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# HIGHLIGHTS

## OF AGRICULTURAL RESEARCH

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Alabama Agricultural Experiment Station Auburn University

Lowell T. Frobish, Director Auburn University, Alabama



# DIRECTOR'S COMMENTS

**C**ONSUMERS OF AGRICULTURAL and forestry products benefit from research conducted in agricultural experiment stations such as the Alabama Agricultural Experiment Station. Benefits of our research program include new and safer products, lower prices, improved nutrition, and a better life style. The average U.S. family receives \$40 of benefits from current expenditures for agricultural research. It is significant to note, however, that research has a greater beneficial impact on low-income than high-income families.



LOWELL T. FROBISH

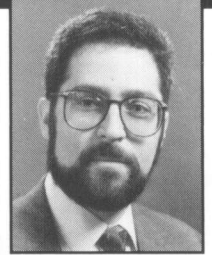
To maintain this high economic return for consumers on funds expended for agricultural and forestry research, we must maintain a research program that is both reactive and proactive. We must continue to be reactive to current problems facing producers and consumers of our products, and ready to respond to new and important problems that can be solved in a short time. At the same time, we must be proactive in anticipating and solving future problems.

Since the settlement of the Virginia Colony in 1607, agriculture has been important in the development of our Nation. In those early years, hand labor was the means of production because labor-saving machinery and equipment had not yet been developed. Scientists soon realized that to clothe, feed, and care for future populations, changes in production were required. Thus, proactive research programs were developed to prepare for the future. Today's challenge is not much different. We must continue to initiate proactive, far-reaching research programs.

To help plan for the future, we have established a Task Force to review Alabama's agricultural and forest industries and to take a hard look at Auburn's research program to support these enterprises. This group has been asked to develop a strategic research plan, officially "Alabama Agriculture and Forestry for the 21st Century," to guide the Alabama Agricultural Experiment Station in the years ahead. The Task Force will be drawing on all resources in Alabama to develop this important strategic plan.

Agricultural research faces a terrific challenge as the 21st century approaches—helping feed a world population that will grow by 80 to 90 million people annually. Planning for this job is made more difficult by the rapid development of new techniques to improve productivity and cost efficiency, and the necessity to compete in the world marketplace. We have the energy to meet this challenge, and the plan being developed will help us succeed.

## MAY WE INTRODUCE



Dr. Arthur Appel, Assistant Professor of Entomology. A native of Los Angeles, California, Appel came to Auburn in 1985 after graduating from the University of California at Riverside with M.S. and Ph.D. degrees in entomology. He previously received a B.A. degree in biology from the University of California at Los Angeles.

Appel's research at Auburn has focused on urban entomology, the study of insects that affect urban environments. He is well known for his work with such insect pests as cockroaches and termites and is the recipient of a Johnson's Wax Fund research fellowship grant to study cockroach behavior. One phase of his research involves studying the physiological ecology of insects. By examining the physical and environmental needs of insects, Appel gathers information that leads to a better understanding of the insect world and also provides new options for control of insect pests.

Results of his study of an unusual carpenter ant infestation in okra are reported on page 5 of this issue of Highlights.



**ON THE COVER.** Carpenter ants were discovered attacking okra plants in a Lee County garden in 1988. (See story on page 5.)

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# PRODUCING LEAN BEEF CAN BE PROFITABLE

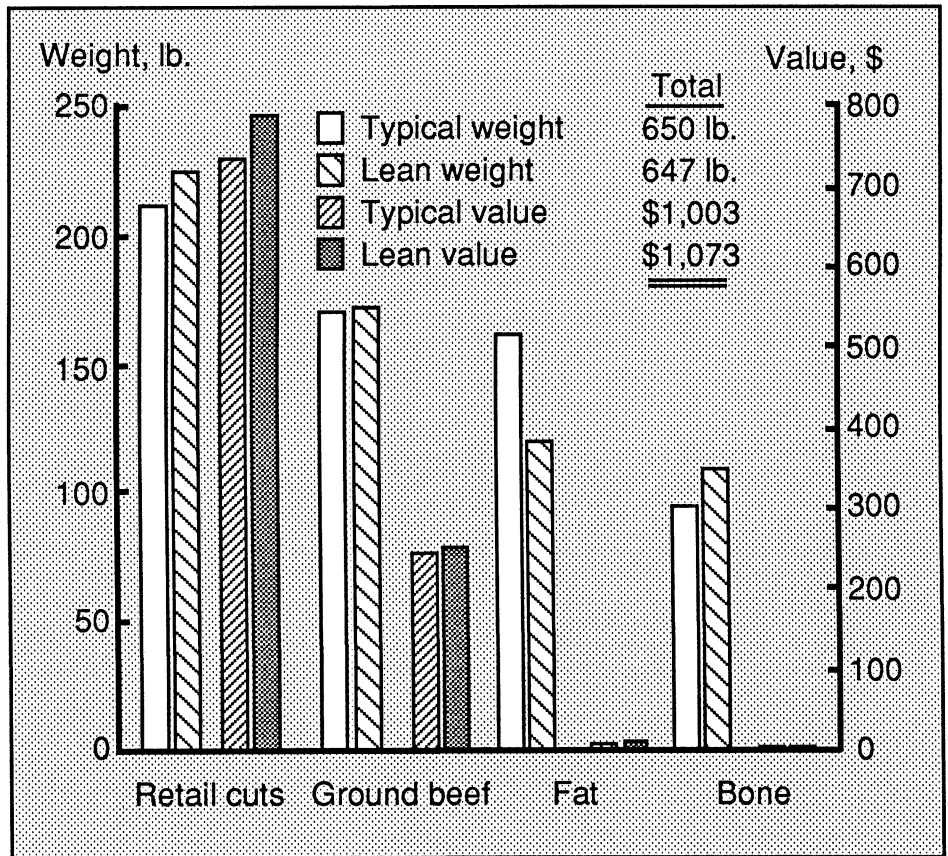
INDIVIDUALS WHO have an active lifestyle or are health conscious now comprise nearly 50% of the consumers in the United States. Many of these people closely watch their fat intake, which has had a significant effect on the market for beef and other meats.

The meat industry has responded to consumer demands by closely trimming meat cuts prior to sale. However, the ideal situation would be to produce cattle that have leaner carcasses that do not require excessive trimming. This need is being addressed in long-range research projects by the Alabama Agricultural Experiment Station. The aim is to develop genetic strains of cattle that produce leaner carcasses that retain desirable qualities of tenderness, juiciness, and flavor.

One study underway looks at the economic aspect by measuring value differences between beef carcasses selected for leanness versus conventional market cattle. At the same time, any differences in sensory qualities, such as tenderness and taste, between the two groups are being identified.

Sixteen beef carcasses were selected at a meat processing plant to fit narrowly defined parameters of leanness. Eight carcasses were selected to be "typical" (USDA Choice, Yield Grade 3) carcasses, while the other eight were selected as "lean" (USDA Select, Yield Grade 2 or better). Carcass weights averaged 650 lb. for each group. Each carcass was divided into boneless, closely trimmed (1/4 in.) retail cuts. Weights of bone, trimmable fat, ground beef trimmings, and retail cuts were recorded. Values were assigned to each component by using current market prices. Taste tests were performed on each of the 10 retail cuts from each carcass for sensory evaluation.

The lean carcasses displayed a higher percentage of bone than the typical carcasses; however, the percent fat was higher for the typical carcasses than for the lean ones, see figure. The most im-



Comparisons of various components of lean and typical beef carcasses show value of producing lean beef.

portant finding of the study was that the percent edible portions (closely trimmed, boneless retail cuts plus ground beef) was 62.8% for lean cattle and 59.6% for typical cattle.

Values assigned to ground beef, fat, and bone shown in the figure were similar between the typical and lean carcass groups, though there was a marked difference in the value of the retail cuts. Based on the values assigned to each component, lean carcasses were worth \$70 more than typical carcasses. Since the costs of production, slaughter, and processing were essentially the same for both carcass types, the leaner carcasses were definitely more profitable than the typical ones.

Sensory evaluation indicated no differences in any sensory traits between the

two groups of carcasses for 9 of the 10 cuts evaluated. The top round from the typical group was found to be juicier than the top round from the lean group.

Production of lean carcasses that have desired eating quality and a substantial value added component is possible when the constraints used in this study are followed. The present "rewards system" for beef cattle makes it imperative for producers to take cattle to USDA Choice grade. Though producers sending cattle to market would not be rewarded for leanness, this study suggests producers who retain ownership of their cattle to the retail sales level could realize increased value.

Huffman is Professor and Egbert is Research Associate of Animal and Dairy Sciences.



# GOLD-COLORED TILAPIA NOW POSSIBLE

**T**ILAPIA ARE one of the most important cultured, warmwater food fishes in the world. These fish grow well, are resistant to diseases, tolerate poor water quality, and are delicious. Because of these attributes, tilapia have been transported throughout the world from their native ranges in Africa and the Middle East. Though production is in its infancy in Alabama, there are several tilapia farms in the State.

Despite the many positive attributes of tilapia, dark skin color makes these fish difficult to market in some locales.

The normal skin color of most species of tilapia is dark, with black (melanistic) pigmentation being the predominant color. In some areas, fish are sold whole or as skin-on fillets. Dark skin color can be a marketing liability when tilapia must compete with brightly colored marine fish.

In the 1970s, mutant red and yellow tilapia (thought to have been *Tilapia mossambica*) were discovered in Taiwan. Commercial interest in these fish was immediate because their bright skin color enabled them to compete at the market with marine fish. Many tilapia farms obtained these mutant, brightly colored fish, but they were hybridized with other species; consequently, there are few pure stocks in existence. This has made it difficult to determine the genetics of body color and to determine how to produce true-breeding populations that will produce only progeny with bright skin color, see figure.

In 1986, gold *T. mossambica* were observed in the John G. Shedd Aquarium in Chicago. A sample of these fish was transported to the Alabama Agricultural Experiment Station in 1987, where they were mated to determine if they were true-breeding. Sixteen families, with a total of 10,331 offspring, were produced, and all offspring were gold, see table.

Black (normally pigmented) *T. mossambica* were obtained from the Tennessee Valley Authority in Muscle Shoals in 1987, and they too were found to breed true: black X black matings produced only black offspring.

Reciprocal black X gold crosses produced fish that appeared to be black when they were smaller than 1 in., but the color changed as the fish aged. These fish had fewer black pigment cells than the black fish, plus some yellow and orange pigment cells, which gave their body a patina. As a result, this phenotype was named "bronze."

In 1988, gold, bronze, and black fish were mated to determine the inheritance of these colors. Results of these matings revealed that body color in *T. mossambica* is controlled by a single autosomal gene with incomplete dominant gene action: the G gene. Gold fish are homozygous recessive (*gg*), black fish are homozygous dominant (*GG*), and bronze fish are heterozygotes (*Gg*). The table shows the types of offspring that are produced by all possible matings among gold, bronze, and black *T. mossambica*.

Because gold tilapia are homozygous recessive, it is easy to produce and maintain a true-breeding gold population. True-breeding populations of gold *T. mossambica* can be produced by culling all melanistic fish (bronze and black phenotypes). Once this is done, the only fish that remain will be gold, and since they are homozygous recessive (*gg*) they will produce 100% gold offspring. Consequently, a single generation of selection will produce a true-breeding gold population of *T. mossambica*. Additionally, because the melanistic phenotypes are easily distinguished, the inadvertent mixing of black, bronze, and gold phenotypes can be easily rectified; the purity of gold *T. mossambica* can be maintained by culling all darkly pigmented fish before they are spawned.

Research is being conducted to assess the growth, viability, disease resistance, cold tolerance, and carcass quality of gold *T. mossambica*, in order to determine their suitability as a commercial stock.

PERCENTAGES OF GOLD, BRONZE, AND BLACK OFFSPRING PRODUCED BY ALL POSSIBLE MATINGS AMONG GOLD, BRONZE, AND BLACK <i>TILAPIA MOSSAMBICA</i>	
Mating	Offspring
Gold X gold	100% gold
Black X black	100% black
Gold X black	100% bronze
Bronze X bronze	25% gold: 50% bronze: 25% black
Gold X bronze	50% gold: 50% bronze
Black X bronze	50% bronze: 50% black



**True-breeding gold tilapia provide bright-skinned fish and benefit marketing efforts.**

Tave is a Visiting Scientist, Rez is a Graduate Student, and Smitherman is Professor of Fisheries and Allied Aquacultures.



# CARPENTER ANTS ATTACK OKRA

## *Observation Indicates "Nuisance" Ant May Actually Be An Economic Pest*

**C**ARPENTER ANTS may be more than just a nuisance or structural pest as has been generally thought. Last year this insect was found feeding on okra in a Lee County garden, causing serious damage to pods.

In Alabama, carpenter ants are known to nest in rotting logs and stumps, under rocks, and infrequently in houses, utility poles, and other wood products. Worker ants sometimes enter kitchens to forage on sugar and other sweets. These ants seldom feed on living plants and have not been reported as pests of an economically important crop. Therefore, when carpenter ants were found attacking a mature stand of okra in 1988, this offered an opportunity to observe the attacks and learn about the ants' feeding habits on okra.

The okra plants attacked by carpenter ants were growing on an area under which a large quantity of woody debris from a construction site had been buried. Plants were 6-8 ft. tall and had all developmental stages: buds, flowers, and early to late pods. Plants were examined from ground level up and ant distribution and activity were recorded. Pod damage was also documented.

Positive identification of the ant was the first step. Its scientific name is *Camponotus castaneus* (Latrielle) (Hymenoptera: Formicidae: Formicinae), but it is widely known as one of the carpenter ants. It is easily identified by its large size (0.28-0.39 in. long), few body hairs, shiny body, and strong acid smell when worker ants are crushed, figure 1. Workers range from yellowish to yellowish-red, and the head and abdomen are darker than the thorax. This ant can inflict a pinching bite, but it does not sting.

The ants were found on all okra plants in the row. Almost all those found were on or near the base of flowers or on developing pods, as illustrated by the cover photo. Ants were also found on the soil between plants.



Ant feeding was concentrated on the outer surface of the flower calyx, but when this leafy portion of the flower was consumed or fell off, feeding shifted to the area where the petals are attached. In severe feeding, the ants chewed into and through the ovary, often resulting in flower drop.

Damage to flowers resulted in malformed pods—curved and stunted rather than straight or slightly bent, figure 2. Such damage obviously reduces the quality of the crop, and would likely prevent sale of okra at the produce market. Feeding also caused brown scar tissue at the base of developing pods. Although it was rare, ants were observed feeding on young pods in the area of the scar tissue.

The malformed pods probably resulted because of the scars that developed from ants feeding on flowers or young pods. These scars affected the flow of nutrients to the developing pod tissue, causing slower growth. With unaffected tissue growing normally, the result was a bent pod.



**FIG. 1 (top).** Carpenter ants are large and easy to identify. **FIG. 2 (bottom).** Misshapen okra pods resulting from carpenter ant feeding.

Control treatments may be necessary in home gardens or other plantings where carpenter ants prove to be a problem. Insecticides labeled for garden use that are known to control this pest include dursban, diazinon, and malathion. Since colonies are often located at a distance from feeding sites, best control results from locating and treating colonies, rather than treating the garden itself.

Appel is Assistant Professor of Entomology; Mount is Professor Emeritus of Zoology and Wildlife Science.

# ROTARY RAKING SHOWS ADVANTAGES FOR PINE TREE SITE PREPARATION

**A**FTER TIMBER harvesting, land that is to be regenerated must be prepared for planting pines to improve survival and reduce competition. The most common mechanical method of site preparation is to shear all standing material at ground-line and rake the residual material into windrows. Alabama Agricultural Experiment Station tests indicate the Symonds Rotary Rake is more silviculturally effective and in some cases more economical than conventional raking.

The rotary rake is a larger version of a hay rake consisting of four, 7.5-ft.-diameter pinwheels with serrated edges connected to a beam with jump arms. The rear assembly is used to adjust the offset angle to control the amount of material raked. The rake is pulled behind a bulldozer or rubber-tired tractor, and as the rake moves forward, material is rolled into a windrow by the pinwheels.

Data were collected on rotary raking operations in central Alabama and compared to conventional raking. Each observation consisted of the time to make a pass through a fixed-length plot and the time to turn the rake around for the next pass. For each plot, independent variables including windrow length, swath width, weight of residual material, stump height and diameter, and slope of the terrain parallel and perpendicular to travel were measured.

Linear regression analysis was used to develop models of raking time as a function of the independent variables. Distance was the most important variable affecting raking time. It accounted for 87.3% of the variability in the data. When added to distance variable, slope in the direction of travel, residual material weight, swath width, and number of stumps per acre also affected raking time. As the values of the variables increased, the raking time increased. The combination of distance and slope produced the best two-variable model, explaining 89.9% of the variability. The

best three-variable model only increased predictability to 90.4%.

Productivity as a function of windrow length and residual material is given in the table for the rubber-tired Franklin 595 and the tracked Caterpillar D7H. Total time was raking time plus the average time to turn the rake. Average swath width for each machine was used to determine the area covered in one pass. As longer windrows (600-800 ft.) were built, the portion of the cycle time involved in turning decreased and, therefore, productivity increased. For short windrows (200 ft.), rotary rake productivity was slightly over 2.5 acres per hour, and increased to almost 4 acres per hour for longer windrows. Although the same equation was used to predict the raking times, the 595 turned faster, but the D7H averaged a wider swath. So, for short windrows the 595 was more productive. Conventional raking on similar terrain was about 1.8 acres per hour regardless of windrow length.

**Rotary raking costs more per hour, but a larger area could be raked in an hour.**

Owning and operating costs were calculated for the Cat D7H and Franklin 595 with a rotary rake and two typical crawler tractors with conventional rakes. The costs per hour for rotary raking with the D7H and Franklin 595 were \$83.93 and \$68.23, respectively. The costs per hour for conventional raking with a 200- and 300-hp crawler tractor were \$48.16 and \$54.92, respectively. Per acre costs ranged from \$20-\$40 per acre for the 200 and 300 hp conventional rakes and \$17-\$29 per acre for the Cat D7H rotary rake and \$15-\$26 per acre for the Franklin 595 rotary rake.

The weighted average productivity for the conventional raking operations was 1.8 acres per hour for a cost of \$26.76 to \$30.51 per acre. Rotary raking averaged

Machine, windrow length, ft.	Turn time	Productivity
	Min.	A./hr.
<b>Franklin 595</b>		
200 .....	1.2	2.6
400 .....	1.9	3.3
600 .....	2.6	3.6
800 .....	3.3	3.8
<b>Cat D7H</b>		
200 .....	1.3	2.6
400 .....	2.0	3.4
600 .....	2.7	3.8
800 .....	3.4	4.0

3.3 acres per hour or more based on the layout of the tract, for a cost range of \$20.78 to \$25.43 per acre or less.

Rotary raking also has some silvicultural advantages. The rake did not move as much soil as a conventional rake, thereby causing less site degradation. This also produced a cleaner windrow which burned completely and facilitated subsequent operations.

The rotary rake is limited to use on slopes of less than 20% and cannot operate in rugged terrain. Tract sizes should be relatively large or the tracts should be close together to justify the problems related to moving the machine, since it is wider than legal highway width restrictions and cannot be pulled at high speeds.

Productivity of conventional raking was not dependent on tract size, while productivity of the rotary rake was highly dependent on the length of the windrow that was produced. The study indicates smaller tracts with broken terrain or with heavy residual material are more suited for conventional raking. Though rotary raking costs more per hour, a larger area could be raked in an hour, making the cost less than conventional raking in some cases. The potential cost saving and reduced site degradation provide some opportunities on selected terrain for rotary raking.

Tufts is Assistant Professor of Forestry.

# GENETIC SELECTION FOR GROWTH ALTERS RESPONSE TO GROWTH PROMOTANTS

**G**ROWTH PROMOTANTS are currently being used experimentally to improve growth rate and body composition of food animals by redirecting nutrients from fat deposition to muscle deposition. Researchers have reported dramatic growth rates and fat loss, but little is known about the effects of these compounds on specific animal genotypes that are bred for fast or slow growth—or the effect on growth and body composition of extremely young animals.

Although not approved for commercial use, beta adrenergic agonists (BAA) are one group of compounds that could be used in the future to alter animal fat content. Published reports indicate a 10-20% increase in muscle and a 40% decrease in fat in some animals injected with a BAA. In Alabama Agricultural Experiment Station tests, the BAA clenbuterol in the diet of young lambs significantly increased muscle weights and decreased fat deposited around internal organs.

To determine the effects of another BAA, cimaterol, on fast- and slow-growing genotypes and on young animals, various doses of the compound were injected into 7- to 21-day-old male Charles River CD rat pups from litters representing two populations genetically selected for large (fast growth) and small (slow growth) size. Body weight typically differs by 32% at 21 days and 50-60% by 9 weeks of age. The number of rats per litter was standardized to 10 pups to reduce variations in litter size. A total of five litters was used from each strain and four pups per litter were stratified across four treatment groups receiving injections of 0, 2, 4, and 8 parts per million (p.p.m.) of cimaterol per kg (kilogram) of body weight.

Large rats weighed approximately 2.2 oz. while small rats weighed only 1.5 oz. at 21 days of age. The effects of cimaterol injection on growth and body composition of neonatal rats of different growth potential are shown in figures 1 and 2.

Data reported by others indicate BAA stimulates growth when given to rats after weaning, but in the AAES study cimaterol reduced body weight gain in the large rats and did not affect small rats. Body composition was not changed by treatment, although the body protein-to-fat ratio tended to be elevated with cimaterol treatment. Administration of cimaterol also inhibited skeletal muscle growth, but caused enlargement of the heart. These results demonstrate the importance of considering age of the animal when using growth-promoting agents. The greater reduction of growth when doses of cimaterol were increased in large rats compared to small ones may

have been due to a higher maintenance energy requirement of this population of rats.

These results also suggest that genotype influences the effectiveness of growth-promoting agents and should be considered when these materials are used experimentally. These tests also indicate that genetic interactions need further investigation, particularly in designing diets and employing new growth promotants in future meat animal production.

Mulvaney is Assistant Professor, Chromiak and Gore are Graduate Research Assistants, and Strength is Professor of Animal and Dairy Sciences.

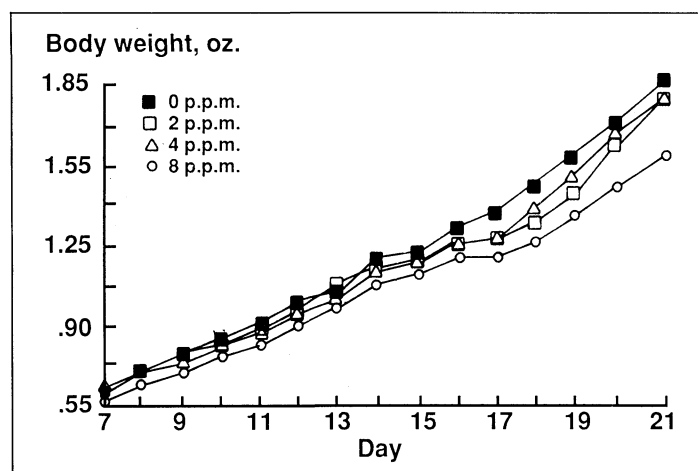


FIG. 1. Effect of cimaterol on large strain rats.

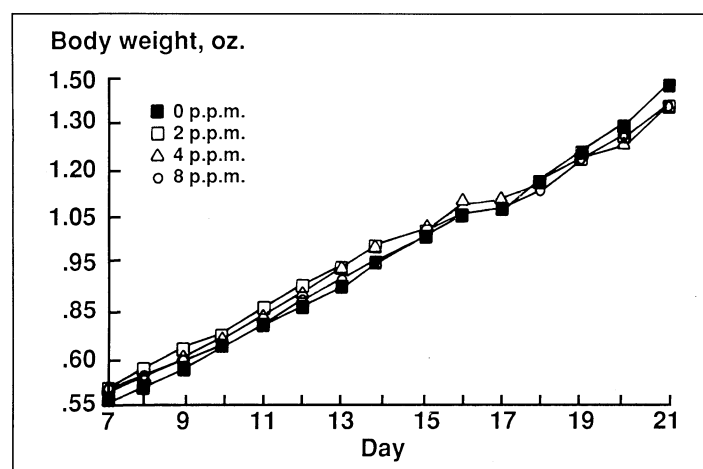


FIG. 2. Effect of cimaterol on small strain rats.



# NEW X-RAY IMAGING TECHNIQUE DIAGNOSES TD IN BROILER BREEDERS

**T**IBIAL dyschondroplasia (TD) is one of the more common skeletal abnormalities that occur in rapidly growing broilers and turkeys. Though TD is not fatal, it causes lameness and prevents birds from getting food and water. The end result is reduced efficiency or even death due to starvation and/or dehydration. TD costs poultrymen millions of dollars annually in replacement birds and much more in poor performance of surviving birds.

TD is characterized by a failure of bone formation in the legs of young chickens, resulting in the persistence of an uncalcified mass of cartilage. Invasion of the enlarged cartilage cells of the growth plate by metaphyseal blood vessels is a prerequisite for resorbing cartilage prior to its replacement by bone, figures 1 and 2. Previously, sacrificing the bird was the only way to detect TD. Now, it can be detected by using low intensity x-ray imaging (Lixiscope), a method developed at the Alabama Agricultural Experiment Station. This technique will detect at an early age the existence of abnormal masses of uncalcified cartilage, and thus which birds have TD.

The incidence of TD was studied in broiler breeders reared under two nutritional management regimens at the AAES. In regimen 1, which is similar to the one used by basic breeders, 100 males and 100 females were fed free choice a broiler ration from 0 to 8 weeks (23% protein—3,200 ME/kg). At 8 weeks of age, these birds were changed to a developer ration of 18% protein and 2,900 ME/kg and placed on a restricted feeding program for the duration of the experiment. This regimen is similar to the one used by commercial broiler breeders. The amount of feed fed from 8 to 20 weeks was determined by the weight the birds needed to achieve breeder recommended body weight by 20 weeks of age. In regimen 2, the same numbers of birds as in regimen 1 were fed the same developer diet free choice

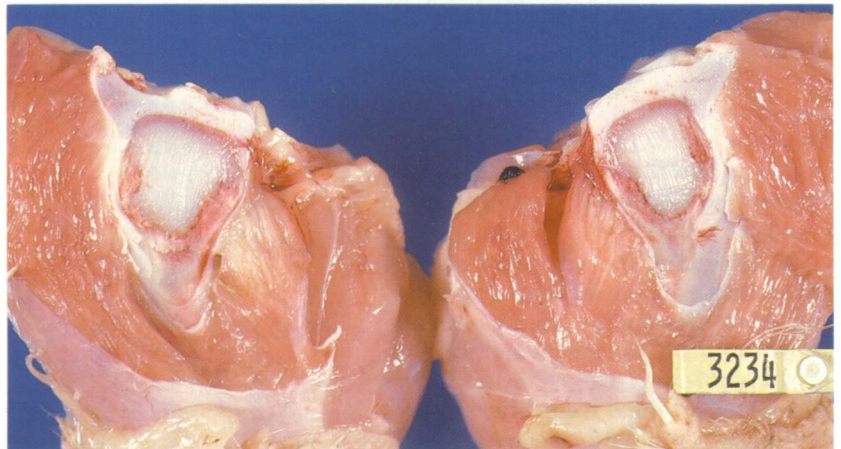


FIG. 1 (top). Proximal end of the tibiotarsus from chicks with normal bone development at 42 days of age. FIG. 2 (bottom). Tibial dyschondroplasia of the proximal tibiotarsus of a chick at 42 days of age.

from 0 to 3 weeks and regulated amounts of feed from 3 to 20 weeks.

TD was determined on the legs of the broiler breeders at 4, 7, 11, and 15 weeks of age using a Lixiscope. The percentage incidence for male birds in regimen 1 at these ages was 14, 20, 9, and 0%, respectively. Only 2% of the females at 7 weeks of age developed TD. None of the birds in regimen 2 developed TD. Peak incidence of TD occurred at 7 weeks of age; at 15 weeks of age none of the birds showed symptoms of the disease.

Though TD cannot be prevented by any known nutrients and reduced growth rate due to reduced feeding is not acceptable, the AAES study demonstrates that the disease can be detected early by using a Lixiscope. This will allow basic breeders to cull infected birds and reduce the incidence of TD by choosing only non-affected birds for their breeding programs.

Wong-Valle is Research Associate and McDaniel is Professor of Poultry Science; Bartels is Professor of Veterinary Medicine; Moran is Professor of Poultry Science.



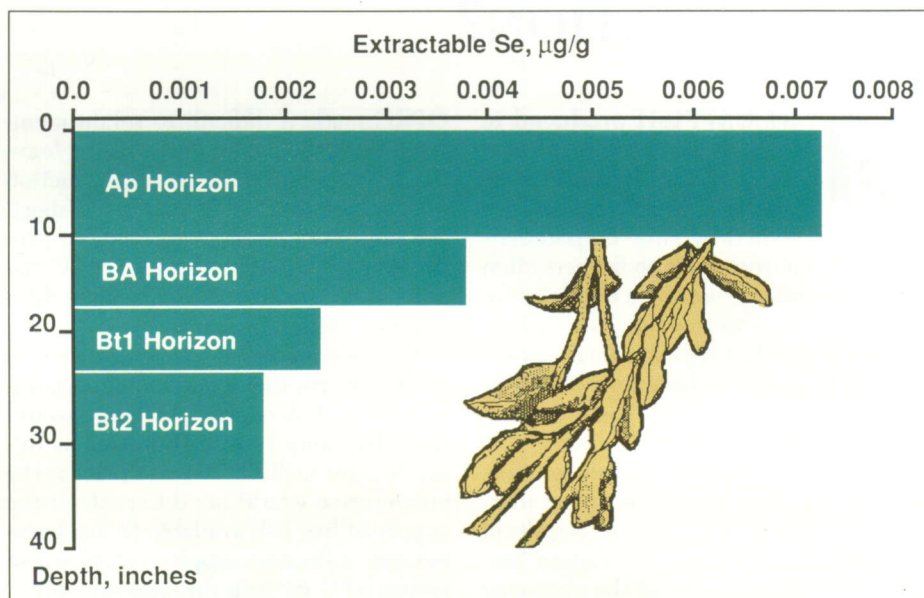
# SELENIUM UPTAKE BY SOYBEANS STUDIED

**S**ELENIUM (Se) is a trace element required in small amounts by both humans and animals. Se deficiency in humans can cause Keshan disease, a fatal heart disease affecting children and pregnant women. In livestock, it can cause a muscular dystrophy known as "white muscle disease," a condition most likely to occur in areas of highly leached, acid soils such as Alabama's Coastal Plains. Se may be leached from sandy soils or converted to an unavailable form in acid soils. Though Se is not required by plants, its availability through plants to humans and animals is important.

A field experiment was conducted at the E.V. Smith Research Center, the main research unit of the Alabama Agricultural Experiment Station located near Shorter, to determine the amount and distribution of extractable Se in a Norfolk soil, a type of Coastal Plain soil, and to determine the uptake of native and applied Se by soybeans.

Extraction and analysis of soil cores from the test area indicated that the highest concentration of native extractable Se in the soil is in the top soil or plow layer, shown as the Ap horizon in figure 1. While the concentrations of Se found in this Norfolk soil are considered low, the concentrations of Se in the hulled soybeans (oil included) were within the desirable range of 0.1-1.0 micrograms Se per gram of food or feed crop, figure 2. Because Se is found in the protein makeup of most crops in low Se areas, high protein legumes often contain more Se than crops low in protein.

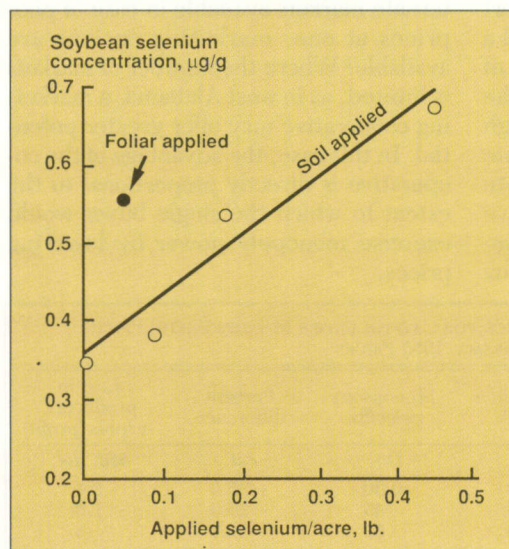
Soybeans were used in the study to determine if Se application would increase Se concentrations in the plants. Application of a water soluble Se compound (selenous acid) to the soil before planting increased the Se content of the hulled soybeans, figure 2. Applying the Se in five foliar sprays at 2-week intervals starting at first bloom gave about the same Se concentration in the hulled soybeans as did six times as much soil-



**FIG. 1.** Soil analysis shows that highest concentration of native extractable selenium is found in the plow layer, shown here as AP horizon.

applied Se. The yield of soybeans was not affected by the application of Se. Crop yields are not usually affected by Se unless the concentrations in the soil are extremely high, as in some arid areas where Se concentrations are high enough to be toxic to plants and animals. No Se toxic symptoms were seen in the soybeans in this test.

**FIG. 2.** Applications of foliar and soil-applied Se increased Se content in hulled soybeans.



Se has traditionally been added directly to human and domestic animal diets as mineral salts rather than to crops through Se-containing fertilizers. Although most people in the United States have adequate Se in their diets, use of Se in hospital diets and in vitamin-mineral supplements is increasing. Se is often added to domestic animal rations via mineral supplements.

Since soil-added Se does not affect plant growth, this study suggests that dietary supplementation of Se is the most efficient way to ensure Se requirements are met for humans and animals. To determine if the Se in mineral salts used in dietary supplements is as available or effective as the organic forms of Se found in plants, soybeans from this test will be used in a feeding study with rats to compare the Se in soybean seed to the Se in a mineral supplement.

Odom is Associate Professor of Agronomy and Soils; Lane is Professor of Nutrition and Foods; Smith is Professor and Rymal is Professor Emeritus of Horticulture.

# ARE CONDITIONS RIGHT FOR CATFISH MARKETING ORGANIZATION?

**M**OST CATFISH produced in Alabama is sold to local processing plants. Because these plants tend to be large and are sometimes owned by large corporations or outside interests, catfish farmers often wonder if they are getting a fair price for their fish. This perceived lack of bargaining power has led Alabama's catfish farmers to consider the merits of selling fish collectively through some type of marketing association.

There is no clear-cut answer to questions about effectiveness of such a marketing arrangement for catfish. Results of Alabama Agricultural Experiment Station research indicate that the economic potential of such a venture in west Alabama hinges on two factors: (1) the ability to control supply, and (2) the competitiveness of the market for live catfish.

In considering supply control, it is well to remember that a marketing cooperative is similar to a cartel. The power of a cartel is governed by the availability of substitutes and the ability to control supply. For example, the OPEC cartel was able to raise prices and extract large sums of money from oil-importing nations because homeowners and industry had few substitutes for oil (in the short run). Thus, OPEC was able to control a large portion of the world's supply of crude. In the long run, however, the market had alternative actions. High prices encouraged consumers to insulate houses, businesses to switch to alternate fuels, and industry to develop alternative sources of supply (from Alaska and elsewhere). Moreover, the high prices set by

OPEC made it difficult to retain membership in the cartel because, by leaving, a member could avoid production quotas that limited revenues. In short, the high prices encouraged added production by OPEC and non-OPEC nations alike, making it increasingly difficult to maintain high prices.

Findings of the Experiment Station study confirm that a marketing cooperative for catfish in west Alabama would face the same type difficulties as described for OPEC. To raise prices, the cooperative would need to restrict the supply of live fish available to local processors. Effective supply control would require (1) getting unanimous agreement among local producers to sell all fish through the cooperative, and (2) somehow insulating the market from supplies from other regions, especially Mississippi. Either condition would be hard to meet. Therefore, west Alabama producers would find a marketing cooperative an ineffective way to raise prices above competitive levels for a sustained period.

The competitiveness of markets in an area has a strong bearing on feasibility of a cooperative. If a catfish farmer has alternate markets available in case of poor prices at one, marketing options are available. Where the number of markets is limited, as in west Alabama, a marketing cooperative may offer greater potential. In this case, the advantage of the cooperative is directly proportional to the extent to which the single buyer would exercise monopoly power by lowering prices.

It is not possible to determine empirically the exact magnitude of price decline that farmers may experience when a monopsonistic market replaces a competitive one. However, economic theory provides some limiting values. In particular, the theory of monopsonistic (single buyer) markets indicates that the supply elasticity for catfish at the farm level is the key to how much a processor would cut price in the absence of competition. (Supply elasticity is defined as percentage change in supply associated with a 1% change in price.)

Three alternative estimates of the supply elasticity parameter for catfish, developed in the Experiment Station's ongoing catfish marketing study, are given in the table. The potential price reductions developed in a model based on these parameters are also given in the table. These estimates suggest a potential reduction in farm price of 11.7-35.0% due to the monopsonistic power that a single processor would hold. This would result in an annual loss of \$0.6-\$2.4 million in producer profits.

A marketing cooperative under west Alabama conditions appears feasible if monopsony conditions hold. The problem of supply control is reduced because Mississippi producers would not divert fish to the Alabama market when the processor pays less than the competitive price. Local producers, moreover, would have a greater incentive to join the cooperative. Without the bargaining power obtained from joining the cooperative, they would be subject to price exploitation by the processor. Finally, the estimated losses in the table suggest a strong economic incentive to form a bargaining association.

The pivotal factor in determining the economic feasibility of a marketing cooperative for west Alabama catfish producers is the competitiveness of the local market. If the farmer has several plants from which to choose a buyer for his fish, a cooperative would not be a viable marketing tool. If, on the other hand, the market for live fish is not competitive, as would be the case if there was only one plant in which to sell, a cooperative is a potentially viable method of increasing producer returns.

POTENTIAL REDUCTION IN THE FARM PRICE FOR CATFISH UNDER MONOPSONISTIC PRICING, WEST ALABAMA, 1983 PRICES

Supply elasticity	Competitive price/lb.	Monopsony price/lb.	Percent difference	Loss in producers' surplus (profit)
	<i>Dol.</i>	<i>Dol.</i>	<i>Pct.</i>	<i>Mil. dol.</i>
1.86.....	0.60	0.30	-35.0	2.4
3.00.....	.60	.45	-25.0	1.6
8.10.....	.60	.53	-11.7	.6

Kinnucan is Assistant Professor of Agricultural Economics and Rural Sociology; Wineholt is an Agricultural Economist with the USDA Agricultural Cooperative Service (formerly Graduate Research Assistant in Agricultural Economics at Auburn).



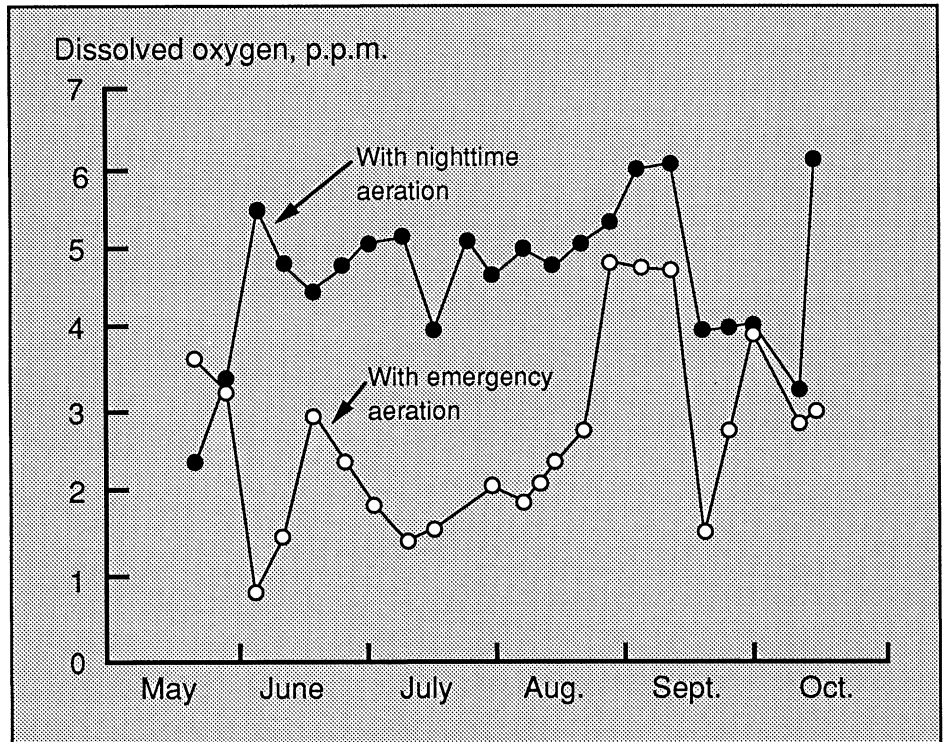
# NIGHTTIME POND AERATION BOOSTS CATFISH PRODUCTION

**A**ERATION IS an essential management tool for the culture of channel catfish in ponds. Most farmers in Alabama use aeration when dissolved oxygen concentrations are less than 2 or 3 parts per million (p.p.m.) as an emergency measure to prevent fish mortality and reduce fish stress. Although emergency aeration is effective, fish are still subjected to low concentrations of dissolved oxygen and stress. An alternative aeration program is to operate electric aerators nightly during the period when dissolved oxygen concentrations normally are below 4 or 5 p.p.m. In late spring, summer, and early fall, dissolved oxygen concentrations often drop this low from midnight until soon after dawn.

An experiment at the Alabama Agricultural Experiment Station compared the influence of emergency aeration and of nighttime aeration on water quality and fish production. In 1986, six ponds were stocked at 4,000 channel catfish per acre (moderate stocking rate) and fed a commercial feed. A maximum feeding rate of 47 lb. per acre per day was attained on July 21 and continued until fish were harvested on October 24. Emergency aeration was used a few times in three ponds when dissolved oxygen concentrations were low. In the other three ponds, aeration was applied from midnight until 6 a.m. every night between May 30 and October 12. The aeration rate was equivalent to 1.5 horsepower per acre of aeration with a highly efficient, floating, electric paddlewheel aerator. Aerators were turned on and off by timers.

Dissolved oxygen concentrations at 6 a.m. were much higher in the ponds with nightly aeration than in the ponds with emergency aeration only, as shown in figure. The average dissolved oxygen concentration at 6 a.m. for all dates was 2.8 p.p.m. in emergency-aerated ponds and 4.5 p.p.m. in nightly aerated ponds.

Harvest weight of fish in ponds with nighttime aeration averaged about 1,000



**Nightly pond aeration resulted in higher levels of oxygen than use of emergency aeration.**

lb. per acre more than in ponds with emergency aeration, see table. The stocking and feeding rates were identical for the two treatments. Greater production in ponds with nighttime aeration resulted from a better feed conversion ratio (pounds of feed per pound of gain) in these ponds (1.32 as opposed to 1.75).

Variable	Aeration	
	Nighttime	Emergency
Fish stocked, no./acre . .	4,000	4,000
Fish harvested, no./acre	3,939	3,808
Harvest weight, lb./acre	4,288	3,258
Average weight/fish, lb.	1.09	0.86
Feed applied, lb./acre . .	5,550	5,550
Feed conversion rate <sup>1</sup> . .	1.32	1.75

<sup>1</sup>Pounds of feed applied per pound net fish production.

Better feed conversion efficiency in ponds with nighttime aeration resulted from higher dissolved oxygen concentrations between midnight and dawn.

An economic analysis of the data gave net returns to land, management, and equity capital of \$696 per acre for ponds with nighttime aeration and \$363 per acre for ponds with emergency aeration only.

The experiment was repeated in 1987 and 1988 with similar results. Both years, feed conversion improved and fish production increased about 1,000 lb. per acre using nighttime aeration. Therefore, it appears that the use of modest stocking and feeding rates with nighttime aeration is an excellent alternative means of producing channel catfish.

Boyd is Professor of Fisheries and Allied Aquacultures.

# BEST RED POINSETTIAS FOR ALABAMA IDENTIFIED IN RESEARCH

**P**OINSETTIAS are Alabama's leading floricultural crop, but the State's high temperatures and light intensities can adversely affect flower timing and quality. Cultivars must be heat tolerant and have strong lateral branches, short internodes, and a good floral display. A short, compact plant is desired.

Most Alabama poinsettias are multi-flowered so the number of flower displays, the small yellow and red cup-shaped structures surrounded by colored leaves or bracts, is important. Color, which ranges from very light to dark red, is also important and can fade in high temperature and light conditions. For consumer satisfaction, cultivars must retain their color, leaves, and bracts when placed in interior environments.

To help determine the best poinsettia cultivars for Alabama, the newest varieties from four cultivar groups (Annette Hegg, Eckespoint C1, Gutbier, and Mikkel) were evaluated for eight growing seasons from 1978 to 1986. Plants were grown in greenhouses, with the cutting rooted directly in the final pot. The growing medium consisted of equal parts of soil, sphagnum peat moss, and perlite. A weekly fertilizer program was followed. After propagation under intermittent mist, plants were grown in sunlight equal to 6,000-10,000 foot candles and a 65°F minimum night temperature greenhouse.

Sixteen cultivars were evaluated each year for flowering time, color, height, and number of flower displays (when 30% of the flowers were shedding pollen). Ten pots of each cultivar were propagated from cuttings on August 10 (8 per 10-in. pot), August 15 (6 per 8-in. pot), August 20 (4 per 7-in. pot), and August 25 (3 per 6-in. pot). Plants were pinched 1 month after propagation to produce multi-flowered plants.

Flowering time differed among cultivars, as shown by data in the table. Gutbier V-10 Amy flowered the earliest, making it useful in early sales, while



Eckespoint C-1 Red flowered the latest. Gutbier V-10 Amy also had the lightest red color and was highly susceptible to fading. Annette Hegg Lady had dark bluish-red bracts that resisted fading. Most cultivars had similar bright red bracts except Dark Red Hegg (dark burgundy red fading to bright red), Gutbier V-14 Glory (rose red), Annette Hegg Supreme (orange-red), Annette Hegg Diva (orange-brick red), and Annette Hegg Top Star (deep red).

The shortest and tallest plants were produced by Gutbier V-10 Amy and Annette Hegg Brilliant Diamond, respectively. All cultivars were of acceptable height. The most flower displays were produced by Gutbier V-10 Amy, but they did not last as long as other cultivars.

Generally, most Hegg cultivars yielded high flower numbers. Eckespoint C-1 Red, Gutbier V-14, and Annette Hegg Brilliant Diamond produced the fewest flower bract displays per plant; however, their color, height, and keeping quality were superior to Gutbier V-10 Amy.

Selection of a cultivar will depend on the grower's needs and the needs of the market. While this study can help growers weigh their options, the need for new varieties offering increased growth efficiency, plant appearance, quality, and disease and pest resistance will continue.

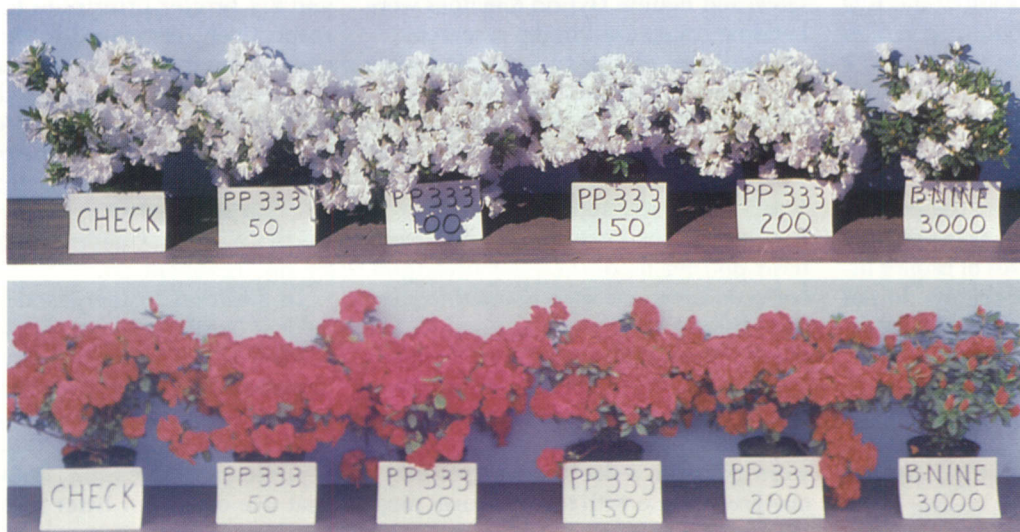
Sanderson is Professor and Martin is former Research Associate of Horticulture; Drane is a former Visiting Professor of Research Data Analysis.

FLOWERING TIME, COLOR, HEIGHT, AND NUMBER OF BRACT DISPLAYS OF MULTI-FLOWERED RED POINSETTIA CULTIVARS

Cultivar	Flowering time	Red color	Height	Flower displays/plant
	Wk.			In.
Annette Hegg Brilliant Diamond . . . . .	9.5	Bright	15.8	3.5
Mikkel Super Rochford . . . . .	9	Bright	14.8	5.4
Annette Hegg Dark Red . . . . .	9	Dark burgundy	14.6	5.4
Mikkel Improved Rochford . . . . .	8	Bright	14.5	4.9
Mikkel Scandia . . . . .	8	Bright	14.0	5.0
Mikkel Heritage . . . . .	9	Bright	13.6	5.5
Eckespoint C-1 Red . . . . .	10.5	Bright	13.6	3.4
Gutbier V-14 Glory . . . . .	9	Rose	13.2	3.5
Annette Hegg Diva . . . . .	8	Orange-brick red	13.0	4.9
Annette Hegg Supreme . . . . .	9	Orange	12.4	5.2
Annette Hegg Lady . . . . .	9	Dark, bluish	12.2	4.1
Annette Hegg Brilliant . . . . .	8.5	Bright	12.1	4.6
Annette Hegg Top Star . . . . .	8.5	Deep	12.1	5.1
Mikkel Triumph . . . . .	9.5	Bright	11.8	4.6
Annette Hegg Super Star . . . . .	8.5	Bright	11.1	4.2
Gutbier V-10 Amy . . . . .	7.5	Very light	10.0	6.3



# NEW GROWTH RETARDANT EFFECTIVE ON FLORIST AZALEAS



Effects of growth retardant treatments on Alaska (top) and Prize (bottom) azaleas.

Plants treated with daminozide actually formed more bypass shoots than untreated plants. Daminozide did suppress bypass shoot elongation of Alaska but not of Prize.

Results with different spray concentrations are noted in the following data:

**G**ROWTH RETARDANTS are considered necessary for florist azalea production. Their use suppresses internode elongation to promote flower bud initiation and hasten flower development. In addition, they may inhibit the growth of unwanted vegetative shoots that develop below flowers (called bypass shoots).

Daminozide and chlormequat are the principal retardants used with florist azaleas. While both are effective, they also have undesirable side effects: daminozide causes delayed flowering and reduced flower size, while chlormequat reduces plant size and delays flowering. Because of these undesirable side effects, research at the Alabama Agricultural Experiment Station is seeking more desirable growth retardants.

A new material that is showing promise is paclobutrazol, which is currently labeled as Bonzi® for use on poinsettia. It is known to be an effective retardant for chrysanthemums, many species of tropical plants, and annual bedding plants. It is proving more effective than daminozide in suppressing bypass shoot development and enhancing flowering of florist azaleas. Prize and Alaska variety azaleas were potted in March 1987 for use in comparing growth retardants.

Plants were placed in a double-polyethylene greenhouse and maintained according to commercial production practices until the following growth retardant treatments were applied September 15:

1. Single paclobutrazol sprays of 0, 50, 100, 150, 200, 250, and 300 p.p.m. (parts per million) in a volume of 2 qt. per 100 sq. ft.

2. A daminozide spray of 3,000 p.p.m., repeated 1 week later.

A hand-held sprayer was used to uniformly wet foliage and stems with spray material. Application was made at approximately 8 a.m. on clear days, with greenhouse at 68°F and 82% relative humidity.

The treated azaleas were placed in a cooler on November 4 and subsequently cooled in the dark at 38°F for 6 weeks. Plants were removed from the cooler January 4, 1988, and forced into bloom in a heated polyethylene greenhouse.

As shown by data collected, bypass shoot number and length decreased for both azalea cultivars as paclobutrazol rate increased. At or above the 150 p.p.m. concentration, essentially no bypass shoots developed on either cultivar. In contrast, daminozide was ineffective in preventing bypass shoot development.

DAYS TO FLOWERING	Alaska	Prize
Untreated . . . . .	50	43
Paclobutrazol, 300 p.p.m. . . . .	55	48
Daminozide, 3,000 p.p.m. . . . .	67	57

FLOWER NUMBER	Alaska	Prize
Untreated . . . . .	195	138
Paclobutrazol, 100 p.p.m. . . . .	225	144
Paclobutrazol, 300 p.p.m. . . . .	201	139
Daminozide, 3,000 p.p.m. . . . .	178	129

FLOWER SIZE (diameter, in.)	Alaska	Prize
Untreated . . . . .	2.6	2.8
Paclobutrazol, 100 p.p.m. . . . .	2.6	2.8
Daminozide, 3,000 p.p.m. . . . .	2.2	2.4

Paclobutrazol rates of 100 and 150 p.p.m. applied 5½ weeks before cooling effectively controlled bypass shoot development and increased flower number of Alaska cultivar. These treatments had only minimal effect on days to flower and flower diameter. With Prize cultivar, 150 and 200 p.p.m. sprays were most effective in preventing bypass shoot development and increasing flower number—without reducing flower size. Daminozide was less effective in controlling bypass shoot number, gave less increase in flower number, delayed flowering, and reduced flower size over the untreated plants. Therefore, paclobutrazol appears to have good potential for becoming the standard for growth retardants for florist azaleas.

Keever is Associate Professor of Horticulture; Foster is Superintendent of the Ornamental Horticulture Substation.

# BROILER LITTER A PROMISING AMENDMENT FOR BEDDING PLANT MEDIA

**T**HE ALABAMA Poultry and Egg Association has identified broiler litter disposal as one of the major problems facing the poultry industry in the coming decade. Alabama's broiler industry alone produces about 1.5 million tons of litter annually. With the anticipated expansion of the poultry industry in the Southeast, it is essential to evaluate all possible uses of broiler litter so waste disposal problems do not hinder further growth in the broiler industry.

One promising area for using large quantities of broiler litter is the ornamental industry, which also thrives in the Southeast. Nursery and greenhouse production now ranks first among agronomic crops in Alabama. The value of potting soil used in the Southeastern United States' ornamental horticultural industry has more than doubled in the past 5 years, increasing from about \$100 million annually in 1982 to \$250 million in 1987. Continued expansion of the potting soil industry depends on the quantity and quality of ingredients used to manufacture the potting mix.

Pine bark serves as the base for the traditional potting medium sold today. It is relatively inexpensive and free of diseases and other harmful organisms. More than half of the potting medium sold is composted pine bark with the remainder being noncomposted or fresh bark. Composted pine bark offers more nutritive value to the plants.

Producers have expressed an interest in adding broiler litter to pine bark medium to enhance the composting process and the quality of the product. Fertilizer value of litter is indicated by analysis of broiler litter samples from Alabama that contained an average of 3% nitrogen (N), 2.8% phosphorus (P<sub>2</sub>O<sub>5</sub>), and 1.7% potassium (K<sub>2</sub>O).

Preliminary research conducted at the Alabama Agricultural Experiment Station has demonstrated that appropriate levels of broiler litter could increase the quality of pine bark medium. Fireball

salvia and Bonnie Hybrid tomatoes were bedding plants used in the research.

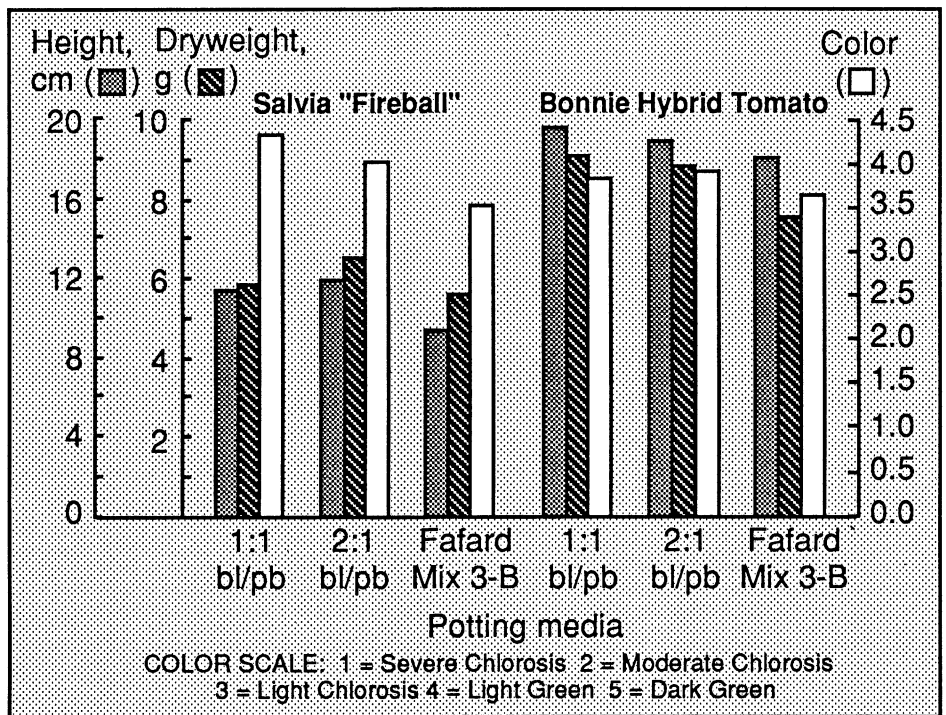
Seedlings of the two species were transplanted into flats with 36 cellpacks each on February 12, 1988. Three media were evaluated: 1 part broiler litter and 1 part pine bark; 2 parts broiler litter and 1 part pine bark; and Fafard Mix No. 3-B, a commercially available pine bark-based potting medium. The litter/pine bark combinations were allowed to compost before they were applied to the plants. Fertilization consisted of weekly applications of 20-10-20 liquid fertilizer mixed to provide a concentration of 200 parts per million (p.p.m.) N. Plants were grown in a double-layer polyethylene greenhouse with temperatures ranging from 65 to 80°F.

When the study ended April 3, 1988, plants were rated on color, height, stem diameter (caliper), and dry weight. Both varieties responded well to broiler litter in the potting medium. Salvia dry weight increased by 5 and 14% with 1:1

and 2:1 broiler litter/pine bark media, respectively, compared to the commercial potting mix, as shown in the figure. Tomato dry weights increased by 13 and 16% with the respective broiler litter media compared to the commercial standard. Fresh weight and height of both plants responded in a similar fashion to the dry weights. Caliper was not affected by any treatment.

In addition to increased plant size, color of both species was improved when broiler litter was used as a medium amendment. This may result from the N in the broiler litter becoming slowly available during the test. While this test is preliminary in nature, it does indicate that use of broiler litter in ornamental potting medium may enhance the potting medium and provide a means of litter disposal.

Gilliam is Associate Professor and Browne is Lab Tech II of Horticulture; Donald is Professor of Agricultural Engineering; Shumack is Head of Horticulture.



Effects of broiler litter combinations on height, dry weight, and color of salvia and tomato varieties.



# ALABAMA AGRICULTURE—2000 STYLE

## *Trend Toward Fewer Farms, Less Land in Farms Expected to Continue*

**A**LABAMA AGRICULTURE seems headed for a future with fewer farms and less land in farms. Beef and poultry should hold their own or maybe even expand. Cotton and peanut acreages should at least maintain current levels, while wheat and grain sorghum may expand. Corn, hog, and dairy production will decline.

That's the picture painted for the year 2000 by projections resulting from Alabama Agricultural Experiment Station research. These projections indicate a continuation of trends that led the State from its large numbers of farms and dependence on row crops in the 1800s to today's situation with fewer farms, more acreage devoted to pasture and forage for ruminant livestock, and a large, vertically integrated poultry industry.

Information on specific farm enterprises reported in the table came from a regional study in which the Experiment Station cooperated. The study addressed such things as consumption of grains by livestock and poultry operations to project grain deficits in Alabama and the need for transportation, storage, and processing facilities.

Making projections for more than a short time in the future is inexact because conditions affecting supply and demand, new technology, and other unforeseen events can make the projections inaccurate. For example, one set of projections made in 1978, just before soybean acreage peaked in Alabama and began its dramatic downturn, greatly over-estimated acreage during the last few years. Therefore, such projections typically carry the wording "assuming present trends will continue."

Projections in the table were made using a combination of several methods. Five types of frequently used projection equations were fitted to data from 1960 to the present for acres harvested, yield, production, and percent of U.S. produc-

tion for crops and to production or numbers and percent of U.S. production for livestock and poultry. The best-fitting equation was chosen in each case and projections were made to the year 2000. Horticultural crops are not included in these projections.

Based on these projections, there is little doubt that number of farms and land in farms in Alabama will continue to decline. Of the cropland harvested, hay land is expected to remain steady or increase slightly. The beef industry, the main user of this hay land, is expected to increase to about a million cows by the year 2000.

Soybeans will continue to be an important crop, but probably will not soon reach the peak acreage of 2.15 million acres recorded in 1979. Instead, acreage is projected at about 560,000. This will produce about 12.9 million bu., far short of the almost 41 million bu. crushed in Alabama plants in 1985. Thus, continued imports will be required if this level of crushing is to continue.

Cotton and peanut crops are difficult to project without knowledge of future government programs. The best estimate for cotton is that the declining acreage will level off and possibly increase slightly. Peanut acreage has been somewhat erratic since 1979, and the

SELECTED ASPECTS OF ALABAMA AGRICULTURE, 1960, 1975, 1987, AND PROJECTED TO 2000

Item and unit	Quantity, by year			
	1960	1975	1987	2000
<b>Number of farms and land in farms</b>				
Farms, number	—	63,000	49,000	44,000
Land in farms, thou. acres	—	13,400	11,000	10,000
<b>Crops harvested and cropland</b>				
Hay, thou. acres	521	630	700	750
Soybeans, thou. acres	135	1,260	480	560
Cotton, thou. acres	860	370	333	400
Peanuts, thou. acres	187	202	220	230
Wheat, thou. acres	48	110	170	270
Grain sorghum, thou. acres	20	33	40	52
Corn, thou. acres	1,705	660	250	140
Other crops, thou. acres	—	161	76	68
Total cropland, thou. acres	—	3,426	2,269	2,470
<b>Yields per harvested acre</b>				
Hay, tons/acre	1.13	1.80	2.10	1.88
Soybeans, bu./acre	24.0	24.5	16.5	23.0
Cotton, lb./acre	421	405	572	600
Peanuts, lb./acre	1,130	2,600	2,115	2,800
Wheat, bu./acre	25.0	24.0	31.0	37.0
Grain sorghum, bu./acre	24.0	37.0	48.0	50.0
Corn, bu./acre	26.0	50.0	72.0	71.4
<b>Crop production</b>				
Hay, thou. tons	588	1,134	1,470	1,410
Soybeans, thou. bu.	3,240	30,870	7,900	12,880
Cotton, thou. bales	756	312	397	500
Peanuts, thou. lb.	211,310	525,200	465,300	644,000
Wheat, thou. bu.	1,200	2,640	5,270	10,000
Grain sorghum, thou. bu.	480	1,221	1,900	2,600
Corn, thou. bu.	44,330	33,000	18,000	10,000
<b>Livestock and poultry</b>				
Broilers raised, thou.	176,654	395,769	666,538	780,000
Hens and pullets Jan. 1, thou.	6,614	12,538	11,400	10,920
Beef cows Jan. 1, thou.	—	1,238	862	1,000
Pig crop, thou. head	1,596	1,207	615	400
Horses, mules, ponies, thou.	100	154	193	200
Milk cows Jan. 1, thou.	—	92	43	20

projection of 230,000 acres is highly uncertain. Wheat and grain sorghum acreage should show increases by 2000.

Alabama's broiler industry is expected to continue its expansion, thereby using large quantities of imported corn and soybeans. Hens and pullets should also continue at a high level. Horses, mules, and ponies are hobby enterprises, but significant users of grain and pasture. Numbers are expected to show continued expansion. There is little doubt that the swine and dairy industries will continue to decline.

Stallings is Associate Professor and Hopkinson is Graduate Research Assistant in Agricultural Economics and Rural Sociology.

A.J. LATHAM and A.E. RUSHING

## KNOW THE ENEMY—PECAN SCAB

Information about  
How Pecan Scab  
Develops Is  
Required for  
Control with  
New Systemic  
Fungicides

**K**NOWING THE ENEMY is the first step in winning any battle. While this rule may be thought of as relating mainly to warfare, it is just as applicable to winning the battle against such farm enemies as pecan scab. Information about timing of scab development and environmental conditions required by the disease-causing fungus is critical to developing workable control measures.

Details about how scab develops is a major need for successful use of the new generation of systemic fungicides, such as propiconazole (trade name Orbit®). Whereas previously used fungicides had to be applied almost immediately after scab infection began, it was anticipated that a systemic fungicide would have a longer interval of time for application to obtain desired controls. The key was to learn about how the disease developed, which is the reason for research on this subject at the Alabama Agricultural Experiment Station.

The study was planned to determine the mode of infection, establishment, and sporulation by *Cladosporium caryigenum* on pecan leaves. Conidia of the fungus were harvested from leaves of greenhouse-grown Schley pecan trees. A water-based suspension was prepared and sprayed onto leaves of disease-free Schley trees growing in 3-gal. pails.

After inoculation, the trees were incubated in a dew chamber at 73.4°F and 100% humidity for 36 hours. Subsequently, the chamber was illuminated for 12 hours, after which the trees were re-

turned to a greenhouse bench.

Leaf discs were excised from each of six trees at 3-, 6-, and 9-hour intervals, then at 12-hour intervals through 96 hours, and finally at 24-hour intervals through 240 hours. The discs were processed to remove chlorophyll, stained to differentiate the fungus from pecan tissues, and mounted permanently for light microscopic and electron microscope examination. Germ tubes extending from *C. caryigenum* conidia were observed at 3 hours after inoculation. At 12 hours after inoculation, 83.2% of the conidia had germinated and 0.4% of the sites of infection showed subcuticular hyphae (fungal "threads" growing under the leaf cuticle). Maximum penetration of pecan tissues was observed at 36 hours. At 48 hours after inoculation, 62.2% of the germ tube terminals were associated with sites of infection and 29.4% of the subcuticular hyphae had become en-

larged and branched. From 72 to 84 hours after inoculation, finger-like protrusions were found along the subcuticular hyphae. After 144 hours, a pale brown cell was observed near the end of each finger-like protrusion and accompanied by a dark brown bulbous terminal cell. Also, at this time, some conidiophores had ruptured the leaf cuticle immediately above the bulbous cell.

Sporulation began 168 hours after inoculation. The subcuticular mass of hyphae subsequently caused the development of a thick, dark olive-green stroma (pincushion-like structure) that produced innumerable conidia. This stroma or "lesion" was readily visible at

240 hours, or 10 days following inoculation of the leaves.

This research demonstrates that continuous pecan leaf wetness for as little as 3 hours at 73.4° can result in a scab infection period, though studies by other researchers had indicated the infection period to be between 6 and 12 hours. Thus, to be effective, fungicides that prevent spores from forming, such as Du-Ter®, Super-tin®, or Triple tin® (triphenyltin hydroxide fungicides), must be applied within 3 hours after leaves become wet. New systemic fungicides such as Orbit, which control the fungal growth within plant tissues, may be applied as long as 4 days after an infection period (first time leaves become wet) to control scab.

Latham is Associate Professor of Plant Pathology; Rushing is a Research Associate of Botany and Microbiology.

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