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HIGHLIGHTS

OF AGRICULTURAL RESEARCH

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ON THE COVER. Flowering dogwoods are a sign of spring, but these trees may be in danger from a new disease, see story on page 5.

UPCOMING EVENTS

March 18	Livestock/Forage Field Day, Piedmont Substation, Camp Hill
April 8	Livestock Field Day, Lower Coastal Plain Substation, Camden
April 22	Forage/Waste Management Field Day, Upper Coastal Plain Substation, Winfield
April 29	Rural Revitalization Conference, Tuskegee University
May 11	Forage and Livestock Field Day, Sand Mountain Substation, Crossville
May 11	Conservation Tillage in Row Crops, Montgomery
May 13	Conservation Tillage in Row Crops, Cullman
May 13	Strawberry Field Day, Chilton Area Horticulture Substation, Clanton
June 23	Horticulture Field Day, E.V. Smith Research Center, Shorter

* For times of meetings contact your county Extension Service office.

DIRECTOR'S COMMENTS

As winter gives way to spring, more and more people will be involved in outdoor activities, two of which are gardening and fishing. This issue of **Highlights** includes articles on a wide range of topics, but gardeners and fishing enthusiasts will want to pay special attention to the articles on dogwood anthracnose and on the balance between clear water and good fishing.

An important mission of the Alabama Agricultural Experiment Station (AAES) is to detect problems before they adversely affect producers and consumers. In the case of dogwood anthracnose, the AAES joins other southeastern universities in seeking to identify the disease, determine how rapidly it is spreading, and search for remedies.

This case is symptomatic of the different types of problems that plague production agriculture. While most producers and consumers only want answers, scientists must investigate many aspects of the problems before a practical, environmentally safe remedy is found.

The article on the tradeoff between clear water and good fishing is a good example of the balancing act scientists must perform in seeking remedies that are not only beneficial to the producers, but also environmentally safe. In the case of water quality in Alabama lakes, scientists could easily find a remedy to poor quality water or to poor fish production. But, the problem of improving both without hurting either is most difficult to solve.

These research projects emphasize the adage, "An ounce of prevention is worth a pound of cure." Our research is becoming more proactive than reactive, a sign of forward-thinking scientists.

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BACTERIA-TREATED SEED PROMOTES BETTER SEASON-LONG HEALTH IN COTTON

Producers are well aware of the need to manage crops effectively while using the least possible amount of agricultural chemicals.

To help growers attain this goal, AAES supports an active and growing research program to develop natural, nonchemical methods to improve plant health.

Based on initial field studies in one AAES "biological control" project, two beneficial bacterial strains show promise in controlling fungi that cause three major cotton seedling diseases. Studies at the E.V. Smith Research Center, Tallahassee, and the Wiregrass Substation, Headland, indicated that organisms known as GUS2000 and GUS376 are effective when applied as seed inoculants. Both bacteria are being tested with numerous crops throughout the nation.

Registered to GUSTAFSON, Inc., of Plano, Texas, these microorganisms are strains of the bacterium *Bacillus subtilis*. GUS2000 is already a component of GUSTAFSON's Kodiak™, a EPA registered product used as a seed treatment for peanuts in Alabama and also marketed for use in cotton and soybeans.

Chemical seed treatments alone do not provide season-long control against pathogens that attack the root system. Field studies were begun in 1992 to compare the impact on cotton production of using the bacteria versus using conventional seed treatments alone. Seedling emergence, disease control, growth promotion, and yields were assessed for each treatment.

One test was aimed at determining the effect of treatments on control of *Fusarium* wilt in cotton, a pathogen for which there is no chemical treatment. Other tests compared control of *Rhizoctonia* and *Pythium*, diseases commonly known as damping-off and shothin, respectively. These three fungi are the main causes of cotton seedling disease in Alabama. About 5% of the State's cotton crop is lost to

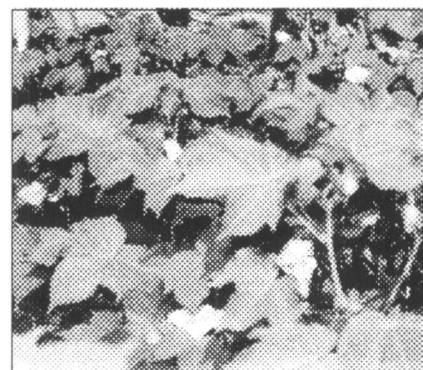
them each year. The fungi can require producers to completely replant their crop in some cases.

Both beneficial bacteria colonized the root systems of cotton plants throughout the growing season. However, two cotton varieties, DP50 and DP5415, showed higher levels of colonization and dominance of the bacteria on their roots.

GUS2000 colonized the taproot of the cotton plant and GUS376 colonized the lateral roots. Combinations of these two organisms could give good total root coverage. However, initial testing of combinations did not show improvements over either organism used alone. Further research needs to be conducted on this subject.

Approximately 30 days after planting, whole seedlings were removed from plots and examined for disease. Plants treated with either GUS2000 or GUS376 showed fewer signs of seedling disease in all rated tests.

Using a peanut inverter, whole mature plants were removed at harvest, and the health and development of root systems were rated. Cotton varieties DP50 and DP5415 showed the best root development, indicating another correlation between the amount of colonization and a healthy root system. Unlike chemical treatments alone,



the addition of bacteria seems to provide long-term protection of the cotton root.

In general, plant emergence and stands were not significantly increased with use of either bacterial treatment. GUS2000 treatments generally showed an increase in stand, though not statistically significant. However, in one test using cotton cultivar DP50, GUS2000 bacteria did result in a significant improvement in stand. In the same test, DP50 showed an improvement in yield.

The GUS2000 bacterium also showed good potential activity against *Fusarium*. Overall disease incidence was reduced in plots treated with moderate to high rates of GUS2000 (see table). Some chemicals have been reported to actually enhance *Fusarium* activity. The addition of a biological control organism could offset or reduce such threats in *Fusarium*-infested fields.

After 1 year of field research with these bacteria, more questions have been raised than answered. However, the bacteria do colonize cotton plants well, and resulting benefits are observed. The potential exists to genetically engineer the bacteria to produce additional antifungal chemicals, and research is being conducted to this end. Continued research should further define the potential of these organisms for use in Alabama cotton production.

Brannen is Extension Research Assistant and Backman is Professor of Plant Pathology.

FUSARIUM WILT CONTROL WITH BACTERIAL SEED INOCULANTS, 1992, E.V. SMITH RESEARCH CENTER, TALLASSEE

Treatment ¹	Healthy plant count ²	Seed cotton yield
	No./50 row ft.	Lb./ac.
Nontreated control	37	779
Vitavax/Terraclor/Apron	30	905
GUS2000 hopper box, high rate	48	1,079
GUS2000 hopper box, medium rate	58	1,104
GUS2000 hopper box, low rate	42	804
GUS376 hopper box, high rate	41	915
GUS376 hopper box, medium rate	28	552
GUS376 hopper box, low rate	32	445
Apron/Terraclor hopper box	30	687

¹Except for the control, all seed were pretreated with a combination of three chemical fungicides, Vitavax, Terraclor, and Apron. In separate treatments, bacterial treatments and extra doses of Apron and Terraclor were added into the hopper box, or seed container on the planter.

²The healthy plant count, taken at 113 days after planting, gives the total number of plants showing no signs of *Fusarium* infection.

DOGWOOD ANTHRACNOSE AFFECTING FLOWERING DOGWOOD IN ALABAMA

A recent AAES survey of state parks and national forests in Alabama indicates dogwood anthracnose, a destructive disease of flowering dogwoods, has spread southward into the State. Previously, the distribution and extent of the disease were not known.

Dogwood anthracnose is characterized by large circular to irregular brown blotches that coalesce along the end and center of the leaves, resulting in blighting of the leaves. The disease is most prevalent in trees that grow in heavy shade.

The AAES survey was initiated in the late spring of 1991 and repeated in 1992. Trees along one or more hiking trails at selected state parks (SP) and national forests (NF) were examined for symptoms of dogwood anthracnose. Specific disease ratings were made for each tree examined in the 1992 survey, and leaves from selected trees were checked for the causal fungus, *Discula destructiva*.

In 1991, extensive spotting and blighting of leaves were seen on most dogwoods in Monte Sano SP in Madison County and

Desoto SP in DeKalb County (elevation 1,500 ft.). Few healthy trees were seen at either site. Light damage was seen on a few scattered dogwoods at an elevation of 1,000 ft. on Taylor Mountain in Lake Guntersville SP in Marshall County and the north rim of Little River Canyon in DeKalb County. No symptoms

were found on trees along trails just above Lake Guntersville in Lake Guntersville SP.

A single dogwood with typical leaf spot symptoms was found at Buck's Pocket SP in DeKalb County and along an access road in the Talladega NF in Calhoun County. No diseased trees were found at two nearby sites in the Talladega NF in Cleburne County or several sites in Cheaha SP in Clay County.

The incidence and severity of dogwood anthracnose worsened in 1992 at many north-eastern Alabama sites (see table).

Light to moderate twig dieback, along with the typical leaf spot and blight associated with this disease, was seen on nearly all dogwoods in Monte Sano SP and Desoto SP (see Figures 1 and 2). On some trees, death of all branches was accompanied by the appearance of numerous water sprouts along the main trunk, and some smaller dogwoods apparently were killed by the disease. Taller dogwoods exposed to direct sunlight typically suffered less damage than smaller, shaded understory trees.

Considerable leaf blight and twig dieback occurred on dogwoods along the north rim of the Little River Canyon and near Coleman Lake in the Talladega



FIG. 1. Leafspotting associated with dogwood anthracnose.



FIG. 2. Later stages of dogwood anthracnose.

NF in Cleburne County. Light injury was found in previously healthy stands of dogwood at several sites in Lake Guntersville SP, Buck's Pocket SP, Talladega NF in

the southwestern corner of Cleburne County, and one site in Bankhead NF in Lawrence County at elevations down to 600 ft. A single diseased dogwood also was found in a residential neighborhood in Birmingham in Jefferson County. Trees at two sites south and west of Cheaha SP in Clay County were healthy, as were all trees examined in Wind River SP, Oak Mountain SP, Wheeler SP, Richwood Caverns SP in Blount County, and three sites in the Bankhead NF in Winston County.

Dogwood anthracnose threatens the health and beauty of flowering dogwoods in forested upland areas of northeast Alabama. Extensive tree death is expected in dogwood stands that have already been ravaged by this disease. Spread of dogwood anthracnose into forested areas at lower elevations (down to 600 ft.) indicates that damage may eventually occur on shaded understory dogwoods over wider areas of Alabama, including home landscapes. Trees on open, sunny sites should not suffer serious injury. Although spot anthracnose and botrytis blight also were identified on trees, dogwood anthracnose is the predominate foliar disease of flowering dogwood in late spring and early summer in north Alabama.

Hagan is Professor and Mullen is Plant Pathologist/Diagnostician of Plant Pathology.

INCIDENCE AND SEVERITY OF DOGWOOD ANTHRACNOSE IN ALABAMA ON FLOWERING DOGWOOD IN 1992			
State park or national forest	County	Incidence	Disease rating ¹
		<i>Pct.</i>	
Rickwood Caverns SP ..	Blount	0.0	5.00
Talladega NF	Clay	.8	4.99
Talladega NF	Cleburne	40.1	4.40
DeSoto SP	DeKalb	91.5	3.20
Buck's Pocket SP	DeKalb	37.2	4.50
Little River Canyon	DeKalb	88.5	3.70
Bankhead NF	Lawrence	.9	4.95
Wheeler SP	Lauderdale	0	5.00
Monte Sano SP	Madison	100.0	2.10
Lake Guntersville SP	Marshall	12.1	4.74
Oak Mountain SP	Shelby	0	5.00
Wind River SP	Tallapoosa	0	5.00
Bankhead NF	Winston	0	5.00

¹In 1992, disease severity was visually assessed on each tree using a modified Mielke-Langdon scale: 0 = dead tree, 1 = 76-100% leaves diseased with numerous water sprouts, 2 = 50-75% leaves diseased with extensive twig dieback, 3 = 25-50% leaves diseased with some twig dieback, 4 = 1-25% of leaves diseased, and 5 = healthy tree.

CAN WE HAVE CLEAR LAKES AND GOOD FISHING?

Some Alabama lakes receive more nutrients than are needed to support quality sport fisheries, according to a study conducted by the AAES and the Alabama Game and Fish Division. However, the 2-year project led to the development of guidelines that resource managers can use to attain water quality standards acceptable to skiers and swimmers, but also adequate to support good populations of the State's most popular sport fish.

Lake management is a tradeoff between extremely clean, clear water — which is good for swimming and other recreation — and greener water, which is better for sport fishing. Nutrients, such as phosphorus, increase communities of algae, the base of a lake's food web. With an enhanced food supply, a lake has a larger population of fish

fertility by examining the concentrations of chlorophyll *a*, a pigment of plankton algae, the dominant plant community in each lake (Table 1). Lake Martin had the least algae, and Weiss Lake had the most. Lakes Jones Bluff and Eufaula were similar, even though Jones Bluff maintained higher nutrient concentrations. A shorter water retention time in the Jones Bluff impoundment was likely responsible for the suppressed algae growth.

Fish were collected by electrofishing and trapnetting, while fishing was evaluated using survey data and bass angler tournament reports (Table 2). Largemouth and spotted bass abundance was greater in lakes Weiss and Eufaula and lower in lakes Martin and Jones Bluff. Crappie also were more abundant in the more productive waters.



higher than those recorded in Lake Martin, estimated fish abundance was only two times higher in Weiss. Furthermore, moderately fertile lakes Jones Bluff and Eufaula supported a black bass and crappie fishery similar or superior to the highly fertile Weiss Lake, indicating benefits derived by the fish population from extra algae leveled out at a certain point.

Taking into account the water retention time in each reservoir, reducing chlorophyll *a* concentrations from extremely high rates — such as those in Weiss Lake [34 parts per

TABLE 1. LIMNOLOGICAL CHARACTERISTICS OF LAKES MARTIN, EUFAULA, JONES BLUFF, AND WEISS DURING 1989 AND 1990 GROWING SEASONS

Lake	Hydraulic retention	Total phosphorus	Chlorophyll <i>a</i>	Depth of water clarity
	<i>Days</i> ¹	<i>P.P.B.</i>	<i>P.P.B.</i>	<i>In.</i>
Martin	338	12	2.5	123
Eufaula	67	41	15.4	55
Jones Bluff	10	60	13.0	40
Weiss	23	102	34.2	29

¹ Hydraulic retention is a measure of how long water is retained in an impoundment before it is allowed to flow through the hydroelectric dam that contains it.

TABLE 2. FISH AND FISHERY CHARACTERISTICS OF LAKES MARTIN, EUFAULA, JONES BLUFF, AND WEISS DURING 1989 AND 1990

Lake	Relative abundance	Relative weight ¹	Crappie ²	Shad ¹	Black bass ¹	Bass catch ³	Mean bass weight ³
	<i>Fish/hr.</i>	<i>Lb./hr.</i>	<i>Fish/day</i>	<i>Fish/hr.</i>	<i>Fish/hr.</i>	<i>Fish/hr.</i>	<i>Fish/hr.</i>
Martin	161	25	1.6	21	19	0.25	0.62
Eufaula	263	43	Not collected	117	35	.29	.82
Jones Bluff	199	34	8.1	97	25	.22	.72
Weiss	335	43	7.2	176	40	.30	.71

¹Electrofishing data.

²Trapnet data.

³Bass tournament data.

with greater growth potential, but excessive algae growth can reduce water clarity, cause taste and odor problems, and result in fish kills.

In an effort to determine optimum lake productivity, scientists examined lakes Martin, Jones Bluff, Eufaula, and Weiss to provide data on water quality and fertility, fish community structure and growth, and fishing quality. Lake Martin had the lowest mineral and nutrient content, followed in order by lakes Eufaula, Jones Bluff, and Weiss (Table 1).

Researchers measured lake response to

However, 53% of the Weiss Lake fish community was comprised of shad (a nonsport bait fish) and 38% of sport fish. By contrast, Lake Martin had 13% shad and 58% sport fish. Shad dominance increases as a lake becomes more fertile.

Bass growth rates were similar among the four lakes, although largemouth bass in Lake Martin were in poorer physical condition. Crappie grew slower in Lake Martin, but crappie growth rate was not different among the three more fertile lakes.

Although Weiss Lake maintained average chlorophyll *a* concentrations 10 times

billion (p.p.b.)] — to 10-15 p.p.b. may not adversely impact high-quality bass and crappie fisheries. At the same time, improvements in water quality and clarity can be achieved.

Therefore, the answer to the question posed in this article is, "Yes." With proper monitoring and management, Alabama can have clean, aesthetically pleasing lakes and good fishing, too.

Bayne is Professor and Maceina is Assistant Professor of Fisheries and Allied Aquacultures; Reeves is Chief of Fisheries Research with the Alabama Game and Fish Division.

COCKROACH CONTROL USING INSECT GROWTH REGULATORS

GERMAN cockroaches breed indoors and rapidly pass through three stages of development (egg, nymph, and adult), making them difficult to control and potential year-round pests in homes, apartments, restaurants, and hospitals. Recent AAES research indicates the disruption of this life cycle using insect growth regulators (IGRs) may be a less toxic alternative to insecticides for control of these pests.

Female cockroaches lay eggs in a protective case that is carried by the female until the eggs are nearly ready to hatch. Each case contains 30-40 eggs that require about 2 weeks to hatch. When cockroach nymphs hatch, they resemble the adults except that they are smaller and lack wings. Nymphs shed their skin by molting several times, increasing in size each molt before becoming adults.

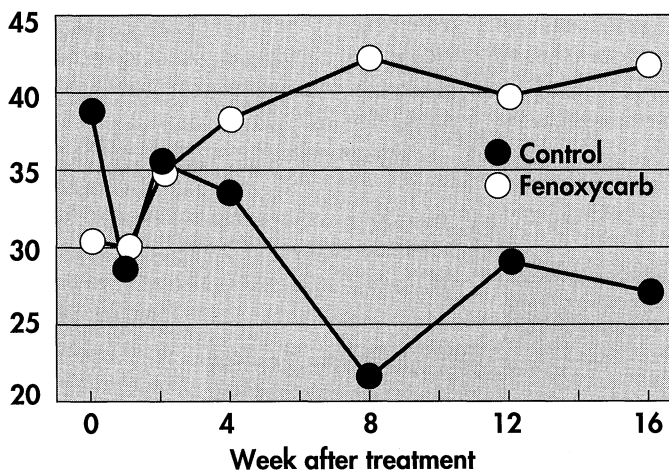
IGR's, which are applied like a regular insecticide spray, can stop nymphs from molting and females from producing eggs. These effects can disrupt an entire breeding population of cockroaches. An additional benefit is that IGRs are much less toxic than many other insecticides and often work at lower concentrations.

Even though German cockroaches live indoors, their numbers tend to decrease in the winter. The Auburn study was done to determine whether an indoor IGR application of fenoxycarb in winter would result in suppression of cockroach numbers into the spring.

Six German cockroach-infested apartments were treated in mid-February 1991 with approximately 1 qt. of 0.2% Torus 2E (fenoxycarb). Torus, which is only available to pest control operators, was thoroughly applied with a compressed air sprayer to cracks and crevices where the cockroaches were living in the test apartment kitchens.

Six additional apartments with German cockroaches were monitored as nontreated controls. All 12 apartments were monitored with 10 sticky traps (trade name: Mr.

Percentage of small nymphs



Average reduction of small cockroach nymphs in Torus treated apartments compared to control apartments.

Sticky®). Six traps were placed in cabinets around the kitchen sink, two in the pantry, one behind the stove, and one behind the

apartments, compared with 42% in the control apartments. The effect of the Torus treatment on the nymphal population may

weeks, control improved in the Torus-treated apartments. At this time, small cockroach nymphs appeared to be most affected by the Torus treatment (see figure). Initially the treated apartments had 39% small nymphs and the control apartments had 31% small nymphs. By week 8, the average percentage of small nymphs was 22% in the treated

PERFORMANCE OF AN INSECT GROWTH REGULATOR AGAINST GERMAN COCKROACHES IN INFESTED APARTMENTS							
Treatment ¹	Cockroaches/ apartment pretreat	Reduction of cockroaches/ apartment, average at					
		1 week	2 weeks	4 weeks	8 weeks	12 weeks	16 weeks
Control	Avg. 495	Pct. 20	Pct. 31	Pct. 39	Pct. 18	Pct. 4	Pct. -24 ²
Torus	499	24	32	20	45	45	28

¹Six apartments in each treatment.
²Negative percent reduction indicates an increase in cockroach numbers.

refrigerator. Traps were left for 1 week, and captured cockroaches were counted before treatment and at 1, 2, 4, 8, 12, and 16 weeks after treatment. The average percent reduction in cockroach numbers from the pretreatment numbers was calculated per treatment for each week. The average percent reduction of small (new) cockroach nymphs in each treatment also was recorded each week.

Torus treatments resulted in less than 50% reduction in cockroach numbers and control was least effective during the first 4 weeks. Reduction of cockroaches averaged 20 to 32% in the treated apartments, compared to a reduction in control apartments of 20 to 39% (see table). However, after 8

be greater than indicated by the data because the treated apartments had 2 to 10% more females carrying egg cases than the control apartments during the 8- to 16-week sampling period.

Based on these results, Torus applied in the middle of the winter did not immediately suppress cockroach populations compared to nontreated apartments. However, the amount of Torus in the apartments may have been high enough to affect the reproductive cycle of the females and thereby reduce the number of offspring in the spring.

Benson is Assistant Professor, Appel is Associate Professor, and Ellenberger is a Research Technician IV of Entomology.

NATURAL AND SYNTHETIC CAROTENOIDS ENHANCE PIGMENTATION OF ORNAMENTAL FISH

Red peppers, marigolds, and tropical fish may seem to have little in common, but AAES research has forged a link between the three that could mean an economic boost to the South's multimillion-dollar ornamental fish industry. Pigments extracted from these

technology, recirculating water systems provide many advantages over a more natural pond, but steps must be taken to ensure proper fish coloration.

Pigments must be supplied in the feeds used. Carotenoids, a group of compounds responsible for the color in carrots and sweet potatoes, also provide the same pigments that give ornamental fish their vivid colors.

Fish are unable to synthesize these pigments and must obtain them in their food. Natural aquatic food organisms are rich in these pigments, which range from red to yellow, but commercial feed ingredients are poor sources. Research was

conducted to determine the effectiveness of supplementing feeds with natural and synthetic carotenoid pigments.

Two species of ornamental fish were fed diets containing various sources of carotenoids in 1-cubic-meter recirculating tanks for 5-week periods and subsequently evaluated by trained judges for quantity and quality of coloration.

Cherry barbs, which have a characteristic deep red color, were fed canthaxanthin (a synthetic reddish-pink pigment) or a natural red pigment extract from red peppers. Canthaxanthin, at 100 parts per million (p.p.m.), or the red pepper extract, at 100 and 400 p.p.m., were added to a commercial salmon starter feed.

Tiger barbs, which have reddish-orange fins, were fed the red pepper extract, an extract from Aztec marigold flowers, or a combination of the two pigments. Pigment concentrations in the feeds were 400 p.p.m. for the single sources and 200 p.p.m. of

each in the combination.

Red pepper extracts contained mainly capsanthin. Marigold extracts contained mainly lutein and zeaxanthin. These pigments are used commercially in the poultry industry to enhance egg yolk and broiler skin color.

The control group of each species was fed nonsupplemented salmon starter in tanks. Additional groups of each fish were fed the nonpigmented starter feed in ponds.

Tank-reared Cherry barbs fed the non-supplemented feed were too pale to be marketable. The red pepper extract produced an intense color in these fish and was more effective than the synthetic pigment. Red pepper extract at 400 p.p.m. produced the most intense colors. Fish fed either concentration of the natural pigment in the recirculating system had similar or better coloration with more uniform quality than those grown in a pond. Color quality of pond-reared cherry barbs was highly variable.

Tank-reared tiger barbs fed the nonsupplemented feed were almost devoid of color. Those fed the marigold extract had a desirable yellow sheen in their skin but lacked the desired red fin color. Red pepper extract produced the characteristic red fins. However, a combination of the extracts gave fish the best coloration of skin and fins. Pond-reared tiger barbs showed less uniform quality in coloration.

Rearing ornamental fish in recirculating water systems allows more control over temperature, disease, and uniformity in fish size, causing many producers to change from ponds. There are several hundred species of ornamental fish with a range of color characteristics. Therefore, identification of suitable pigment sources for coloring different fish will be increasingly important. This study showed that feeding the right pigment at the right concentration will allow production of ornamental fish that equal or exceed the quality of pond-reared fish.

Duncan is Senior Research Associate and Lovell is Professor of Fisheries and Allied Aquacultures.



FIG. 1 (above). From top, cherry barbs fed 400 p.p.m. red pepper extract, fed 100 p.p.m. red pepper, fed 100 p.p.m. canthaxanthin, raised in the pond control, and raised in the recirculating system control. **FIG. 2. (above, right).** From top, tiger barb fed a mixture of red pepper and marigold extracts, and a control fish from the recirculating system.

plants were used to enhance the color of two popular aquarium dwellers.

The commercial value of most ornamental fish depends on good coloration. Fish reared in ponds and fed natural foods obtain a desirable hue, but many producers are growing ornamentals in a controlled environment where natural food is absent. High-

TALKING TO CHILDREN ABOUT SOCIAL SKILLS HELPS THEM GET ALONG WITH OTHERS



Good parent-child communication can help children get along with their peers.

Being able to get along well with others in childhood is the single best predictor of later life adjustment, including school success. Children learn the important social competencies that make for later success in every aspect of life through their families. But how do parents help children learn such important skills as solving problems and respecting the feelings of others?

There is abundant research evidence that when parents are both warm and loving and also firm in their expectations, children do better in relationships with others. But is being loving yet firm sufficient to ensure that children know how to handle the many difficult issues that arise in day-to-day interactions with others, issues such as how to respond to rebuffs by a peer or how to make a new friend? Or can parents help their children learn to handle social situations by providing good advice about interpersonal relationships? Until recently, almost no information was available from research studies about what parents normally do to teach children the skills for getting along with others and which, if any, actions are most helpful.

In order to increase our understanding of how parents teach children important social skills, researchers with the AAES undertook a study with 61 mothers and their 3- to 5-year-old children. The families were mostly middle income and lived in or near a small city in Alabama. The mothers and children watched a series of short videotaped stories (acted by child actors) about things that often happen between young children in preschool classrooms. For instance, in one story a child knocks over another's block tower. In an-

other there is space for only two children at a game, but a third child wants to play. Each mother was asked to pretend that the event in the story had happened to her child and to talk to the child about what had occurred.

Most mothers talked to their children about several aspects of the short stories. Many mothers talked about why the children had acted the way they did and about how children in the stories were feeling. Many mothers tried to help their children think of ideas about what to do should the event happen to them by asking, "What would you do if that happened to you?" Mothers and children often identified strategies, such as explaining to the peer the child's feelings or talking about classroom rules. When children suggested strategies that the mothers thought were not appropriate, many mothers tried to get children to think of the consequences of taking such action. For instance, a mother might ask, "But if you did that, how would she feel. How do you feel when your sister does that to you?"

As the researchers expected, the children of mothers who were warm and supportive tended to get along well with other children. But the researchers were interested in whether the advice mothers gave children also contributed to children's social competence. Children of mothers who talked about the videotaped stories in positive ways, suggesting friendly strategies and expressing an optimistic attitude toward the event, had good relationships with other children. This was true even after taking into consideration the quality of the mother-child relationship.

Based on these findings, child develop-

ment experts can begin to answer some of the questions almost every parent has about how to help their children get along well with peers.

First, parenting that is warm and affectionate, yet firm, lays the groundwork for children's success. But it appears that parents can give their children additional help in developing social skills to meet the challenges they will face in school by talking about the situations they encounter. This does not mean that parents must "tell" their children the best way to handle a situation. In fact, there probably is no single strategy that will always work. Rather, parents can help by problem solving with the child about events that arise in interactions with others. Getting the child to think of alternative strategies and evaluate their consequences, and helping the child develop a positive, optimistic attitude toward others seems particularly helpful. Reasoning with children about social situations in these ways probably helps children learn to be constructive and positive themselves when faced with the everyday challenges of getting along with others.

Although the children in this study were developing normally and were not having problems in social development, the results of the research have implications for children who need special help in getting along with others. With the data from this study and future studies, teachers of young children will be able to provide information to parents who seek advice on how they can help a child who is shy or overly aggressive with peers.

Mize and Pettit are Associate Professors of Family and Child Development.

SHOULD PRODUCERS FEED YOUNG PIGS FOR MAXIMUM PERFORMANCE?



Swine producers have found that feeding complex diets containing special ingredients after weaning or feeding diets high in amino acids during the grower phase can optimize the performance of young pigs. However, the use of these high-nutrient diets can be costly and producers must weigh this additional cost against the overall productivity and efficiency provided by these diets.

Little information is available on the effects of growth responses obtained during the starter and grower periods on the performance of pigs in subsequent production phases. A recent AAES study addressed this issue.

Crossbred pigs (Landrace x Hampshire x Duroc) weaned at about 25 days of age were assigned to either a simple or complex diet with four pens (eight pigs per pen) per diet. Pigs had free access to feed and water. After a 4-week starter phase, 48 pigs were selected for the grower-finisher phase of the study.

At an average weight of 49 lb., pigs that had been fed each of the starter diets were assigned within sex to grower diets containing either 0.62% or 1.12% lysine. When pigs weighed about 110 lb., backfat thickness was measured by an ultrasound instrument and the animals were assigned within grower diet to one of two finisher diets that

contained either 0.62% or 0.90% lysine. Pigs were housed and fed individually during the grower-finisher phase.

At an average weight of 238 lb., all pigs were slaughtered, carcass traits were evaluated, and the amount of lean they had gained was determined. The effects of only starter and grower diets on the performance of pigs are presented in the table.

As expected, pigs fed a complex diet consumed 14% more feed, gained 33% faster, and were 17% more efficient than those fed a simple corn and soybean meal-based diet. Pigs fed the complex diet reached 40 lb. 5 to 6 days sooner than pigs on the simple diet.

Starter diets, however, had no effect on weight or lean gain of pigs in the subsequent phases.

Carcass backfat thicknesses measured at the end of the finisher phase were lower in pigs fed a simple diet during the starter phase. Feeding a restricted diet during the early phase of development is, however, likely to extend the time required for those pigs to reach market weights, which may negate the advantage of improved carcass quality depending on the market incentive for lean pork.

During the grower phase, pigs fed a diet high in lysine gained faster than those fed a diet low in lysine. In addition, average ultrasound backfat measured at the end of the grower phase was 25% lower (0.44 versus 0.58 in.) in those pigs fed a high-amino

acid diet, indicating that improved weight gain was achieved through greater deposition of lean and less deposition of fat. Pigs previously fed a diet low in lysine, however, gained faster and more efficiently during the finishing phase than those fed a diet high in lysine.

Because of this turnaround, there were no differences in the overall performance of pigs during the grower-finisher phase. Similarly, feeding grower diets containing a marginally deficient (0.62%) or an optimum level of lysine (1.12%) seemed to have no effect on carcass traits or lean gain. The results indicate that the advantages obtained during the grower phase by feeding a diet high in amino acids were lost in the finisher phase.

Based on these results, it seems that formulating diets to promote optimum performance of weaning pigs will translate into

EFFECT OF STARTER AND GROWER DIETS ON WEIGHT GAIN, DAYS TO MARKET, CARCASS BACKFAT, AND LEAN GAIN IN PIGS

Item	Starter diet ¹		Grower diet ²	
	Simple	Complex	0.62%	1.12%
Weight gain, lb./day				
Starter	0.66	0.88	-	-
Grower	1.86	1.98	1.85	2.00
Finisher	1.94	1.92	2.00	1.86
Grower-finisher	1.89	1.94	1.93	1.90
Days (15 to 238 lb.)	143.6	137.8	139.7	141.7
Avg. carcass backfat, in.	1.15	1.25	1.21	1.19
Lean gain (110 to 238 lb.), lb./day739	.729	.739	.730

¹Simple diet = based on corn and soybean meal; complex diet = based on a base mix containing milk products, fish meal, steam rolled oats, and other special ingredients; fed for 4 weeks after weaning.

²Grower diets contained 0.62 or 1.12% lysine (1.77 or 3.20 grams lysine/Mcal digestible energy); constant proportions among amino acids were maintained by using a fixed proportion of corn and soybean meal; fed between 49 and 110 lb.

better overall performance. However, grower pigs can be fed marginally deficient levels of amino acid without adversely affecting the overall rate and efficiency of growth or carcass traits at the end of the finisher phase.

Chiba is Assistant Professor of Animal and Dairy Sciences.

REDUCING PRODUCTION INPUTS MAY BE PROFITABLE FOR COTTON PRODUCERS

In recent years, cotton producers have been faced with increasing costs for chemicals, labor, fuel, and other inputs needed for conventional tillage systems, though the prices they receive for cotton seed and lint have remained stable. This threat to profitability has been accompanied by increased pressure on farmers working highly erodible land to employ conservation tillage practices. But it is possible that these two factors may work hand in hand to increase the profitability of cotton production.

An AAES field study was initiated at the Tennessee Valley Substation, Belle Mina, to determine the economic feasibility of changing tillage systems and reducing chemical inputs. The study, which was conducted in 1991 and 1992, compared conventional and conservation tillage systems.

Cotton was planted on April 24 both years of the test. The conservation tillage

used at either 2 or 4 pt. per acre at planting.

Cotoran was applied broadcast in no-till plots and applied in a band over the row in conventional plots. Conventional plots were cultivated twice each year and post-directed with Bladex® plus MSMA® to maintain acceptable weed control. No-till plots received only Cotoran at planting in 1991. In 1992, no-till plots were post directed with Bladex plus MSMA in July to supplement the Cotoran treatments.

All combinations of tillage, in-furrow insecticide, fungicide, and Cotoran rate were represented in a range of treatments. In addition, untreated plots, where no chemicals were used at planting, were included for

The threat to profitability has been accompanied by increased pressure to employ conservation tillage practices

each tillage system. All plots received insecticide sprays as needed to control insects. Data obtained included crop stand counts, thrips counts, visual weed control ratings, boll counts, and seed cotton yields. Alabama Cooperative Extension Service cotton production budgets were used to calculate net returns for each treatment assuming \$0.62 per

lb. for lint, \$0.03 per lb. for seed, and no program participation. Crop stand counts and total bolls per plant were not affected by tillage or any chemical input. Prickly sida and annual morningglory control was good to excellent in both tillage systems regardless of Cotoran rate. Thrips counts revealed total thrips numbers (adult and larvae) were significantly higher on no-till plots in both years. Thrips counts were not affected by Temik rate either year. Yields were much higher overall in 1992 than in 1991 due to improved growing conditions. However, yields were approximately equal for both tillage systems, Temik rates, fungicides, and Cotoran rates in both years. Although analysis showed yields were not statistically different, the 5-lb.

Temik rate produced numerically higher yields than the 3-lb. rate in conventional systems.

Net returns above variable costs for treatments that provided the two lowest and two highest dollar amounts in each tillage system are shown in the table. Net returns above all specified expenses, both fixed and variable, resulted in all treatments losing money in 1991 (not shown). Reducing tillage and most pesticide inputs at planting did not greatly affect yield either year. Numerically lower yields overall with no-till treatments resulted in conventional tillage generally providing higher net returns. The 5-lb. Temik rate provided higher net returns in conventional tillage.

During the 2 years of this study, good weather conditions prevailed at planting. Stand counts and thrips control may change significantly in adverse weather conditions.

Although 2 years is not long enough to fully evaluate these systems, these results indicate that cotton producers in the Tennessee Valley may be able to reduce tillage and some chemical inputs and still obtain positive net returns above variable costs. The two best no-till treatments compared favorably with some conventional till treatments.

Patterson is Associate Professor of Agronomy and Soils; Goodman is Associate Professor of Agricultural Economics and Rural Sociology; Norris is Assistant Superintendent, Tennessee Valley Substation; Freeman is Assistant Professor of Entomology.

EFFECT OF INPUT LEVELS ON MEASURED VARIABLES AND NET RETURNS

Treatment ¹	Seed cotton			Net returns		
	Thrips	1991	1992	1991	1992	Avg.
				<i>Dol./ac.</i>	<i>Dol./ac.</i>	<i>Dol./ac.</i>
NT TE3 FUR COT4	40	1,468	3,783	1.00	563.00	282.00
NT TE3 HOP COT4	43	1,462	3,575	13.00	528.00	270.00
NT TE3 HOP COT2	41	1,533	3,772	40.00	585.00	313.00
NT TE5 FUR COT2	47	1,675	3,624	58.00	531.00	295.00
CT TE3 FUR COT4	21	1,625	3,657	47.00	551.00	299.00
CT TE3 HOP COT4	28	1,576	3,570	47.00	542.00	295.00
CT TE5 FUR COT2	29	1,723	3,919	63.00	607.00	335.00
CT TE5 HOP COT4	30	1,783	3,853	83.00	596.00	340.00

¹NT = notill, CT = conventional till, TE3 and TE5 = Temik 15G at 3 lb. or 5 lb. per acre assuming a price of \$2.70 per lb., FUR = Terrachlor Super X in-furrow at 8 lb. per acre assuming a price of \$1.70 per lb., HOP = Apron + Terrachlor in hopper at 2 oz. per acre assuming a price of \$2.25 per oz., COT2 and COT4 = Cotoran 4L at 2 pt. or 4 pt. per acre assuming a price of \$36.00 per gal.

treatments involved planting into the previous year's cotton stubble after spraying Roundup® at 1 qt. per acre to kill emerged weeds. In-furrow insecticide, Temik 15G®, was used at either 3 lb. or 5 lb. per acre at planting. A hopper-box fungicide treatment of Apron® plus Terrachlor® was compared to Terrachlor Super-X® in-furrow fungicide. Finally, Cotoran 4L® herbicide was

TROPICAL CORN OFFERS NEW OPTIONS FOR CONSERVATION-TILLAGE

Many growers hesitate to use winter annual legumes in rotation with summer crops, because the expense of reseeding and killing legumes can outweigh the value of the nitrogen (N) these plants supply. However, conservation tillage systems utilizing new tropical corn hybrids may increase the advantages of using winter annual legumes.

Tropical corn is planted in late spring (mid-May to mid-June), which gives the legume time to mature, maximize N fixation, reseed, die, and dry down. In addition, N released by the legume also may be better utilized by tropical corn than by temperate corn because of the late planting date of tropical corn. Tropical corn, therefore, could utilize a higher percentage of N from the legume. Additionally, practicing conservation-tillage would allow the legume to reseed.

Research at the AAES studied N management of three tropical corn hybrids (Dekalb 678C, Pioneer 304C, and Pioneer 3072) in a conservation-tillage system following reseeded crimson clover or winter fallow.

Nitrogen rates ranged from 0 to 180 lb. of N per acre. Tibbee crimson clover was seeded at the Sand Mountain Substation, Crossville, and at the E.V. Smith Research Center, Shorter, in October 1988. It has naturally reseeded every year since then. The rows were subsoiled, leaving clover residue in the row middles. Tropical corn hybrids were then planted into the residue.

Weather and insect problems affected yields at both locations during some years. However, the benefits provided by the clover mulch were evident in both grain and silage yields. Acceptable grain and silage yields were produced with as little as 45 lb. N per acre. In the fallow system, 180 lb. of N per acre were needed to produce a comparable yield.

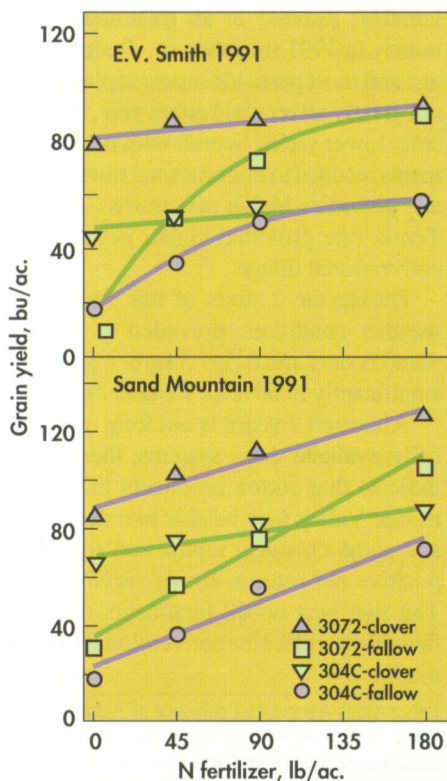
Severe drought and heavy infestations of fall armyworm caused crop failures at both locations in 1990. The only yield determined was for silage at Sand Mountain. The clover system increased silage yield 2.3 tons per acre (from 11.9 tons per acre following fallow to 14.2 tons per acre following clover). This higher yield was likely the result of improved soil moisture under the clover system.

In 1991, Pioneer hybrid 3072 replaced Dekalb hybrid 678C because it was identified as a top grain producer, while the other hybrids are better adapted for silage. Silage production for both hybrids was similar (25 tons at Sand Mountain and 19 tons at E.V. Smith), but Pioneer 3072 had a higher grain yield potential than 304C (see figure).

Reseeded crimson clover resulted in grain yield increases for both hybrids that ranged from 32 to 69%. The response of Pioneer hybrid 3072 to the cover crop was greater than that of Pioneer hybrid 304C. At both locations, 45 lb. of N per acre following



Crimson clover reseeds into tropical corn.



Grain yield response of tropical corn hybrids to applied N as affected by cover crop.

clover produced equivalent or greater grain yields than the 180 lb. of N per acre following fallow. Silage yield following clover was similar for both hybrids. Yield increased from 18.8 to 19.1 tons per acre at E.V. Smith and from 23.3 to 25.9 tons per acre at Sand Mountain when N rates were increased from 45 to 180 lb. per acre. Following winter fallow, however, silage production increased 35% at both sites when N fertilizer was increased from 45 to 180 lb. N per acre.

Although spring planted corn, when planted on time, generally yields better than tropical corn, it cannot fully utilize the benefits provided by winter annual legumes. Using tropical corn-clover systems, however, allows the initial seed cost of crimson clover (\$18 per acre) to be quickly offset by savings in N fertilizer. Improved soil moisture and reduced erosion are added benefits.

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FUSARIUM-RESISTANT WATERMELON DEVELOPED IN AAES RESEARCH

Plant breeders at the AAES have released new shipping-type watermelons that are resistant to *Fusarium* wilt, a fungus-associated disease responsible for severe production losses in Alabama.

The only practical way to control *Fusarium* wilt is by using watermelon varieties inherently resistant to the disease. Several resistant varieties have been developed for the Southeast, but most are resistant to only one race of *Fusarium*, not acceptable for shipping, or poorly adapted to local production areas. AAES-supported research has resulted in the development of several new varieties that overcome most or all of these problems.

Researchers surveyed watermelon germplasm and found several melons that were highly resistant to the two types of *Fusarium* wilt found in Alabama — *Fusarium oxysporum* races 0 and 1. These melons were selected as parents for a breeding program to incorporate resistance to the disease into commercial shipping watermelons. Other goals were to produce a

melon with desirable horticultural traits and with resistance to the foliar diseases anthracnose and gummy stem blight.

Plant breeders, with assistance from Auburn plant pathologists, have released four new shipping-type watermelons to date. First was AU-Producer, which is resistant to *Fusarium* races 0 and 1. It is now grown commercially throughout the world. AU-Jubilant, the second variety, is resistant only to race 0. Two subsequently released varieties are highly resistant to both races. These are AU-Golden Producer, which has yellow-orange flesh; and AU-Sweet Scarlet, which has intense, dark red flesh.

Fusarium wilt, a vascular disease caused by a soil-inhabiting fungus, is the most serious soilborne disease in watermelons. *Fusarium* can survive in the soil for years, or it can be seedborne. It enters the plant by infecting the roots during any stage of growth.



Heavy soil infestation of *Fusarium* may result in plant death before the emergence of seedlings, or it can cause young plants to develop rot and wilt with little evidence of stem injury.

On older plants, the first visible sign of *Fusarium* is a wilting or yellowing of leaves on the lateral runners. Wilting occurs rapidly; at first, only a single runner may be affected, but the entire plant eventually dies. Rotten spots appear on one side of the affected stem near the ground and extend as long, narrow, brown streaks. Infected plants are usually stunted.

The new, highly resistant varieties and breeding lines of watermelons were grown in *Fusarium*-infested soil in the South and in production areas worldwide, and they exhibited resistance against the disease.

Norton is Professor, Boyhan is Senior Research Associate, Abrahams is Technician, and Huang is Research Assistant of Horticulture.

Top of page: Fusarium wilt. From left to right below: AU-Producer, AU-Jubilant, AU-Golden Producer, AU-Sweet Scarlet

DISEASE INJURY, YIELD, AND FRUIT CHARACTERISTICS OF VARIETIES OF WATERMELON, FOUR ALABAMA LOCATIONS, 1988-1992

Variety	Disease index ¹			Yield	Fruit weight		Soluble solids ²	Quality of preference ³	Days to maturity	Flesh color
	Anthracnose	Fusarium wilt	Gummy stem blight		Lb.	Lb.				
						Pct.				
Charleston Gray	5	3	5	34,820	19.2	10.0	7.3	80	Red	
Crimson Sweet	5	2	5	31,031	18.2	10.7	8.0	75	Red	
Jubilee	5	3	5	33,830	22.2	9.9	7.9	90	Red	
AU-Producer	2	1	2	35,910	19.8	11.0	8.2	75	Red	
AU-Golden Producer ..	2	1	2	35,378	20.0	11.1	8.2	75	Yellow	
AU-Sweet Scarlet	2	1	2	29,208	19.6	11.4	9.0	75	Dark red	

¹Disease index: 0 = no injury to 5 = all plants diseased.

²Total soluble solids determined with Bausch and Lomb refractometer, 0.25% scale.

³Response index: 9-10 = excellent, 7-8 = good, 5-6 = acceptable, and below 5 = unacceptable.



BOTH FEED AND DAYLENGTH RESTRICTION ARE IMPORTANT IN RECYCLING LAYING HENS

After about 1 year, egg production by laying hens typically declines to nonprofitable levels. To prepare them for a second production cycle, hens are usually "recycled," a management technique that involves restricting feed intake and sometimes restricting exposure to light. AAES research suggests that combining these techniques may decrease the duration and increase the effectiveness of recycling programs.

During recycling, management techniques are designed to reduce body fat and weight, terminate egg production, cause the reproductive organs to regress, and force the birds to molt. These changes are generally stimulated by a period of fasting, followed by a period of limited feeding. When hens are ready to resume production, they are returned to free choice feeding with a layer diet, which stimulates regeneration of the reproductive organs and returns the hens to a high level of egg production.

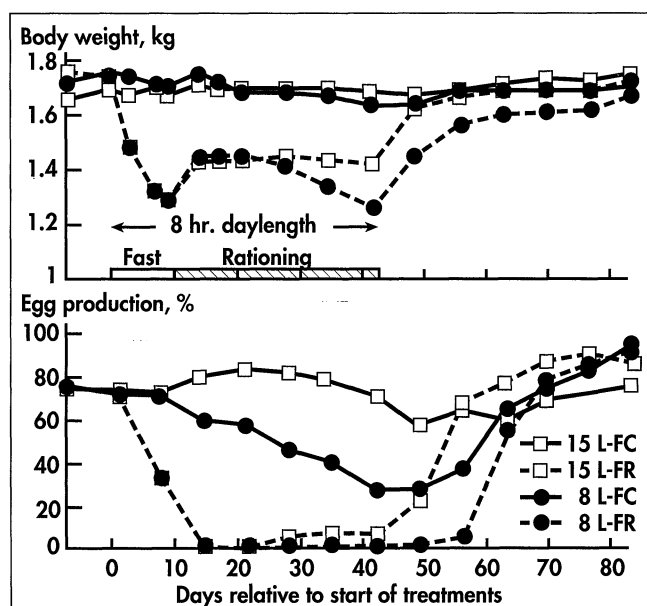
The AAES study evaluated the individual and combined effects of feed and daylength restriction on the recycling of laying hens. For the study, Single-Comb White Leghorn hens that had been in production for 37 weeks were placed on one of the following treatments: layer feed free choice and 15-hour daylengths for 84 days; layer feed free choice and 8-hour daylengths for 42 days, followed by 15-hour daylengths for 42 days; 15-hour daylengths while fasted for 9 days and then provided a ground corn ration (11 lb. per 100 birds per day) for 33 days, then returned to the layer feed free choice for 42 days; and the feed restriction program and 8-hour daylengths for 42 days, then returned to the layer ration free choice and 15-hour daylengths for 42 days.

Body weights of hens fed free choice remained constant regardless of daylength (see figure). Body weights of feed-restricted hens decreased markedly during fasting and increased moderately once ground corn

rationing was initiated at 10 days. Even though they received the same amount of ground corn daily, body weights of hens subjected to both 8-hour daylengths and feed restriction decreased during ground corn rationing, while body weights of hens subjected to feed restriction and 15-hour daylengths remained constant. This difference in body weights was maintained until 35 days after free choice feeding was reinitiated (day 77).

Egg production was terminated by 9 days of fasting (see figure). However, feed restricted hens subjected to 15-hour daylengths reinitiated production during ground corn rationing, while feed restricted hens subjected to 8-hour daylengths remained out of production. Egg production gradually declined in free-choice fed hens exposed to 8-hour daylengths. Egg production returned to high levels rapidly after the resumption of free choice feeding in hens subjected to 15-hour daylengths. High levels of production were attained more gradually in hens exposed to 8-hour daylengths, regardless of the feeding program used. At the end of the experiment, production by hens that had been exposed to 8-hour daylengths was greater than that of hens that remained on 15-hour daylengths.

Fat pad weights, an indication of body fat content, were progressively decreased by 9 days of 8-hour daylengths, 9 days of fasting, and 9 days of 8-hour daylengths and fasting combined. Fat pad weights recovered during the following 33 days, but the relationship between the treatments remained the same. Ovary and oviduct weights, which indicate



Effect of feed and daylength restriction on body weight and egg production of laying hens (15 L = 15 hr. daylength, 8L = 8 hr. daylength, FR = feed restriction, FC = free choice feeding).

the degree of regression of the reproductive system, were decreased to the same degree by 9 days of fasting, regardless of the daylength used. Ovary and oviduct weights and molting were not affected by 9 days of 8-hour daylengths.

Ovary and oviduct weights were decreased, and molting was stimulated to the same degree during either the 42 days of feed restriction or 8-hour daylengths. Ovary and oviduct weights were decreased, and molting was stimulated most markedly in hens that were simultaneously subjected to 42 days of feed restriction and 8-hour daylengths.

The combination of feed and daylength restriction rapidly and effectively terminated egg production, decreased body weight and fat, and stimulated reproductive organ regression and molting. In addition, egg production by hens subjected to daylength restriction increased most rapidly and attained the highest levels during the last week of the study. Therefore, these hens would be expected to have the best post-recycling production performance.

Lien is Assistant Professor and Roark is Research Technician of Poultry Science.

FERMENTATION OFFERS OPTION FOR HANDLING POULTRY CARCASSES

Every poultry production facility is faced with the reality of disposing of birds that die during the growout process. Disposing of these carcasses in a safe and cost efficient manner is becoming an increasingly critical management issue for producers, and now a fermentation technique may provide an effective on-farm management option.

Some 18 million broilers are processed weekly in Alabama, generating nearly 800 tons of dead poultry during the same time period. Such losses represent no greater than 5% total mortality during a 7-week growout period. Producers typically have

Recent AAES studies have explored the fermentation of poultry carcasses in an effort to develop a microbiologically and environmentally sound method for stabilizing the carcasses, allowing them to be stored on farm and subsequently transported to a rendering facility at the end of a 7-week growing cycle.

This research uses lactic acid fermentation, an age-old process, to preserve the carcasses. During fermentation, sugars are converted into organic acids, such as lactic acid, which lowers pH to below 4.5 and preserves the organic material. Fermentation is accomplished by combining ground carcasses with a fermentable carbohydrate,

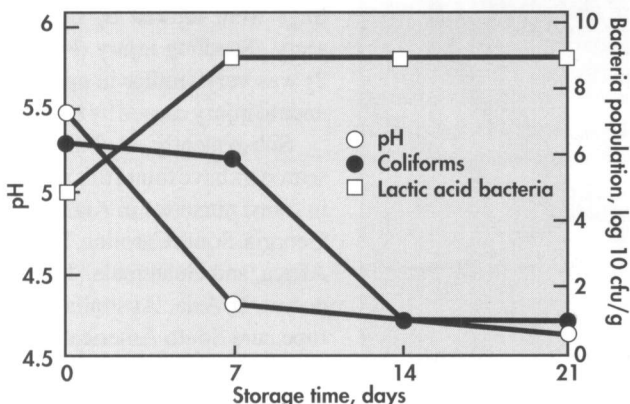


Fig. 1. Successful fermentation of poultry carcasses occurs when fermentable carbohydrates are converted into organic acids from increased lactic acid bacterial action, resulting in a decline of pH. Preservation of carcass nutrients occurs as coliform bacteria and pathogenic microorganisms are killed.

disposed of dead birds by burial or incineration. Concerns about the impact of burial on water quality and the high cost and inefficiency of incineration have caused producers to seek alternative methods of disposal.

Rendering the carcasses into a valuable protein byproduct meal that can be used in animal feed is one alternative, but this requires that the carcasses be transported to a rendering facility. The spread of pathogenic microorganisms during routine pickup and transportation of "fresh" (daily mortalities picked up off the floor) or frozen carcasses to the rendering site presents a substantial threat to biosecurity.

such as sugar, whey, or ground corn.

For the study, ground carcasses were combined with a carbohydrate source and layered into small sealed vessels for 5 consecutive days to simulate a continuous system that would be encountered on a commercial broiler farm. During 30 days of storage at temperatures of 35, 70, or 90°F, pH and populations of lactic acid bacteria and coliform bacteria were periodically determined.

Large batch studies involving 150 lb. of fermented material also were initiated and monitored for pH and microbiological parameters. Selected batches were rendered into a usable feed ingredient.

Results of this research indicate that the addition of at least 6% sugar, 8% whey, or 15% ground corn on a weight-to-weight basis promotes fermentation. These additions caused a decline in pH from 5.6 to a range of 4.2-4.5 within 7 days (Figure 1). Levels of lactic acid bacteria dramatically increased to suitable levels for the preservation of carcass nutrients within 10 days. Coliform bacteria and pathogenic microorganisms, such as *Salmonella*, were killed by the fermentation

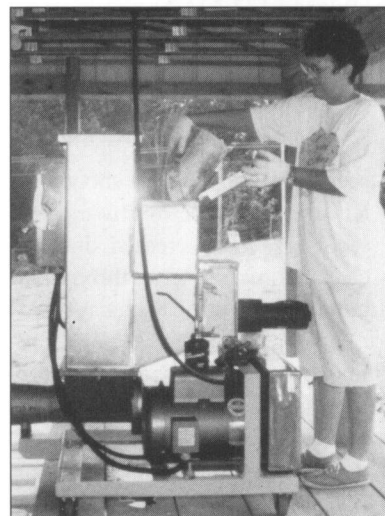


Fig. 2. On-farm fermentation system installed on a commercial broiler farm.

process. The results also indicated that carcasses can be fermented and stored on-farm for up to 10 weeks before being rendered into a usable feed ingredient.

Information from AAES studies has contributed to the construction of two on-farm fermentation facilities on 86,000 and 68,000-bird capacity broiler farms in northern Alabama (Figure 2). A specially designed grinding unit allows for the simultaneous addition of a carbohydrate source during carcass grinding. Each day, broiler mortalities are ground and ground corn is added at a level of 20%. The mixture is fed directly into an enclosed tank.

From both locations, the resulting ferment is transported for rendering at the end of a typical grow-out cycle (45-49 days later). More than 30,000 lb. of fermented carcasses have been processed into a suitable feed ingredient.

Based upon these studies, it appears that fermentation can be adapted for the stabilized, pathogen-free storage of broiler carcasses during a typical 7-week growout. Unlike routine pickup of "fresh" mortalities, fermentation and subsequent storage of dead poultry reduces transportation costs by 90% and eliminates the potential for transmission of pathogenic microorganisms via rendering products.

Blake and Conner are Assistant Professors of Poultry Science; Donald is Professor of Agricultural Engineering.

A NEW INSECT PEST OF PINE NURSERIES IDENTIFIED

The incidence of malformed pine seedlings with multiple shoots (often referred to as "bushy-topped" seedlings) has increased dramatically in forest nurseries throughout the South, with some nursery managers reporting up to 30% crop injury. AAES research indicates that a new pest, *Taylorilygus pallidulus* (T bug), may be responsible for some of this damage.

Although southern pine seedlings were injured as far south as Florida and as far north as Virginia, researchers at the AAES were the first to suspect that a plant bug (family Miridae) was causing the problem. However, it was initially believed that the tarnished plant bug (*Lygus lineolaris* or L bug) was the only insect causing the injury.

Caging studies had demonstrated that L bugs feeding on the terminals of young loblolly pine seedlings would result in malformed terminals and the subsequent development of multiple shoots. Trapping studies in forest nurseries found a correlation between the amount of injury and the number of L bugs caught. Therefore, as nursery managers began to apply insecticides to control L bugs, the percentage of trees damaged was dramatically reduced, but not eliminated.

The first recorded trapping of T bugs, which also are in the family Miridae, at a pine nursery occurred in 1987 at Carters Nursery in Georgia. White sticky traps (Rebell®) were distributed throughout the nursery and the number of plant bugs trapped was recorded several times a week. Adult L bugs ranged in color from yellowish-green or yellowish-brown to brown, while adult T bugs were green (Figure 1). At various times in May, June, and July, the number of T bugs equaled or exceeded that of L bugs. However, at that time there were no published reports of T bugs injuring pine seedlings. Since L bugs were known to cause injury to conifers, the presence of T bugs was considered of secondary importance until 1991, when T bugs were suspected of caus-

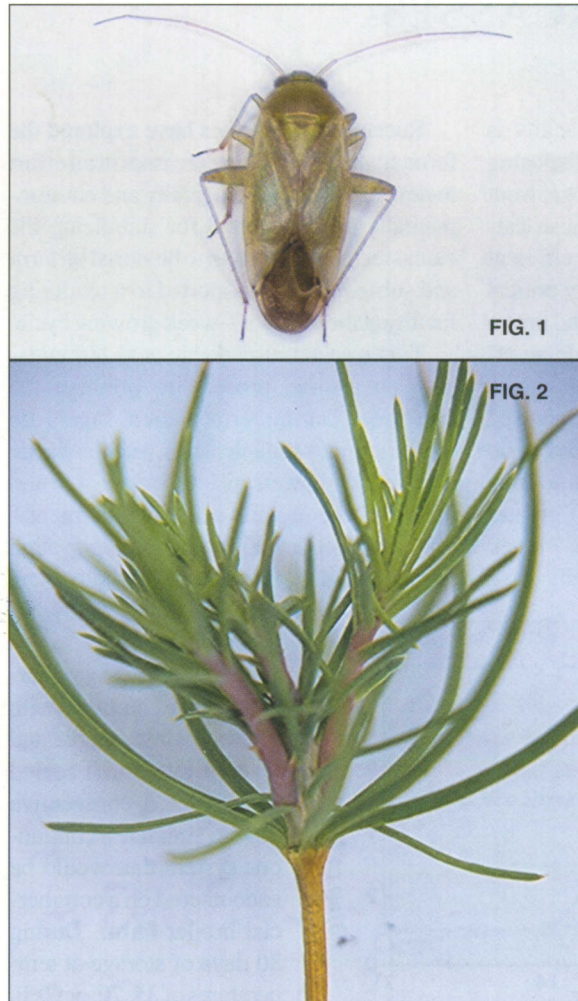


Fig. 1. T bug, or the plant bug *Taylorilygus pallidulus*, which prior to 1959, was called *Lygus apicalis*. Fig. 2. Shoot deformity resulting from T bug feeding on a young pine seedling.

researchers placed 35 adult T bugs along with newly germinated pine seedlings. A few days after the insects had been introduced into the cages, the growing tip on some seedlings died. Later, seedlings started sprouting multiple leaders with deformed needles. A total of 27% of the *Pinus pinaster* seedlings were injured by the insects. Seedling injury (Figure 2) was very similar in appearance to injury caused by L bugs.

Subsequently, Auburn researchers have found this insect in forest nurseries in Alabama, Georgia, South Carolina, South Africa, and Guatemala. It also occurs in Asia, Australia, Europe, and South America. It is therefore a potential pest of pine seedlings throughout the world.

ing bushy top symptoms in nurseries in South Africa.

A subsequent caging study by AAES

South is Associate Professor and Zwolinski is Post-Doctoral Fellow of Forestry.

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