at harvest (see table). There was a slight yield advantage to using more than 80 pounds N per acre as urea or ammonium nitrate when applied at the V8 stage. At silking, the higher rates may not be as efficiently used by the crop.

This experiment demonstrates the importance of timely use of nitrogen whether it is applied with ground equipment or by airplane. Delaying urea application until silking resulted in a 25% yield loss over what could have been made if the same rate was applied at the V8 stage. On the other hand, the silking application resulted in about twice as much grain as would have been made if the crop was abandoned with no N applied.

If urea is unavailable, ammonium ni-



**Aerially applied 30% UAN solution will desiccate corn leaves. Plants will recover from damage at this stage but not if UAN is applied at silking.**



**Aerially applied urea (top) is the material of choice when salvaging a corn crop in a wet year. UAN solution (30%) (bottom) can completely desiccate a crop and reduce grain yield to half what would have been made if no additional N was applied.**

top of corn at two stages of growth: the eight-leaf stage (V8), which occurs 6-8 weeks after planting; or later at early silking.

As expected, leaf burn was severe when the UAN solution was used. Although the damage looked bad at the V8 stage, the crop

EFFECTS OF AERIALY APPLIED NITROGEN ON CORN GRAIN YIELD

Source	Time of application	N rate <sup>1</sup>	Grain yield	Leaf burn <sup>2</sup>	
				V8 <sup>3</sup>	Silking
		Lb./a.	Bu./a.		
None .....	—	0	71	0	0
Urea <sup>4</sup> .....	V8	80	125	0	-
Urea .....	V8	160	150	0.5	-
Urea .....	silking	80	98	-	0
Urea .....	silking	160	111	-	0
Ammonium nitrate .....	V8	80	127	1.0	-
Ammonium nitrate .....	V8	160	142	2.0	-
Ammonium nitrate .....	silking	80	100	-	0.7
Ammonium nitrate .....	silking	160	96	-	1.0
UAN <sup>5</sup> .....	V8	80	128	2.2	-
UAN .....	V8	160	117	3.0	-
UAN .....	silking	80	36	-	3.5
UAN .....	silking	160	24	-	4.8

<sup>1</sup>Forty pounds N per acre were applied preplant. The rates reported in this table are supplemental.

<sup>2</sup>0 = little or no leaf burn; 5 = 80-100% leaf damage.

<sup>3</sup>The V8 stage of growth is approximately 6-8 weeks after planting.

<sup>4</sup>Urea applied in this treatment was prilled.

<sup>5</sup>UAN is a solution of liquid urea and ammonium nitrate.

trate was found to be an acceptable alternative for aerial application. Nitrogen solutions should be avoided because of foliar burn—particularly if the application is late.

Mitchell is an Associate Professor of Agronomy and Soils.



# FOLIC ACID SUPPLEMENTATION CAN IMPROVE REPRODUCTIVE PERFORMANCE OF SOWS

Improving the reproductive efficiency of sows is important because it is a primary factor determining the profitability of most swine operations. Many producers are weaning pigs earlier and following intensive production schedules in an effort to increase reproductive efficiency. Obviously, these management practices place high biological demands on sows.

Addition of folic acid to the sow diet might be one way to increase litter size and the performance of baby pigs during the nursing phase. Folic acid is a vitamin found

in feedstuffs in variable amounts, and it can be produced by bacteria in the intestine of various species. Until recently, the folic acid content of practical diets and bacterial synthesis were believed to be adequate to meet the pig's requirement. Since the early 1980s, however, there have been several reports indicating that folic acid supple-

mentation can have beneficial effects on the reproductive efficiency of swine. As part of a collaborative project involving experiment station researchers in five southern states, a study was conducted to evaluate the effect of folic acid supplementation on the reproductive performance of sows. The basal diet was calculated to contain 0.34 parts per million (ppm) folic acid. This diet was supplemented with 0-4 ppm folic acid. Sixty-six crossbred gilts and multiparous sows (sows that had produced several litters) were assigned to dietary

treatments at least 21 days before breeding. They remained on their respective treatments continuously throughout gestation and lactation for three reproductive cycles.

The total number of pigs born increased as supplemental dietary folic acid increased (see table). Baby pig survival rate was not influenced by the dietary treatment, consequently the advantage in litter size obtained at birth was maintained throughout the 21-day lactation phase. Similarly, although there was no difference at birth, total litter weight at day 21 of lactation increased as the folic acid content of diets increased.

Sow weight loss during lactation increased as dietary folic acid increased, most likely because of

the larger litters being nursed. However, days required to return to estrus after weaning were not affected by the addition of folic acid. This and other findings indicate that the increase in weight loss during lactation had no immediate or even long-term adverse effects on the reproductive performance of sows.

Mid-gestation is a critical period for sows because placental and fetal tissues develop very rapidly during this phase. Virginia researchers collaborating in this project have shown that blood folic acid concentrations decreased progressively from weaning to late gestation, and this depression can be attenuated by supplemental folic acid. Along with other functions, folic acid is essential for the synthesis of important genetic substances that are involved in proper development and growth of various tissues and organs. This aspect of folic acid might be especially important for unborn animals. Attenuating this decline in blood folic acid concentrations in sows during the gestation phase by dietary supplementation, therefore, could have a positive effect on litter size, possibly by decreasing embryonic mortality.

Unexpectedly, although the beneficial effect of folic acid on litter size has been observed in many previous studies, it was not observed at other stations in this current regional study. However, considering the preponderance of data supporting the benefits of the vitamin, litter size is likely to be improved by supplemental folic acid. In a comprehensive review of published folic acid investigations, a collaborator in the regional project reported that all studies showed a positive response to the vitamin in reproductive efficiency.

It has been suggested that folic acid should be included routinely in the breeding herd vitamin premix, which can be accomplished with a minimal cost, even though the need for supplementation during lactation has not been demonstrated and the sow's body can store only a limited amount of this vitamin. In addition, folic acid supplementation might be more beneficial in some instances where the ovulation rate in the female is greater, such as breeds that ovulate more, sow herds in advanced parities, and flushed gilts or sows. Consequently, the embryonic mortality rate might be reduced with the addition of folic acid in the sow diet.

Chiba is an Assistant Professor of Animal and Dairy Sciences; Eason is Superintendent and Dawkins is a Herdsman of the Sand Mountain Substation.

EFFECT OF SUPPLEMENTAL FOLIC ACID  
ON REPRODUCTIVE PERFORMANCE OF SOWS<sup>1</sup>

Variables <sup>3</sup>	Supplemental folic acid <sup>2</sup>			
	0	1	2	4
Litter size				
Total pigs at birth ..	9.51	9.97	10.12	10.59
Pigs at day 21 .....	8.59	9.09	8.76	9.58
Litter weight (lb.)				
At birth .....	34.6	31.4	33.6	33.2
At day 21 .....	97.8	100.8	98.3	109.7
Piglet survival rate to day 21 (pct.) .....	92.9	95.3	92.2	93.9
Sow weight loss during lactation (lb.) .....	2.9	7.9	10.4	19.7
Return to estrus after weaning (day) .....	6.0	6.3	6.4	6.0

<sup>1</sup>Gilts and sows were placed on dietary treatments 21 days before breeding and remained on their respective treatments continuously throughout gestation and lactation for three parities.

<sup>2</sup>Folic acid supplements are expressed in parts per million (ppm).

<sup>3</sup>There were 41, 37, 43, and 39 litters for diets supplemented with 0, 1, 2, and 4 ppm of folic acid, respectively.



# ROSEMARY EXTRACT SHOWN TO IMPROVE SHELF LIFE OF FRESH PORK SAUSAGE

Rancidity is one of the most significant factors affecting the shelf life of fresh pork sausage products. The breakdown of fats during storage causes a disagreeable odor, taste, and color. Chemicals such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and propyl gallate are generally used to prevent such problems, but consumers are becoming increasingly concerned about chemical food additives. However, they still want consistent high quality.

Rosemary extract contains natural compounds that could replace these common chemical preservatives. A combination of rosemary extract and potassium lactate or sodium lactate could provide a product with acceptable storage quality and more natural ingredients. Potassium and sodium lactates, which are widely used in the meat industry to improve shelf life, are reported to be effective in controlling bacterial growth and preventing development of unpleasant flavor, odor, and color.

Six fresh pork sausage treatments were formulated in an AAES study to test use of these compounds. All treatments consisted of 25%-fat pork sausage with seasonings and 3% added water, along with various combinations of preservatives: (1) 3% sodium lactate; (2) 3.4% potassium lactate; (3) 3% sodium lactate and 500 parts per million (ppm) rosemary extract; (4) 3.4% potassium lactate and 500 ppm rosemary extract; (5) BHT and propyl gallate; (6) BHA and propyl gallate; and (7) control pork sausage with no additives.

Fresh sausage patties were frozen for 12 weeks to simulate storage conditions encountered prior to retail display. "Fresh" in this sense means that the products were not cured. Patties were evaluated for fat break-

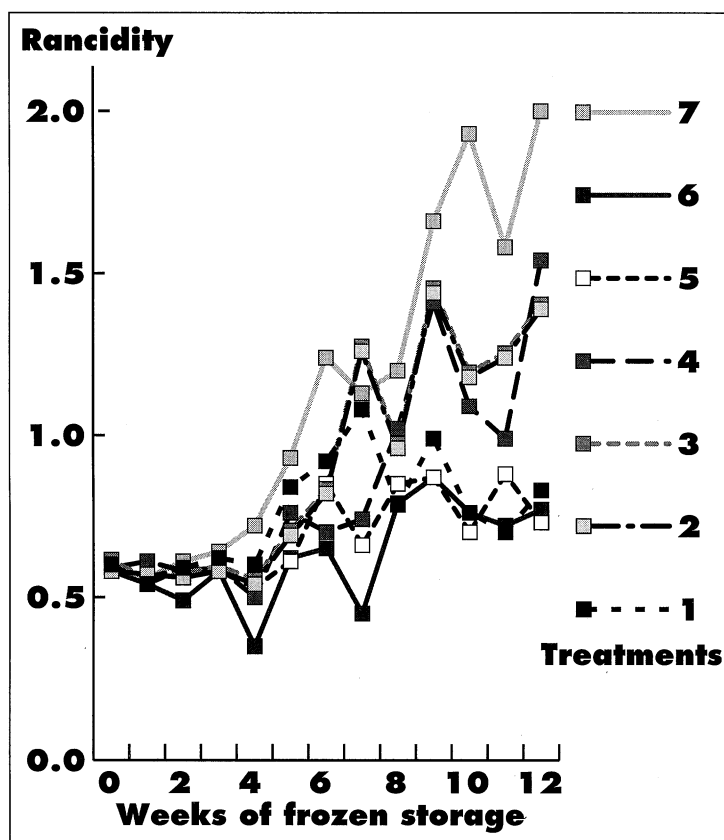
down, or lipid oxidation, during that time using a rancidity measurement known as "TBARS." Color stability was evaluated with a Hunter color difference monitor, as well as by a visual appraisal panel, over an eight-week period.

During frozen storage, redness value decreased, while percent discoloration increased for all sausage treatments. There were no differences among treatments in color properties.

The control sausage had the highest level of rancidity among the treatments tested (figure). Treatments with potassium and sodium lactates alone were less rancid than the control sausage, but they were more rancid than treatments that included BHA, BHT, or propyl gallate. This indicates that potassium and sodium lactates do have some preservative properties. The treatments with rosemary extract and potassium or sodium lactate performed as well as treatments with BHA, BHT and propyl gallate added.

The results of this study indicate that fresh pork sausage produced with rosemary extract and potassium or sodium lactate has the same storage quality as products containing the more traditional chemical additives. This information could be used to give consumers a product with fewer additives and more natural ingredients.

Bradford is a former Research Associate, Huffman is a Professor, and Britt is a former Graduate Research Assistant in Animal and Dairy Sciences.



Effects of frozen storage on TBARS, a measurement of rancidity, on seven pork sausage treatments (described in text). TBARS is expressed as milligrams of Malonaldehyde per kilogram of meat; the higher the concentration, the more rancid the meat.



# ALL-AMERICAN SELECTIONS DISPLAY GARDEN YIELDING INFORMATION ON BEDDING PLANTS

**T**rial gardens provide useful information on the performance of flower and vegetable plants for breeders, growers, landscapers, retailers, and hobbyists. AAES research has been helping supply that information to Alabamians for several years and has now joined an international evaluation effort.

Since 1990, the AU Department of Horticulture has evaluated cool- and warm-season annual flowering plants at the Patterson Greenhouse Complex in Auburn to help meet the university's teaching and landscaping needs. Through a cooperative effort of the department and the AAES, these evaluations were expanded in fall 1991 to the E.V. Smith Research Center in Shorter, where land and technical assistance were more readily available for the garden which steadily grew in size. In January 1993, this expanded garden was designated as an All-American Selections (AAS) Display Garden.

AAS was established in 1933 to evaluate and publicize new, improved varieties of seed-propagated flowers and vegetables. Since 1933, 565 plant varieties have been designated as AAS Winners, indicating superior performance compared to existing varieties in diverse locations across the United States and Canada. The other AAS Display Gardens in Alabama are Birmingham Botanical Garden and Bellingrath Gardens and Home. There also is an official Trial Garden at Callaway Gardens,

Georgia.

Results of these evaluations at Auburn and the E.V. Smith



TOP-PERFORMING PETUNIAS IN 1993 AAS TEST AT E.V. SMITH RESEARCH CENTER	
Color	Cultivar
Red grandiflora	Candy Pops Burgundy
Red multiflora	Celebrity Burgundy
Rose grandiflora	Flash Rose
Rose multiflora	Primetime Rose
Salmon grandiflora	Dreams Salmon
Salmon multiflora	Primetime Salmon
Pink grandiflora	Flash Pink
Pink multiflora	Carpet Flame
Purple grandiflora	Flash Velvet
Lilac grandiflora	Daddy Orchid
Lilac multiflora	Celebrity Lilac
Blue multiflora	Primetime Blue
Star multiflora	Celebrity Rose Star

some 230 varieties of summer annuals were displayed at the center. Panda Pink torenia and Dazzler Red, Accent Orange, Accent Deep Pink, Impact White, and Dazzler Punch impatiens all displayed superior performance as annuals for planting in shaded areas. Encore begonia, Volcano coleus, Buddy Purple and Buddy White gomphrena, Showstar melampodium, Rigida Polaris verbena, and White Star narrow-leaf zinnia were excellent heat-tolerant plants for sunny areas in this evaluation.

From November 1992 to April 1993, about 130 varieties of cool-season bedding plants were evaluated. Some of the superior performing pansies were Universal Red, Maxim Yellow, Melody Yellow Blotch, Crystal Bowl Deep Blue, Universal Purple, and Melody White Blotch.

In 1993, evaluations were made for 231

Center have identified several superior annuals for both warm- and cool-season planting. From May to October 1992,

varieties of summer annuals, nearly 200 of which were petunias. The best performers in each color category of petunias are listed in the table.

Of the species other than petunias, vinca Blush Cooler, Tropicana Blush, Grape Cooler, and Peppermint Cooler performed well throughout the season. Melampodium Showstar, nirembergia Mont Blanc, and zinnia linearis Orange and White Classic also performed well all summer long.

Few varieties performed well in the purple multiflora, blue grandiflora, white grandiflora and multiflora, star grandiflora, and mixed grandiflora and multiflora categories.

These results cannot be used to make recommendations since weather, hardiness zone, soil, exposure, and cultural practices can affect the growth of plants from season to season. Comparison of results from this AAS Display Garden with others in Alabama and the Southeast will improve the reliability of recommendations researchers make from their observations in the garden.

Deneke is a former Assistant Professor, Behe is an Assistant Professor, and Williams is an Assistant Professor of Horticulture; Bannon is Director of the E.V. Smith Research Center.



# AIR POLLUTION INJURY OBSERVED IN TALLADEGA NATIONAL FOREST

Ground-level ozone is considered an important air pollutant toxic to plants, since it can be transported long distances from urban sources to rural, forested areas. Concentrations of the pollutant are highest during the growing season, because the chemical reactions that create ozone are light- and temperature-driven, and stagnant air masses are more common in the spring and summer. Elevated ozone concentrations are known to exist in Alabama, but their effect on the state's forests is not yet known.

As part of a long-term study, AAES and U.S. Department of Agriculture Forest Service researchers found that visible ozone-related injury is prevalent in national forests in Alabama and Mississippi. Injury prevalence and severity varied in each of the three years of study, and some areas were more damaged than others. The Talladega National Forest suffered the most injury.

In 1991, three research plots were established in Talladega, along with similar plots in Mississippi's Holly Springs and DeSoto national forests. Each plot included up to 50 plants of four selected species — blackberry, black cherry, sweetgum, and yellow poplar. These species are known to be sensitive to ozone injury and therefore can

serve as "bioindicators" to provide early warning of problems caused by the pollutant. Researchers surveyed each plot for visible ozone injury in late summer 1991-93.

The most common symptoms of ozone injury are dot-like lesions of tan, red, brown, purple, or black. Other symptoms include small areas of dead tissue and loss of color. In severe cases, leaves can age prematurely and fall off. Before field work began, laboratory research was used to verify these distinctive ozone symptoms. See the figures.

Ozone injury was greatest in 1992 and least in 1993. This variation is explained by the fact that plant response to ozone is moderated by other environmental factors. Ozone is a gas which enters leaves through the same pores that control exchange of carbon dioxide, oxygen, and water vapor. During the 1993 growing season, these pores, or "stomata," were often partly closed due to a regional drought. In 1992, however, adequate soil moisture allowed them to remain fully open.

In 1992, 66%, 58%, and 34% of the observed plants at Talladega, Holly Springs, and DeSoto national forests, respectively, showed signs of ozone injury. In general,



Figures 1,2. Ozone stippling on yellow-poplar (top). Ozone stippling on black cherry (bottom).

blackberry was found to be the most severely injured plant.

Ozone is created when hydrocarbons and nitrogen oxides from manufacturing and automobile exhausts react in the atmosphere. The Talladega National Forest suffered greater ozone injury most likely because it lies between Atlanta and Birmingham, which have ample sources of these pollutants. Other investigators observed ozone injury in the Bankhead National Forest in Alabama and the Cohutta National Forest in Georgia.

Results from this study indicate that ozone is prevalent in forested areas in this region. However, more research is needed to determine if the pollutant is affecting the growth and productivity of these ecosystems.

Chappelka is an Associate Professor of Forestry, and Wergowske is an Air Resource Specialist with the USDA Forest Service.

AVERAGE INCIDENCE AND SEVERITY OF OZONE INJURY FOR THE TALLADEGA NATIONAL FOREST, 1991-93<sup>1</sup>

Species	1991		1992		1993				
	Plants studied	Pct. injured		Plants studied	Pct. injured		Plants studied	Pct. injured	
		Plants	Leaves		Plants	Leaves		Plants	Leaves
Blackberry .....	149	49	47	150	74	52	194	52	27
Black Cherry .....	40	53	55	63	57	23	108	16	14
Sweetgum .....	100	36	31	100	57	44	144	24	18
Yellow-poplar .....	113	65	39	130	68	32	108	12	17

<sup>1</sup>This table shows the number of plants observed from each of four sensitive species, the percentage of these plants that suffered ozone injury during the study period, and the average percentage of the leaves damaged on each plant.



# MANAGING PEANUTS FOR MINIMIZING AFLATOXINS

Calcium has long been known to affect peanut crop quality and yield. Recent AAES research has shown that calcium can also lessen the risk of contamination of peanuts with carcinogenic compounds called aflatoxins. In tests in the Wiregrass area of Alabama, peanuts grown in soil with extractable calcium concentrations of 400 pounds per acre [200 parts per million (ppm)] or greater had less invasion by the fungi that produce aflatoxins.

Peanut quality and marketability are commonly affected by the presence of aflatoxins, which are produced by the fungi *Aspergillus flavus* and *A. parasiticus*. Aflatoxin-producing fungi are commonly found in the light sandy soils in which peanuts are grown and most frequently occur when hot, dry conditions prevail. High temperatures favor growth of these fungi, limit growth of competing organisms, and stress peanut plants, thereby making infection more likely. Since these fungi are found in the soil and invade peanut tissue throughout plant growth, controlling this problem is difficult. However, proper peanut crop management can lead to reduction of peanut seed invasion by aflatoxigenic fungi.

Peanuts produced under conditions of severe calcium deficiency have decreased yield. Severe calcium deficiency can make peanuts more susceptible to drought stress due to decreased root development. Even under moderate levels of calcium deficiency, peanuts may be produced with a greater incidence of "pops" or immature seeds.

In addition, soil calcium at concentrations of 400 pounds per acre has been shown to be optimal for seed germination. However, this concentration exceeds calcium needed for optimal yield.

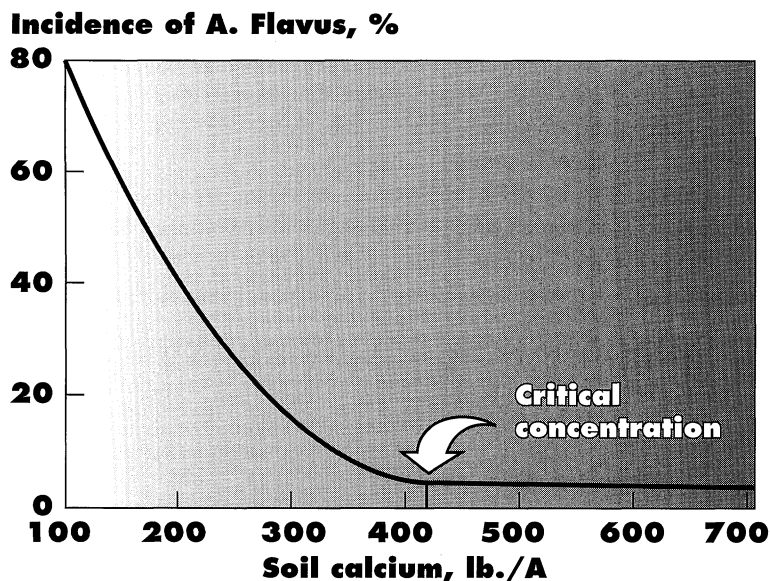
Six on-farm experiments in 1991 and four in 1992 were initiated on Coastal Plain soils of Southeast Alabama. Cultivars planted were Florunner, Sunrunner, and GK 7 in both years, and Georgia Runner in one trial in 1992. At each site, two treatments were applied — a no-gypsum treatment and 500 pounds per acre of gypsum (calcium source) applied over the row at early bloom. This provided two soil calcium concentrations at each site, with inherent differences among sites. Plots were harvested, graded, and subsampled for elemental analysis, germination, and incidence of fungal invasion. Aflatoxins were determined by fluorescence on an HPLC.

In the two years of the trials, rainfall during the growing season was such that aflatoxins were not a problem. However, *A.*

*flavus*-type fungi did invade the peanut seed. As shown in the figure, invasion of peanut seed by aflatoxigenic fungi may be quite high when soil calcium is low. However, at the critical concentration of 440 pounds per acre of calcium in the soil, presence of *A. flavus*-type fungi reached a minimum. This concentration is higher than the 300 pounds per acre of calcium required for maximum yield.

In addition, calcium concentrations in seed were determined relative to fungal invasion. At 230 ppm seed calcium, seed invasion by aflatoxigenic fungi was minimized. The minimum seed calcium required for maximum germination is 320 ppm. Fewer data points were used for determining the critical seed calcium to invasion by *A. flavus* than for determining the seed calcium needed for optimum germination. Further research may show that the critical seed calcium concentration for germination is similar to that for invasion by *A. flavus*, as they are for soil calcium relative to germination and incidence of *A. flavus*.

Since it is currently not possible to treat a peanut field with fungicides to control *A. flavus*, it is important to understand the relationship between seed contamination and seed quality. Crop quality can be optimized through certain management practices that may differ from optimizing yield production, including supplemental calcium even when existing soil calcium is adequate for maximum yield.



Incidence of *A. flavus* as soil calcium concentration increases. At the critical concentration of 440 pounds per acre, presence of *A. flavus*-type fungal invasion of seed reached a minimum.

Bowen is an Associate Professor of Plant Pathology and Adams is an Associate Professor of Agronomy and Soils.

# IMPROVED DIAGNOSTIC TOOL DEVELOPED FOR MAJOR POULTRY DISEASE

Infectious bursal disease (IBD) virus, a very common and highly contagious pathogen, affects all aspects of poultry and egg production, costing producers hundreds of millions of dollars per year worldwide. IBD affects the bursa, a gland vital in the immune system of chickens, resulting in poor health, slow growth, immune suppression, and high mortality. The virus is difficult to kill, and it can also interfere with vaccination against other diseases.

The diagnosis of IBD is difficult because its symptoms are easily confused with those of other diseases. A rapid, sensitive diagnostic test was needed for improved control of this economically important poultry disease. To meet this need, Auburn researchers developed a new technique that can quickly provide accurate diagnosis of IBD. The technique is not only more sensitive than traditional methods, it can provide a diagnosis within 24 hours, compared to three or more days with other diagnostic tools.

COMPARISON OF MONOCLONAL ANTIBODY TEST RESULTS WITH VISUAL ANALYSIS OF INFECTIOUS BURSAL DISEASE-INFECTED CHICKENS

IBDV <sup>1</sup>	Microscopic lesions <sup>2</sup>	MAB Staining <sup>3</sup>
Virulent .....	4	3
Vaccine .....	1	1
None .....	0	0

<sup>1</sup>Groups of 21-day-old chickens were inoculated with pathogenic, disease-causing IBD virus or a mild IBD vaccine and compared to chickens not exposed to either treatment.

<sup>2</sup>A score of 0 indicated that no lesion was present, while 4 indicated severely injured tissue.

<sup>3</sup>A score of 0 indicated that no cells tested positively for IBD virus; 1, only a few lightly stained cells; 2, widely scattered cells; and 3, numerous dark stained cells.

Researchers produced monoclonal antibodies (MABs) — genetically engineered molecules designed to seek out and mark specific viruses or other microscopic agents — to detect the presence of the IBD virus in chickens. The MABs are very specific re-

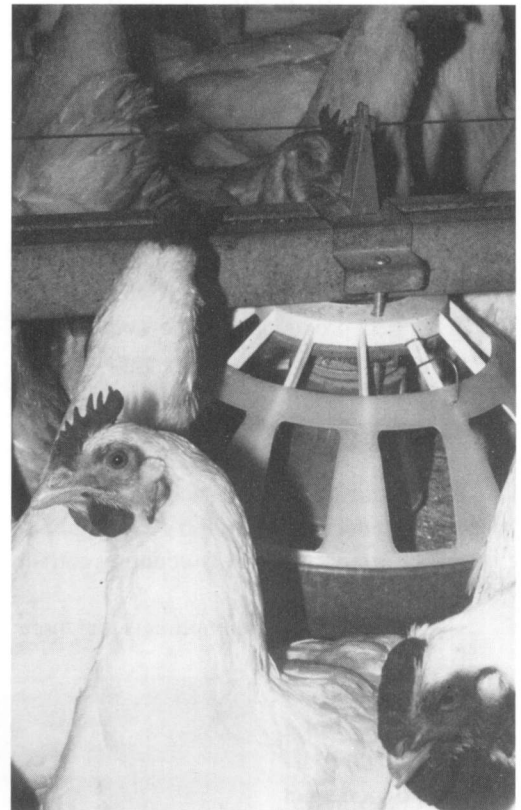
agents that bind only to the IBD virus. They were used to modify a commercially available immunoperoxidase test kit, allowing researchers to identify damaged tissue and quickly confirm whether the damage was caused by the IBD virus.

Tissues from chickens suspected to carry the virus are preserved with formaldehyde and imbedded in paraffin. The wax-encased samples are sliced into one-cell-thick sections and mounted on microscope slides. Slides are treated with a solution containing the MABs, which seek out and bind to IBD viral proteins in the cells. When the solution is applied, a chemical reaction stains infected cells with a yellow-brown color.

All veterinary diagnostic laboratories routinely use “formalin-fixed, paraffin-embedded” tissue samples to examine for the microscopic lesions caused by IBD. Auburn’s technique allows for a more definitive diagnosis by confirming the presence of the virus, in addition to detecting the lesions.

To determine the accuracy of the test, researchers injected some chickens with a mild IBD virus vaccine and others with a highly pathogenic, disease-causing virus. Injections were done when the birds were 21 days old, and tissue samples were taken three days later.

Chickens which received the very virulent IBD virus had severe microscopic lesions (see table). These birds also exhibited other symptoms and experienced mortality rates characteristic of the disease. There was a direct association between the severity of lesions and the intensity and numbers of positively stained cells marked in the experimental diagnostic test. Tissues from birds infected with pathogenic viruses had numerous, dark-stained cells, indicating



areas of IBD virus replication.

In contrast, birds infected with mild vaccine viruses had no clinical disease or gross lesions and only mild microscopic lesions. Tissues from these birds included only a few lightly stained cells. Also, control birds, which were not injected with either viral treatment, had no clinical disease, no lesions of any kind, and no positively stained cells.

These results indicate that the new diagnostic technique is not only accurate in detecting IBD, it is sensitive enough to distinguish between vaccines and full-blown clinical cases of the disease. This test is now used by the Alabama State Veterinary Diagnostic Laboratory in Auburn and at similar labs around the world to aid in the diagnosis of IBD.

Giambrone is a Professor of Poultry Science, Hoerr is Director of the Alabama State Veterinary Diagnostic Laboratory, and Cruz-Coy is a Research Leader with the Maine Biologic Laboratory in Gainesville, Ga.



# MORE ACCURATE SAMPLING OF CATFISH EGGS AND FINGERLINGS

Catfish egg hatching success and fingerling survival can range from 0-100%, depending upon a variety of interacting factors that can leave farmers perplexed. An often overlooked aspect of catfish production is the accuracy of techniques used to inventory eggs and fingerlings.

AAES researchers found many of the traditional enumeration methods used by catfish farmers to be inaccurate. Studies were conducted to develop general guidelines for more accurately counting catfish eggs and fry.

One traditional assumption is that there is a standard number of eggs per pound of egg mass, but this assumption does not account for the age of the mass. During incubation, the amount of material binding the eggs decreases as embryos develop. As a result, the number of eggs is actually greater in masses three days and older than in younger masses (Figure 1).

Egg masses are generally brought to the hatchery at one to four days. Researchers studied 97 egg masses in this age range which weighed a total of approximately 900 pounds. They determined that the mean number of eggs per pound was 12,258. But when the masses were divided according to age, researchers determined that one- to two-day-old masses contained 10,442 eggs per pound, while three- to four-day-old masses contained 13,620.

Eggs are typically incubated in paddlewheel troughs, which hold about 22

pounds of egg mass. Assuming a 100% hatch, 22 pounds of the one-to-two-day-old egg masses would yield approximately 230,000 fry; the older egg masses, approximately 300,000. If the overall mean number of eggs was used — not considering egg mass age — the

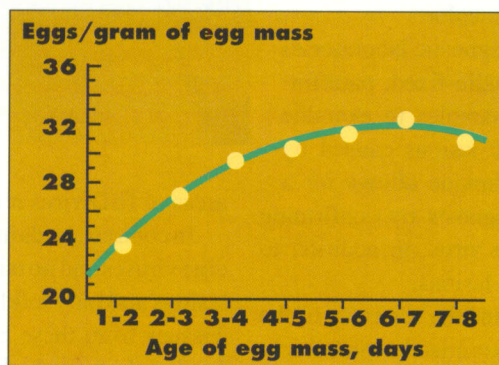


Figure 1. As an egg mass ages, the number of eggs it contains increases.

by determining how much water they displace. Traditionally, it was assumed that 1,000 one-day-old fry displaced one fluid ounce. However, researchers determined that the count can range from 1,853 to 2,191 fry per ounce. Traditional methods would underestimate the inventory by 46-54%, resulting in overstocked ponds and false estimates of survival at harvest.

Researchers determined that a more accurate inventory of fry can be obtained by using a balance with a precision of 0.3 ounce to weigh six 50-fry samples and then applying a correction factor to adjust for the amount of water in each sample. A pan containing a known amount of water is



Figure 2. Estimate the total number of fry by the change in water volume in a graduated wide-mouthed container.

farmer would expect 270,000 fry. Thus, it would appear that the younger eggs yielded only an 85% hatch, while the older ones yielded 111%.

Catfish fry are often inventoried by determining how much water they displace. Traditionally, it was assumed that 1,000 one-day-old fry displaced one fluid ounce. However, researchers determined that the count can range from 1,853 to 2,191 fry per ounce. Traditional methods would underestimate the inventory by 46-54%, resulting in overstocked ponds and false estimates of survival at harvest.

Researchers determined that a more accurate inventory of fry can be obtained by using a balance with a precision of 0.3 ounce to weigh six 50-fry samples and then applying a correction factor to adjust for the amount of water in each sample. A pan containing a known amount of water is

placed on the balance. Some additional water is introduced when fry are added to the pan. The amount of extra water is about the same whether 50 or 1,000 fry are added, which means the weight of this water is proportionally greater in smaller samples. To correct for this imbalance, farmers should weigh several samples ranging in size from 50 to 1,000 fry to determine the weight of the surplus water (Figure 2). Once this factor is known, the farmer can weigh the six 50-fry samples, subtract the weight of the extra water from each sample, and arrive at an accurate inventory of young fish.

Ideally, catfish fry are removed from incubation and enumerated the day they hatch, but often that is not possible. Researchers found that the number of fry per fluid ounce decreased 9% each day past hatching. Therefore, if fry are not collected daily, farmers should allow for a 9% reduction in the number of fry per ounce each day the collection is delayed.

Phelps is an Associate Professor, and Walser and Tamassia are Graduate Research Assistants in Fisheries and Allied Aquacultures.



# MAX-FLEX FAST FENCE™ EVALUATED FOR REDUCING DEER DAMAGE

Deer often cause severe damage to fruit and vegetable crops in commercial and home settings. AAES studies suggest that excluding deer with special fences may provide the best long-term approach to control this damage.

Woven or electric wire fence can be used to exclude deer, but more information is needed on the effectiveness and proper arrangement of these fences to achieve maximum control. A two-year study assessed the effectiveness Max-Flex Fast Fence™ electric fencing materials (polytape). Objectives of the study were to determine the effectiveness of different configurations of polytape for excluding white-tailed deer from agricultural plots and to determine the plot size where a single strand of polytape ceases to be effective. The study was conducted in two phases on areas with historically high deer densities at the Piedmont Substation in Camp Hill.

In the first phase, plots of approximately 45x25 feet (1/40 of an acre) were established and planted with soybeans. Fencing configurations tested included a single strand of polytape placed 30 inches above the ground; a three-wire offset fence using polytape; two strands of polytape placed 18 and 36 inches above the ground; and a five-wire fence constructed of polytape.

These four treatments and a control plot were randomly assigned to plots. Within each plot, six-foot-wide strips of tilled ground were checked for the presence of deer tracks. Fence voltage was maintained between 3,000 and 5,500 volts. Fiberglass posts, one-half inch in diameter, were used for line posts, and fiberglass t-posts were used for corner posts.

The second phase of the study tested the



Soybean plots protected by a two-strand electric polytape fence. Typical deer damage on an apple tree (inset).

effectiveness of a single-strand polytape fence 30 inches above the ground for excluding deer from plots of various sizes up to one acre. These plots were planted with soybeans and maintained as in Phase 1.

Results of the first phase showed that a single strand of polytape was as effective in preventing deer from entering the plots as the more elaborate fence configurations. This may be a result of the visual repellency of the small 25x45-foot plot in conjunction with the electric charge of the fence. Deer were routinely seen entering other larger enclosures fenced with the same and with different configurations and materials in fields adjacent to this test.

The effectiveness of the single strand was much less conclusive in the second phase, with deer entering all plots at some time during the study (see table). However, there does appear to be a direct relationship between plot size and number of deer tracks observed in the plot.

The control of deer was highest in the smallest plot and decreased as plot size increased. This indicates that smaller polytape enclosures may effectively prevent deer from entering. As size of

succeeding years in the same location often require more complex electric fence structures to prevent deer entry.

Results of phase one indicate that a single strand of polytape electric fencing, if properly installed and maintained, can be a suitable deterrent to deer in a small garden or ornamental planting. The quick, easy, and relatively inexpensive installation of polytape electric fences will enhance their desirability by homeowners and gardeners. A fence made of a single polytape strand can be blended into many home and garden settings and offers some degree of deer control with minimal aesthetic interference to the landscape setting.

Deer population, distance from cover, attractiveness of the plant material that has been enclosed, the availability of alternate food materials and cover, and other repelling or attracting factors are additional considerations that will influence the level of deer control.

polytape enclosure increased, control of deer was reduced to the point that the fenced area received heavy deer damage.

These observations suggest that, when starting with minimal electric fence structures,

EFFECTIVENESS OF POLYTAPE FOR EXCLUDING DEER FROM VARIOUS SIZE PLOTS <sup>1</sup>	
Plot size	Effectiveness <sup>2</sup>
<i>Acre</i>	
1/40	76
1/10	63
1/4	48
1/2	28
1	26

<sup>1</sup>A single strand of polytape 30 inches above the ground was used.  
<sup>2</sup>Indicates the percent of observations in which no deer tracks were observed.

considerations that will influence the level of deer control.

Owen is Superintendent of the Piedmont Substation; Armstrong is an Assistant Professor, Stribling is an Associate Professor and Causey is a Professor of Zoology and Wildlife Science.



# CORN MOLD TOXINS REDUCE GROWTH AND DISEASE RESISTANCE IN CATFISH

**F***usarium moniliforme*, a corn mold commonly found in North America, produces mycotoxins called fumonisins (B<sub>1</sub>, B<sub>2</sub>, and B<sub>3</sub>). Fumonisin B<sub>1</sub> has recently been established as an animal toxin. AAES research indicates that these mycotoxins can affect channel catfish performance.

The toxin's effects vary with species and dosage. Diet concentrations of 10 parts per million (ppm) have caused leucoencephalomalacia in horses; 30 ppm can cause pulmonary edema in pigs; and 50 ppm can result in liver cancer in rats. Chickens and cattle seem to be less sensitive than other species to fumonisins.

Large amounts of corn and corn screenings are used in commercial catfish feeds

in the South, but no data were available on sensitivity of fish to fumonisins. The AAES study was conducted to determine the sensitivity of channel catfish to toxins from *F. moniliforme*. Strain 826 of the mold is a prolific producer of fumonisins and was originally isolated in South Africa from corn associated with leucoencephalomalacia in horses. This strain was used to inoculate sterilized corn to produce a culture of toxic corn.

Fumonisin B<sub>1</sub> concentration of the cultured corn was measured at Auburn's Plant Pathology Diagnostic Laboratory. Different combinations of clean and toxic corn were used to formulate diets containing various concentrations of fumonisin ranging from 0-720 ppm. A wide range of fumonisin concentrations

were used because of the uncertainty of the sensitivity of channel catfish to the toxin. Year-one, two-gram catfish and year-two, 30-gram catfish were fed the experimental diets for 12 weeks.

A decrease in weight gain was observed as fumonisin concentration increased in the diet. There was a significant reduction in weight gain by year-one fish fed the lowest dose of fumonisin, which was 20 ppm (see figure). Weight gain by year-two fish also was reduced at the lowest dose concentration but not as much as that of the smaller fish. Fish fed diets with 80 ppm of

fumonisin were lighter in color and had yellow spots (lipoid bodies) in the liver.

At the end of the feeding trial, year-two fish fed the control, 20 ppm, and 80 ppm fumonisin treatments were challenged with the bacterial pathogen *Edwardsiella ictaluri*, which causes enteric septicemia in channel catfish. Based on 12-day mortality counts, fumonisin reduced resistance to the bacterial infection in relation to diet concentration (see table).

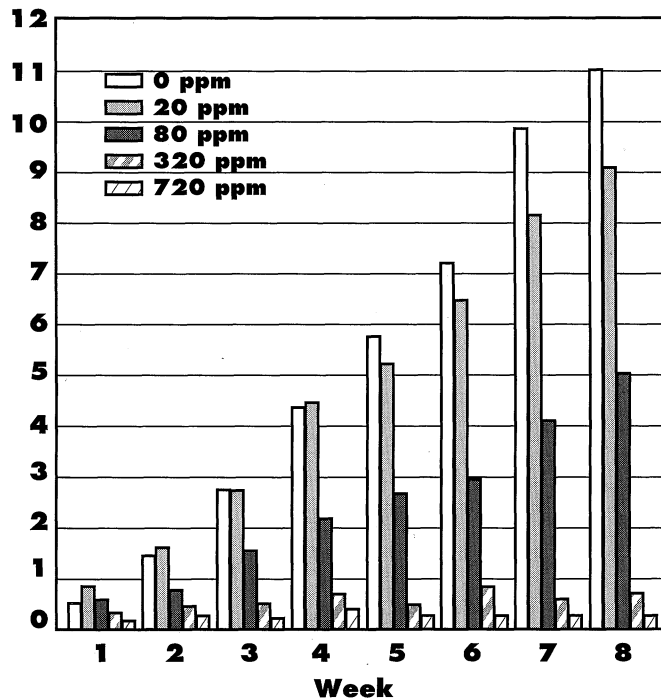
Fumonisin has a chemical structure similar to sphingosine, a component of cell membranes and nerve tissue. The mycotoxins cause toxicity by altering metabolism of sphingosine in animal tissues. Sphingosine levels in the serum, head kidney, and liver were reduced in fish consuming as little as 20 ppm of fumonisin.

Measurement of fumonisin concentration in feed mixes before and after extrusion pelleting showed that fumonisins are heat tolerant and are not destroyed during processing. A limited survey of grains and grain byproducts used in catfish feeds in the South found fumonisins in these products, especially corn and corn screenings. However, amounts did not exceed 10 ppm. Much higher concentrations have been reported in animal feedstuffs in the United States.

The fact that the lowest dose of fumonisin used in the study, 20 ppm, affected the performance of the fish indicates that lower dietary doses should be examined. This also indicates that ingredients used in commercial catfish feeds should be monitored for occurrence and concentration of fumonisins just as they are for aflatoxins.

Lovell is a Professor and Lumlertdacha is a Graduate Research Assistant of Fisheries and Allied Aquacultures; Kemppainen is an Associate Professor of Physiology and Pharmacology; Lenz is an Assistant Professor of Pathobiology; and Shelby is a Research Associate of Plant Pathology.

**Weight gain, g/fish**



Average weight gain of year one channel catfish fed diets containing various concentrations of fumonisin.

Fumonisin	Pct. mortality
ppm	
0.....	27.8
20.....	44.4
80.....	88.9

# EVALUATION OF LOW-INPUT FUNGICIDE SPRAY PROGRAMS FOR CONTROL OF EARLY BLIGHT ON TOMATOES

Controlling early blight in Alabama's \$15 million commercial tomato crop is a major concern, but growers also are concerned with reducing the amount of fungicide they use. Auburn research indicates that two low-input fungicide programs may help growers accomplish these goals.

Early blight, caused by the fungus *Alternaria solani*, can cause severe defoliation, resulting in reduced fruit yield and quality. Conventional calendar-based spray schedules usually call for the fungicide mancozeb to be applied at seven- to 10-day intervals, beginning at transplanting and continuing through harvest. Using this schedule, growers may make 10 or more fungicide applications during the growing season.

Some pesticide labels recommend a range of rates that change with the size of the crop. These rates often are written in a way that results in a large concentration of material being applied when the crop is young and prone to pesticide injury.

Assuming that the recommended mancozeb concentration controls early blight on mature tomatoes, that same concentration should control the disease on young tomatoes. A low-volume, constant-concentration (LV-CC) fungicide spray program has been developed based on using reduced amounts of fungicide early in the season, when less water is necessary for complete coverage, without reducing the concentration of the product.

TOM-CAST (Tomato Disease Fore-

caster) is a weather-based model for the timing of foliar fungicide applications on field-grown tomatoes. The program was developed to control foliar diseases, such as early blight, anthracnose, and Septoria leaf spot. TOM-CAST uses two weather measurements: leaf wetness and air temperature (during the wetness period) to assess disease risk and determine optimum fungicide spray intervals. TOM-CAST has been successfully implemented in tomato production areas in the United States and other countries.

A two-year study was conducted to evaluate a LV-CC fungicide spray program and the TOM-CAST program, both alone and in combination, for control of early blight on fresh market tomatoes. Field evaluations were conducted on spring-transplanted tomatoes in 1992 and a spring and fall tomato crop in 1993 at the North Alabama Horticulture Substation in Cullman. Early blight severity was assessed weekly and total yield (number and weight) by grade was determined at harvest.

In 1992, more early blight was observed in plots sprayed using the TOM-CAST program. However, there was no difference in yield between TOM-CAST plots and plots treated with the standard calendar-based spray program. No differences were observed in disease severity or yield between the LV-CC and the standard spray

program. The LV-CC and TOM-CAST treatments used 38% and 49% less fungicide material, respectively, compared to the standard. TOM-CAST recommended four fewer sprays than the standard spray program.

In both tests in 1993, no differences were observed in disease severity or yield among treatments. In the spring test, the

TOTAL NUMBER OF MANCOZEB SPRAYS APPLIED AND TOTAL PRODUCT USED IN THREE FIELD TESTS WITH DIFFERENT SPRAY PROGRAM

	Spring 1992		Spring 1993		Fall 1993	
	Sprays	Amount	Sprays	Amount	Sprays	Amount
	<i>No.</i>	<i>Grams</i>	<i>No.</i>	<i>Grams</i>	<i>No.</i>	<i>Grams</i>
ST <sup>1</sup> .....	13	668	12	890	11	815
LV-CC <sup>2</sup> .....	13	414	12	680	11	525
TC <sup>3</sup> .....	9	340	5	371	5	334
LV-CC+TC <sup>4</sup> .....	-	-	5	334	5	315

<sup>1</sup>ST = standard fungicide application.

<sup>2</sup>LV-CC = low-volume, constant-concentration.

<sup>3</sup>TC = TOM-CAST or Tomato Disease Forecaster.

<sup>4</sup>LV-CC+TC = combination of low-volume, constant-concentration and TOM-CAST.

LV-CC, TOM-CAST, and LV-CC plus TOM-CAST treatments used 23%, 59%, and 63% less fungicide material than the standard spray program. TOM-CAST recommended seven fewer sprays than the standard. In the fall test, the LV-CC, TOM-CAST, and LV-CC plus TOM-CAST treatments used 35%, 59%, and 61% less fungicide material, respectively, than the standard spray program. TOM-CAST recommended six fewer sprays than the standard.

In response to higher production costs, increased public awareness of pesticide residues on food products, and contamination of the environment, growers are actively seeking methods to reduce pesticide usage. Both low-input spray programs evaluated in this study appear to be viable alternatives for tomato growers in Alabama. Each reduced the amount of fungicide material applied without reducing yield or fruit quality. Further reductions in the amount of fungicides required were obtained when the TOM-CAST and LV-CC programs were combined.

Sikora is an Assistant Professor and Bauske is a Post-Doctoral Fellow of Plant Pathology; Zehnder is an Associate Professor of Entomology; and Hollingsworth is Superintendent of the North Alabama Horticulture Substation.



# WIDTH AFFECTS STRENGTH OF GLUED-LAMINATED TIMBERS

High quality southern pine lumber produced in Alabama is an important ingredient in glued-laminated (glulam) timber products manufactured here and in other states. Glulam timbers are frequently used as beams, columns, or arches in residential and commercial construction. Common examples include garage door headers and arches in religious buildings.

To make glulam products, structural finger joints are cut into the ends of individual laminated boards. One board is spliced and glued to another by joining the finger joints. Layers of spliced boards are then glued together to produce wood members of practically any size and length. The strength of glulam beams is determined by the strength of the lumber, as well as the strength of the adhesion at the joints.

Recently, researchers found that traditional methods did not always accurately predict the strengths of wide finger joints and glulam beams. An AAES study, with support from the American Institute of Timber Construction, was conducted to gain a better understanding of the effects of width on the strength of single finger joints and complete glulam timber beams.

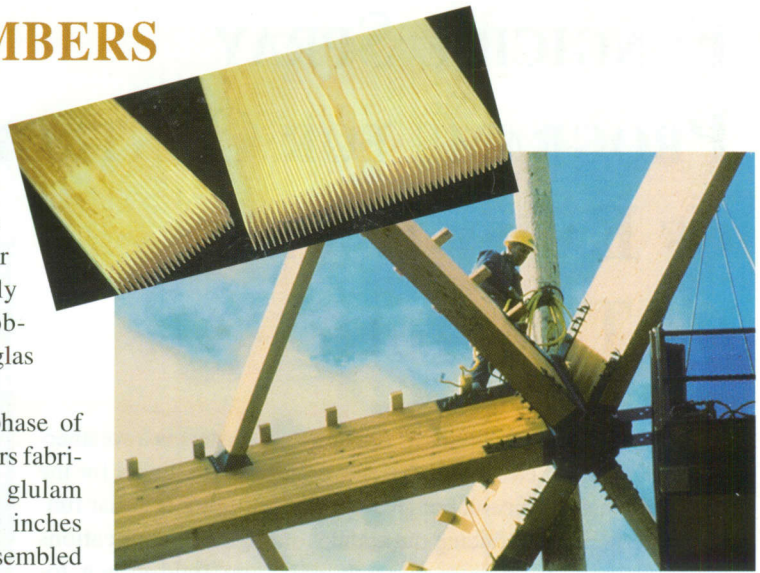
For the first phase of the project, 10 manufacturers supplied finger joints made from several grades of 2x8, 2x10, and 2x12 southern pine and Douglas fir lumber. Researchers determined each specimen's tensile strength, the amount of stress that a joint can withstand before breaking in tension. A testing device was used to pull apart sets of glued joints.

Results showed that finger-joint tensile strength decreased as width increased. For example, the average tensile strengths of No. 1 southern pine finger joints decreased by 10% when the width increased from eight inches to 10 inches. They decreased another 4% when the width increased from 10 inches to 12 inches. As width increases, there is a greater probability that the finger

joint will have a strength-reducing characteristic. The width effects in the southern pine finger joints were slightly less than those observed in the Douglas fir lumber.

In the second phase of the study, researchers fabricated Douglas fir glulam beams six and 10 inches wide. They also assembled finger joints that matched the ones used to make the glulam beams. The beams were tested by bending them with increasing force until they failed, while the joints were tested in tension as described in the first phase.

Results showed that increasing widths had a greater impact on the tensile strength of the finger joints than on the bending strength of the glulam beams. For example, the average tensile strength of one grade of Douglas fir finger joints decreased 26% when the width increased from six inches to 10 inches. However, the average bending strength of entire beams made of the same grade of wood decreased only 4% for the same increase in width. This difference indicates that the process of gluing together several laminations allows load sharing



Glued-laminated beams used in building construction. Laminated boards with structural finger points cut into the ends (inset).

across the width of the beam, thereby compensating for most of the width effects in the finger joints.

This information significantly aids in understanding the behavior of lumber and structural finger joints in wide glulam timber beams. Although the study confirmed that glulam timbers are a strong product, the results are being used in new quality control procedures for manufacturing wider finger joints and the resulting glued-laminated timber beams. The end result will be safer and more economical wood structures for the consumer and more valuable products from Alabama's forests.

Taylor is an Assistant Professor of Agricultural Engineering.

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