

HIGHLIGHTS

OF AGRICULTURAL RESEARCH



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ON THE COVER. Business is booming at Auburn University's fee-fishing pond and live-fish market, especially after an advertising campaign that has increased sales up to 50%, see story on page 14.

DIRECTOR'S COMMENTS

The announcement recently by President Muse of the establishment of a Food Technology Institute at Auburn provides many challenges and opportunities for those of us in the Experiment Station.

The Food Technology Institute (FTI) is an association of scientists from the Colleges of Agriculture, Engineering, Sciences and Mathematics, and Veterinary Medicine and the School of Human Sciences. The FTI provides opportunities for research to improve food safety, develop value added products from Alabama-grown commodities, improve marketing strategies for food producers, and provide technical support for developing new food-related industries in the State.

In announcing establishment of the FTI, Dr. Muse noted that it has more potential to positively impact on the State's economy than any program currently underway at Auburn University. By developing new food industries that better utilize commodities produced in Alabama, the FTI can create many new jobs and generate millions of additional dollars of new income annually.

As the primary research component of the FTI, we in the Experiment Station are excited about the opportunities this new organization provides. It provides an ideal forum for research and extension—components of a land grant university like Auburn—to work together. The ultimate beneficiary of the FTI will be all the people of Alabama.

UPCOMING EVENTS

June 23	Horticulture Field Day, E.V. Smith Research, Shorter
July 1	Fruit and Vegetable Field Day, Chilton Area Horticulture Substation, Clanton
July 13-16	American Peanut Research and Education Society Meeting, Huntsville
July 22-24	Alabama Farmers Federation Commodity Conference, Birmingham
July 29	Cotton Field Day, Tennessee Valley Substation, Belle Mina
August 4	Agronomy Field Day, E.V. Smith Research Center, Shorter
August 12	Field Crops Field Day, Prattville Experiment Field
August 17	All Commodity Field Day, Sand Mountain Substation, Crossville
August 19	Horticulture Field Day, Piedmont Substation, Camp Hill

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EDITOR'S NOTE. Mention of trade names does not indicate endorsement by the Alabama Agricultural Experiment Station or Auburn University of one brand over another. Any use of pesticide rates in excess of labeled amounts in research reported does not constitute recommendation of such rate. Such use is simply part of the scientific investigation necessary to evaluate various materials. No chemical should be used at rates above those permitted by the label. Information contained herein is available to all persons without regard to race, color, sex, or national origin.

A CONSERVATION TILLAGE PRACTICE THAT RESISTS COMPACTION

Uncontrolled field traffic can cause hardpan formation which restricts root growth, thus reducing plant productivity. But cooperative AAES- U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) research indicates that using an in-row subsoiler in a conservation tillage practice can help avert soil compaction immediately beneath the row.

An experiment was conducted at the E.V. Smith Research Center, Shorter, to determine the effects of tillage and traffic treatments on physical condition of soil. For the study, intensive soil sampling was conducted at the conclusion of a five year wheat-cotton double cropping system.

A special research vehicle, the USDA-ARS Wide Frame Tractive Vehicle (WFTV), was used as a platform to conduct all operations. This vehicle allows for a 20-foot cropping zone (eight 30-inch rows) that can be kept free of traffic by farm equipment. A tractor was driven on plots designated for traffic to simulate equipment traffic from normal farming operations on both wheat and cotton.

Several different tillage treatments for cotton were used to determine the interaction of traffic with tillage systems. These treatments included:

- (1) CT-SS = conventional tillage with no subsoiling (disk, field cultivate, and plant);
- (2) CT+CD = conventional tillage with initial complete hardpan disruption (disk, field cultivate, and plant);
- (3) CT+SS = conventional tillage with in-row subsoiling (disk, field cultivate, in-row subsoil, and plant), and;
- (4) NT+SS = no-tillage with in-row subsoiling (in-row subsoil and plant).

Each tillage treatment had both traffic and no-traffic treatments.

Soil penetrometer readings were used to determine the depth to the hardpan. This measurement is important because it indicates the depth of effective crop rooting.

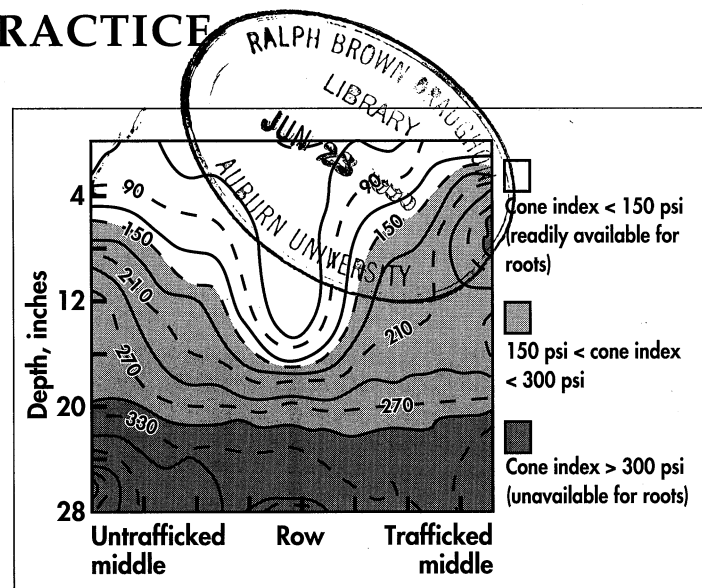
The soil condition resulting from years of continuous tillage and traction research

provided vital information about the damaging effects of traffic on soil that was conventionally farmed. In the conventional farming system without any deep tillage (CT-SS), traffic caused the depth to the hardpan to decrease by almost 22% and the cotton lint yield to decrease more than 14% (see table).

In the tillage treatment that was completely disrupted with a V-frame subsoiler at the beginning of the five-year study (CT+CD) traffic caused the depth to the hardpan to decrease by 35% and cotton lint yield to decrease by 14%. The benefits of complete disruption disappeared and this was the poorest yielding tillage treatment when traffic was not controlled.

When an in-row subsoiler was used with conventional tillage (CT+SS), traffic did not affect the depth to the hardpan, but decreased cotton lint yield by almost 9%.

With the NT+SS treatment, traffic actually had a positive effect providing a cotton yield increase of 2%. These plots were the most productive and had maximum yields of any in this experiment. Traffic negatively affected the depth to the hardpan slightly, but this was less than 5%. One reason that traffic was not detrimental in



Cone index contours for the NT + SS tillage treatment when traffic is applied to row middles.

the NT+SS treatment was that the soil structure was able to support the applied traffic loads and withstand the damaging effects of traffic. This is illustrated in the contour plot that shows a profile of the crop row and traffic path for tillage treatment NT+SS subjected to traffic (see figure). Even though traffic did compact the soil beneath the row middle, the in-row subsoiler provided adequate rooting depth beneath the row.

This experiment indicated that in conventional tillage systems that did not include an in-row subsoiler, traffic negatively affected both the depth to the hardpan and crop yields. However, when the conservation tillage practice of in-row subsoiling was used, the resulting soil structure allowed the soil to withstand the detrimental effects of traffic. Though farmers don't have WFTVs, they can control the negative effects of traffic and maintain surface residue cover by combining conservation tillage with an in-row subsoiler.

DEPTH TO HARDPAN AND 1991 COTTON LINT YIELD AS AFFECTED BY TRAFFIC AND TILLAGE TREATMENTS		
Treatments	Depth to hardpan	Cotton lint yield
	<i>In.</i>	<i>Lb./a.</i>
No Traffic		
CT-SS	9.1	955
CT+CD	11.0	912
CT+SS	14.6	872
NT+SS	16.9	957
Traffic		
CT-SS	7.1	815
CT+CD	7.1	786
CT+SS	14.6	794
NT+SS	16.1	978

Raper is Adjunct Assistant Professor of Agricultural Engineering and Agricultural Engineer with the USDA-ARS-National Soil Dynamics Laboratory (NSDL), Reeves is Adjunct Associate Professor of Agronomy and Soils and Research Agronomist with USDA-ARS-NSDL, Burt is Adjunct Professor of Agricultural Engineering and Research Leader with USDA-ARS-NSDL, and Torbert is Soil Scientist, USDA-ARS, Temple, Tex .

PINE SEEDLINGS MEASURED WITH A LOW COST MACHINE VISION SYSTEM

More than 1.5 billion pine seedlings are planted in the South every year. The success of forest regeneration activities is strongly influenced by seedling quality. Better quality seedlings tend to have higher survival and growth rates. AAES research may soon provide a fast, economical way to assess seedling quality.

Quality is usually assessed by evaluating morphological properties, such as root collar diameter and shoot height. However, typical forest nurseries bundle and ship up to several hundred thousand seedlings per day, making quality assessment of every seedling impractical. Nurseries therefore use sampling techniques to monitor seedling quality, but the measurement of large numbers of seedlings is still required. Research on seedling quality improvement also involves the measurement of large numbers of seedlings.

Measuring seedlings by hand is slow and subject to measurement and recording errors. Available electronic measurement methods are either destructive or nearly as slow as manual measurements because extensive operator input is required for every seedling measured. AAES investigators have developed a low-cost machine vision system to quickly measure and record pine seedling properties.

The PC-based system, which uses Charge-Coupled-Device (CCD) video cameras and digital image processing techniques, relies on backlighting and manual seedling placement in a specified location to simplify image processing requirements. An important feature of the system is the use of multiple cameras to maximize resolutions for different seedling parts. The system measures root collar diameter, shoot height, and shoot and root projected areas. Seedling measurements are acquired and automatically recorded with a single flip of a switch.

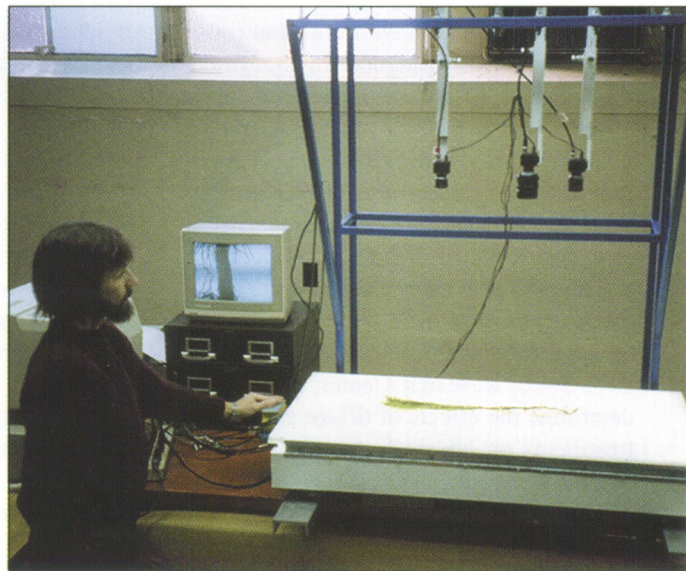
Tests were conducted with both two-camera and three-camera configurations of the system. The two-camera configuration

had one camera focused on the root collar area, while the other camera had a field of view encompassing the entire seedling. The three-camera configuration had one camera focused on the root collar area, one on the shoot area, and one on the root area. This configuration gives higher image resolutions for the shoot and root projected area measurements. Tests evaluated how well machine vision measurements of root collar diameter and height compared to manual measurements and how well machine vision projected area measurements compared to dry weights and to projected area measurements obtained destructively with an infrared line-scan device.

For the manual comparison tests, each seedling was measured by two persons so that the variability inherent in manual measurements could be assessed. Root collar diameter and height results showed good agreement between machine vision and manual measurements. Variability for machine vision measurements compared to manual measurements was no greater than variability for manual measurements compared to each other.

Projected area measurements, which cannot be measured by hand, are of interest because of their potential for predicting weight, surface area, and volume. Machine vision shoot and root projected area measurements were moderately correlated to dry weight measurements. The line scan device, or area meter, was used as an independent standard to assess the accuracy of the machine vision projected area measurements. Machine vision and area meter projected area measurements were highly correlated.

The two-camera system had a much shorter cycle time than the three-camera



PC-based machine vision system for measuring pine seedlings.

system (about six seconds per seedling versus 18 seconds per seedling), but both of these cycle times can be reduced substantially by upgrading the microprocessor used in this study. A fast cycle time is desirable for making measurements on a large number of seedlings, but manual seedling placement will require at least a few seconds for each seedling, so there is a limit to how rapid the cycle time can be.

The higher resolution of the three-camera configuration did not improve the accuracy of projected area measurements as expected, although it is difficult to make a direct comparison because separate tests were conducted with each configuration. For seedling measurements in a nursery production setting, the two-camera configuration may be better because of its simplicity and speed. For research purposes, there may be additional measurement requirements, especially related to roots, that can be met with a three-camera configuration.

This study demonstrated the feasibility of rapidly measuring pine seedling morphological properties using low-cost machine vision technology.

Wilhoit and Kutz are Assistant Professors and Fly is former Research Graduate Assistant of Agricultural Engineering; South is Associate Professor of Forestry.

PUBLIC OPINIONS — PRIVATE FORESTS

Perceived environmental effects are the litmus test for public approval of forestry practices, according to an AAES study funded partly by the Alabama Universities/Tennessee Valley Authority Research Consortium. A statewide telephone survey of 1,007 randomly selected households indicated that Alabamians — those who own forests and those who do not — care about environmental conservation.

Perhaps the most hotly debated issue in forest management is the tradeoff between environmental protection and private property rights. The study indicated that most Alabamians want a balance of these values, but one that favors the environment.

Fully 84% agreed with the statement, “Private property rights are important, but only if they don’t hurt the environment.” A majority supported government regulations to protect natural beauty, streams and wetlands, and threatened and endangered species. Most of the forest owners interviewed supported regulations to protect wetlands and endangered species. However, strong majorities also supported compensation for forest owners when regulations cause them to lose money.

The survey further indicated that much of the public accepts cutting trees as a necessary forest management practice. Seventy-two percent agreed that “Trees are like any other crop, and they should be cut and replanted to provide consumer products.” Moreover, 55% felt that the amount of tree cutting in their area is “about right.”

This apparent acceptance is conditional, however, upon the lack of adverse environmental effects. A central concern for the environment appears to drive opinions about timber harvesting and other forest management practices.

Clearcutting remains a contested practice, with slightly over half the public approving its use on private lands. Similarly, half approved of the use of prescribed fire to control competing vegetation on private

land. In contrast, chemical weed control, although long used in agriculture, has yet to win widespread public acceptance for forest management. Only 33% agreed with the practice.

Those who oppose clear-cutting, prescribed burning, and chemical weed control base their opposition on the perception that the practices destroy wildlife, deplete dwindling resources, or have other negative environmental consequences.

Unfamiliarity with forests and the environmental effects of management activities likely caused at least some of this disapproval. For example, although Alabama forest acreage increased dramatically over the past 50 years, 77% believe forest land decreased over that time.

Asked how often landowners spray pine forests with chemicals, 61% said they did not know, and 26% think spraying is done at least yearly. In fact, the most intensively managed pine plantations in the South are sprayed at most three times during their entire lifetime of about 35 years.

Although most respondents were not well informed about forestry, they were fairly educated; 85% completed high school, and half had some college training. Respondents were from all walks of life, including professionals, managers, entrepreneurs, and others. Opinions were based not only on a limited knowledge of forestry, but also on



Fully 84% agreed with the statement, “Private property rights are important, but only if they don’t hurt the environment.”

personal observations, expertise in other areas, and news coverage of environmental issues.

Forestry professionals may find in these results a valuable lesson: forestry activities perceived to protect or enhance the environment are likely to enjoy public approval. Both the public and forest owners are likely to disapprove of practices that do not match this perception. The profession faces dual challenges: to continue to develop environmentally friendly management methods and to educate a skeptical public.

Bliss is Assistant Professor of Forestry.

IMMUNE STATUS OF CHILDREN WITH PHENYLKETONURIA

Infants born in hospitals throughout Alabama and the U.S. have their heels pricked about 72 hours after birth to obtain a blood sample that is tested for the presence of an inherited disorder called phenylketonuria or PKU. PKU is a lifetime condition in which the ability of the body to breakdown phenylalanine, an amino acid found in protein, is impaired. The incidence of PKU in the United States is about one in 12,000.

If not treated, PKU results in severe mental retardation, but if diagnosed and treated with diet therapy, there are no harmful effects. Infants diagnosed with PKU are put on a diet that restricts phenylalanine intake. Infants and children with PKU must avoid high-protein foods such as milk, eggs, cheese, yogurt, meat, fish, and poultry, and must limit their intakes of other foods containing protein such as breads, grains, pastas, and vegetables. Thus, simple food combinations such as cereal with milk, or a sandwich with peanut butter, cheese, or lunch meats cannot be consumed.

Specially designed formulas referred to as medical foods provide infants and children with the majority of their daily needs for protein, vitamins, and minerals. Diets of children with PKU are very restrictive in

the choices of foods allowed, and often as the children get older compliance with the diet diminishes, resulting in higher plasma phenylalanine concentrations. Adherence to the diet, however, can also lead to impaired mineral status and alterations in plasma amino acid concentrations.

Deficiencies of amino acids such as phenylalanine and tyrosine, minerals such as iron, selenium, and zinc, and other nutrients diminish immune system function. For example, nutrient deficiencies can result in decreased production or function of: (1) antibodies that help destroy foreign substances in the body; (2) complement, a group of proteins that work with antibodies to destroy foreign substances in the body; (3) interleukins that influence blood cell function and ultimately antibody production; and (4) white blood cells that can directly kill or assist in the destruction of foreign substances. Children with PKU may be at risk for impaired immune system function because of the PKU condition itself or because of the diet therapy used to treat PKU. Investigators at the AAES have begun to assess selected aspects of immune system functioning in children with PKU on diet therapy.

Twenty-two children with PKU were re-

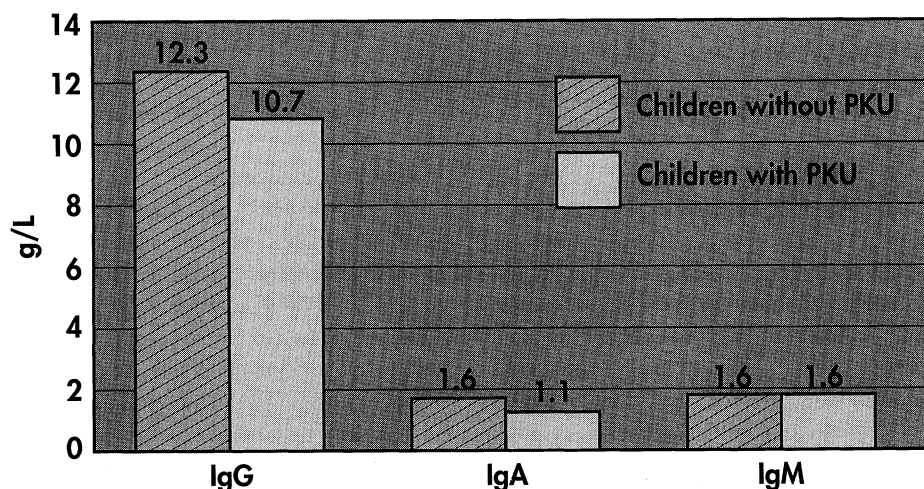
cruited from four centers that treat PKU in the United States. Blood samples were obtained from each child to examine cellular and humoral immune system function. Researchers measured white blood cell numbers and concentrations to examine cellular immunity, as well as concentrations of antibodies, complement, and other proteins involved in humoral immune function.

Immunological data of PKU children who were maintaining normal plasma phenylalanine concentrations were compared with those children with PKU who were not adhering to diet and thus had relatively high plasma phenylalanine concentrations. Data from children with PKU were compared with published data from age-matched children without PKU. While no differences in immune status were observed between children maintaining normal versus high plasma phenylalanine concentrations, as a group children with PKU had lower concentrations of certain antibodies than children without PKU (see figure).

No significant differences in plasma concentrations of other antibodies, complement, and white blood cells were found between children with and without PKU nor within children with PKU with differing plasma phenylalanine concentrations. No correlations were found between plasma phenylalanine concentrations and immunological parameters.

Results of this research suggest that moderate differences in plasma phenylalanine concentrations do not appear to affect selected immune system parameters. This does not mean that it is safe to exceed the recommended maintenance of plasma phenylalanine concentrations, since plasma phenylalanine concentrations in excess of normal ranges can lead to declines in arithmetic, language, and perceptual skills; shortened attention span; impaired short-term memory; and visual motor perception and motor coordination problems. Further studies are needed to investigate causes for lower than normal concentrations of antibodies in children with PKU, as well as causes for impaired nutrient status of children with PKU on diet therapy.

Gropper is Assistant Professor and Chaung is former Graduate Research Assistant of Nutrition and Food Science (now Associate Professor of Veterinary Medicine, National Ping-Tung Institute of Agriculture, Taiwan).



Concentration of three major antibodies (IgG, IgA, IgM) in children with and without PKU.

INTEGRATED PEST MANAGEMENT EFFECTIVELY CONTROLS SMOKYBROWN COCKROACHES

The smokybrown cockroach is a common insect around homes in Alabama. Control of this insect takes many forms, including the use of insecticidal sprays by homeowners and professionals. Indoor insecticidal sprays used by homeowners do not effectively reduce abundance of cockroaches, because cockroaches residing outdoors will reinvade when the chemicals dissipate.

AAES research explored options for outdoor control of the smokybrown cockroach. These studies focused on improving management strategies, based on the insect's behavior, that provide effective control yet reduce insecticide use.

Two outdoor trials were conducted to evaluate the efficacy of two different management strategies in 18 homes in Auburn during the summer of 1992. Three experimental treatments were used: a no-management control, a perimeter spray, and an integrated pest management (IPM) approach.

The perimeter treatment consisted of spraying insecticide three feet up from the base of the house and 10 feet out into the yard with a power sprayer. The spray was a wettable-powder formulation of chlorpyrifos at the rate of five ounces of active

ingredient per 100 gallons of water. This is one approach used by professional pest control operators in Alabama.

The IPM treatment combined two tactics: applying an insecticidal spray to crevices around the outside of homes and removing litter and debris from within a foot of the house to remove cockroach habitats. Crushed gravel was used near the homes to replace the debris. After application of treatments, cockroaches were sampled weekly at each house to assess changes in their abundance.

Cockroach abundance was reduced approximately 40% in the first trial with no difference noted between the IPM and perimeter treatments (see figure). However the IPM treatment was safer and less expensive because it reduced chemical usage by 75%.

In the second trial, the rate of chlorpyrifos in the perimeter treatment was increased to the mid-range of recommended rates, eight ounces per 100 gallons of water. Three additional tactics were included in the IPM treatment. The first additional tactic was an application of a pelletized ant-and-cockroach bait containing 0.5% chlorpyrifos, which was applied within three feet of homes with pine straw, fallen leaves, or ivy, and next to other cockroach habitats, such as garden borders, large rocks, or railroad

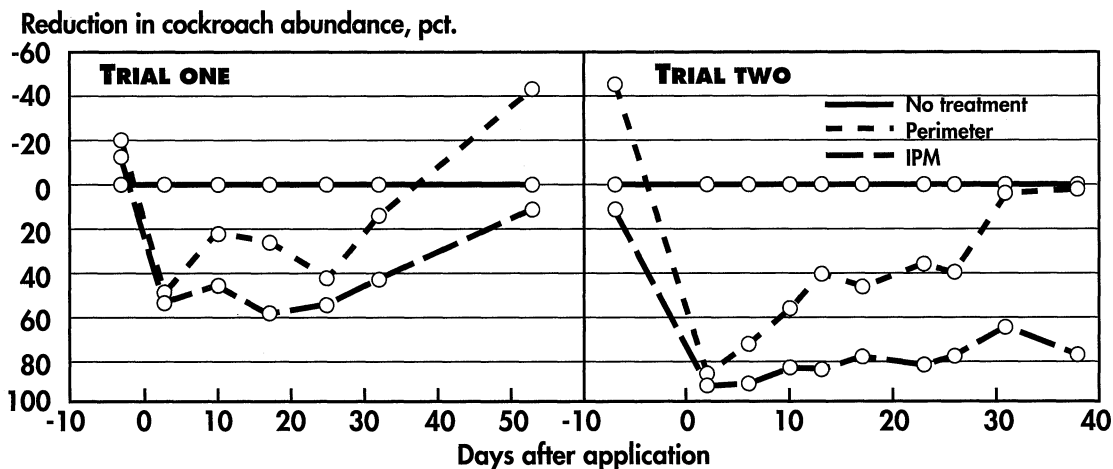
ties. The second tactic added was the application of a gel bait containing 2% hydramethylnon, which was applied in sheltered crevices, such as in porch corners, under ledges, in crawl space gratings, and under garage doors. The third tactic was the release of insecticidal smoke in out-buildings and crawl spaces. The smoke contained 12.5% permethrin.

More than 80% reduction in cockroach abundance was achieved in the second trial, nearly twice as much as in the first trial. In addition, the IPM treatment reduced abundance longer than the perimeter treatment (see figure). The IPM treatment maintained cockroach populations below those in the perimeter treatment for the duration of the trial, using only one-fourth of the insecticide of the perimeter treatment.

This second IPM approach proved effective because it took advantage of several aspects of cockroach behavior. Insecticidal sprays and the insecticidal smoke kill cockroaches where they hide during the day. Pelletized and gel baits attract hungry cockroaches to feed on insecticide in their normal feeding areas, close to where they hide. Finally, removal of litter reduces hiding places next to the base of homes and reduces cockroach activity near doors and other entrances. By targeting management tactics

at cockroaches where they hide and forage, use of insecticide can be decreased and cockroach control can be maintained for a longer period than by employing a standard perimeter spray. Thus, the IPM treatment appears to be an effective, safe, and economical way to manage outdoor cockroaches.

Smith is Post Doctoral Fellow, Appel and Mack are Associate Professors, and Benson is Assistant Professor of Entomology; Keever is Associate Professor of Horticulture.



Reductions in cockroach numbers for each trial.

GRANULAR INSECTICIDES HARMFUL TO BENEFICIAL ARTHROPODS IN PEANUTS

Lesser cornstalk borers can reduce peanut yield and quality, especially in hot, dry weather, when population outbreaks are likely to occur. Recent AAES research indicates that insecticides applied too early may lose effectiveness before outbreaks occur, and may have a double negative impact by killing off beneficial insects that prey on lesser cornstalk borers.

In AAES research, granular insecticides were especially damaging to beneficial arthropods such as striped earwigs and fire ants that live on the soil surface, where the granules are applied. It is important to maintain an abundance of beneficial arthropods in peanut fields because they provide cheap and effective control of many insect pests, including lesser cornstalk borers. Destroying beneficials also increases the abundance of some insect pests in other crops.

Field experiments were done at the Wiregrass Substation, Headland. Sun-runner peanut seeds were conventionally planted in a Dothan sandy loam soil, using a randomized complete block design in both years, with four replicates of five treatments and a nontreated control. Plot size was eight rows wide by 50 feet long. Herbicides and fungicides were applied according to Alabama Cooperative Extension Service recommendations. Insecticides used were Lorsban 15®G at two pounds of active ingredient (a.i.) per acre, Mocap® 15G at three pounds of a.i. per acre, Dyfonate®

10G at two pounds of a.i. per acre, Fortress® 10G at one-half pound of a.i. per acre, Counter® 15G at two pounds of a.i. per acre, and a nontreated control. Treatments were applied at peanut flowering with a small-plot granular applicator.

Pitfall traps were used to sample for arthropods that live on the soil surface. Pitfall traps were used because granular insecticides remain on the soil surface, so their greatest effects should be on arthropods that live and crawl on the surface of the soil. Each trap was composed of two plastic drinking cups that were buried to their tops in the soil, filled one-third full with antifreeze, and covered with a 12-inch aluminum pie plate held above the ground with nails. The pie plate was hung over the traps to deflect water. Traps were monitored weekly for at least seven weeks after application. Contents of traps were removed, returned to the laboratory, and identified.

Applications of granular insecticides had very transitory effects on insect pests such as the corn earworm and fall armyworm. The applications had no effect on beneficial arthropods such as bigeyed bugs and spiders that inhabit the foliage (Table 1).

Predators such as striped earwigs and red imported fire ants were the most abundant beneficial insects. Abundance of these predators declined in some treated plots for



Pesticide programs designed to kill harmful insects, such as this adult male lesser cornstalk borer, can also kill beneficial insects.

as long as one month, which would increase the probability of economic damage from insect pests such as the lesser cornstalk borer (Table 2).

A potentially serious result of applying a granular insecticide to peanuts is the reduced abundance of fire ants and striped earwigs. These two predators were the most abundant arthropods sampled, so the negative effects of granular insecticides could increase the probability of economic damage from lesser cornstalk borers and other insect pests. These results underscore the need for timely applications of insecticides based on scouting.

Mack is Associate Professor of Entomology.

TABLE 1. ABUNDANCE OF SELECTED PREDATORS BY TREATMENT COMBINED OVER ALL SAMPLE DATES, 1990

Insecticide	Imported fire ants ¹	Bigeyed bugs	Spider (canopy) ²	Spider (soil-dwelling) ¹	Ground beetles ¹
Nontreated	20.8	0.8	0.2	1.7	3.9
Lorsban	4.2	.6	.2	1.2	4.3
Mocap	7.3	1.3	.1	1.3	4.4
Dyfonate	9.6	1.0	.3	1.7	4.5
Fortress	8.8	1.1	.3	1.7	5.2
Counter	12.0	.6	.4	1.0	4.5

¹Number per trap per week from pitfall traps.

²Number per six row-feet per week, from beat sheets.

TABLE 2. ABUNDANCE OF STRIPED EARWIGS FOR 35 DAYS AFTER TREATMENT ON JULY 5, 1990

Insecticide	Days after treatment				
	5	12	19	28	35
Nontreated	14.9	8.6	23.0	112.5	100.5
Lorsban	3.9	4.1	13.1	89.4	102.6
Mocap	2.9	5.3	20.3	90.9	135.1
Dyfonate	5.4	6.6	25.5	97.9	133.1
Fortress	1.5	6.9	36.8	101.9	132.1
Counter6	2.1	10.8	89.0	130.9

MATTED ROW STRAWBERRY VARIETY PERFORMANCE IN CENTRAL AND NORTH ALABAMA



Selecting the best performing variety is crucial to the success of a commercial strawberry operation. Although many varieties are available, only a few will provide high yields and superior fruit quality.

While the economics of successful production make high yields a primary consideration when selecting varieties, additional fruit quality characteristics must be considered in the final decision. Other criteria include consistency of annual cropping, vigor, runner-making ability, disease resistance, and other plant performance factors; as well as berry size, firmness, sugar content, flavor, and other fruit quality characteristics.

Varieties are categorized as early-, mid-, or late-season in ripening. Differences in the first harvest date usually do not vary greatly among varieties. The greatest difference in ripening is the time of peak harvest, which may vary seven to 10 days between the earliest and latest ripening varieties. In some years the difference in the ripening seasons may be short and peak harvest seasons of the varieties overlap.

Strawberry variety trials were conducted at the Chilton Area Horticulture Substation (CAHS) in Thorsby, North Alabama Hor-

ticulture Substation (NAHS) in Cullman, and Tennessee Valley Substation (TVS) in Belle Mina.

In the first experiment, 21 varieties were planted at the NAHS and TVS. In a second, 16 varieties were planted at the CAHS and TVS. In a third test, 23 varieties were planted at the CAHS.

The varieties evaluated were Earlibelle, Sunrise, Earliglow, Titan, Prelude, Surecrop, Pocahontas, Scott, Cardinal, Ark6086, Allstar, Atlas, Douglas, Parajo, Vista, Rosanne, Sentinel, Ark6686, Arking, Delite, Tennessee Beauty, Redchief, Tioga,

Albritton, Apollo, Chandler, Aiko, Guardian, Honeyoye, Lester, Sequoia, Lateglow, and Marlate.

Large seasonal and location fluctuations were seen in many important performance characteristics, such as yield and berry size. The seven overall best varieties were Earliglow, Sunrise, Titan, Allstar, Cardinal, Scott, and Delite (see table).

Several top-yielding varieties were not in the top seven due to additional undesirable traits. For example, Tennessee Beauty has a relatively soft, small berry and average dessert and processing quality. Apollo produces sterile pollen and variable yields, as well as being drought susceptible. Alternatively, some average-yielding varieties, such as Earliglow, are listed because of other characteristics, such as earliness and exceptionally good flavor and processing quality for freezing.

More detailed information concerning the 33 varieties tested in this study is presented in AAES Bulletin 619, "Performance of Strawberry Cultivars in Central and North Alabama Grown on the Matted Row System."

Himelrick is Associate Professor, Dozier is Professor, and Caylor is Research Specialist of Horticulture; Pitts, Hollingsworth, and Webster are Superintendents of the Chilton Area Horticulture, North Alabama Horticulture, and Tennessee Valley substations, respectively.

TOP PERFORMING STRAWBERRY VARIETIES AVERAGED OVER SEVEN YEARS AND THREE LOCATIONS

Variety ¹	Total yield	Harvest season	Average fruit weight	Percent soluble solids ³	Berry firmness ⁴	Degree exterior color ⁵	Degree interior color
	<i>Lb./a.</i>		<i>Grams²</i>				
Earliglow	7,170	Early	6.9	8.1	8.0	4.5	4.2
Titan	8,761	Early	9.8	7.2	7.3	4.2	3.6
Sunrise	8,439	Early	9.0	7.3	7.7	4.2	3.7
Allstar	8,806	Mid	10.2	6.9	9.0	3.6	2.5
Cardinal	8,302	Mid	10.2	7.2	8.0	4.5	4.1
Scott	9,582	Mid	9.2	7.2	8.7	4.4	4.1
Delite	10,040	Late	10.0	6.4	7.9	3.9	2.7

¹Listed in order of ripening.

²One ounce equals 29 grams.

³The higher the percent of soluble solids, the sweeter the berry.

⁴Firmness rating: 1 = very soft, 10 = very firm.

⁵Degree of color: 1 = green, 5 = dark red.

CAN SOLID WASTE BECOME A RESOURCE INSTEAD OF A LIABILITY?

The U.S. discards approximately 200 million tons of municipal solid waste (MSW) each year, creating many disposal problems. Auburn University and Tennessee Valley Authority (TVA) researchers have demonstrated a promising method of recycling MSW into a valuable raw material that can be used to produce biodegradable plastic.

Landfills and incinerators are now the primary means of MSW disposal, but they may cause water and air pollution. And while MSW production is increasing, the capacity to handle it is decreasing.

Many landfills and incinerators have been closed, and sites for new disposal facilities are often difficult to locate. Recycling is one of the most promising ways to manage MSW and reduce its environmental impact.

Newsprint, wood, cardboard, and yard waste — which comprise 56% of all MSW — are primarily made of plant fibers called cellulose, a network of

thousands of simple sugar units. These wastes can be broken down into individual sugar units, chiefly glucose and mannose, using sulfuric acid. The sugars can be fermented by microorganisms to produce a variety of fuels and chemicals. Microbial fermentation has been used for many years to produce ethanol from the glucose found in corn.

Recently, a 100% biodegradable plastic was manufactured from lactic acid and ap-

proved for use by the Food and Drug Administration. This product may replace some of the 15 million tons of conventional plastic used in the U.S. every year. This development has stimulated interest in producing large quantities of inexpensive lactic acid. MSW could provide a low-cost source of sugars for lactic acid production, in addition to reducing the volume of waste in landfills.

AU and TVA researchers are developing the technology to use microorganisms to convert MSW to lactic acid. The waste used in these experiments was newsprint that had been treated with 2% sulfuric acid at 250°F causing the paper to break down (hydrolyze) into its component sugars, yielding 4.1% sugar.

Since the hydrolyzate may contain compounds harmful to lactic acid-producing bacteria, it is treated with calcium hydroxide and filtered. Nitrogen supplements, which the bacteria require for growth, also are added.

An evaluation of eight types of bacteria showed that one in particular had the potential to produce high levels of lactic acid from MSW (Table 1). Culture *L. pentosus* 227 produced 0.187 pound of lactic acid from one gallon of hydrolyzate (2.24 grams per 100 milliliters).

To further improve the ability of the culture to produce lactic acid, the sugar concentration of the MSW hydrolyzate was increased to 8.2% and the hydrolyzate was buffered by adding 5% calcium carbonate. Since lactic acid is produced from sugar, the increased sugar should improve lactic acid production. The higher buffer capacity should help alleviate inhibition of lactic

TABLE 1. EVALUATION OF *LACTOBACILLUS* CULTURES FOR PRODUCTION OF LACTIC ACID FROM MSW¹

Bacteria evaluated	Sugar used	Lactic acid produced	Sugar to lactic acid conversion
	g/100 mL ²	g/100 mL ²	Pct.
<i>L. arabinosus</i> 787	3.04	1.86	61
<i>L. arabinosus</i> 788	3.01	1.82	60
<i>L. arabinosus</i> 813	3.33	1.70	51
<i>L. arabinosus</i> 531	3.18	1.67	52
<i>L. pentosus</i> 227	3.63	2.24	62
<i>L. pentosus</i> 473	3.84	1.93	50
<i>L. plantarum</i> 422	2.95	1.96	66
<i>L. xylosum</i> 4449	1.83	0.82	45

¹MSW hydrolyzate contained 4.1% total sugars and no added calcium carbonate.

²One pound equals 454 grams; one gallon equals 3,785 milliliters.

TABLE 2. OPTIMIZATION OF LACTIC ACID PRODUCTION CONDITIONS FOR CULTURE *L. PENTOSUS* 227¹

Fermentation time	Sugar used	Lactic acid produced	Sugar to lactic acid conversion
	g/100 mL ²	g/100 mL ²	Pct.
Days			
0	0	0	0
1	2.00	1.54	77
2	6.23	5.32	85
3	7.49	6.50	87
4	7.54	6.05	80
5	7.54	6.04	80

¹Total sugar concentration was 8.2%, and 5% calcium carbonate was added.

²One pound equals 454 grams; one gallon equals 3,785 milliliters.

acid production caused by the higher acidity associated with increased yields of acid. Under these conditions, culture 227 produced 0.542 pound of lactic acid per gallon of MSW hydrolyzate (6.5 grams per 100 milliliters), almost three times more than previously demonstrated (Table 2).

Industry is exploring the production of lactic acid from corn for the manufacture of biodegradable plastic. However, the use of solid waste has significant environmental advantages. Studies are in progress to further improve the process of converting MSW to lactic acid.

McCaskey is Professor, Zhou is Visiting Scholar, and Britt is Research Associate of Animal and Dairy Sciences; Strickland is Project Manager, Biotechnical Research Department, Tennessee Valley Authority.

A 100% biodegradable plastic may replace some of the 15 million tons of conventional plastic used in the U.S. every year.

ENERGY SAVINGS WITH USE OF DOUBLE SIDEWALL CURTAINS ON BROILER HOUSES

Heat energy is used by broiler producers during the first three weeks of a growout to provide an optimum environment for bird survival. Depending upon time of year, brooding energy used during this time will range from 75% to 100% of the total energy used for the entire growout period. Heat supplied during the last four weeks serves primarily to improve feed conversion and efficiency. Since LP gas, which is the primary source of heat utilized in broiler houses, is expensive relative to other energy sources, conservation is a major concern of broiler producers.

From an energy use consideration, the ideal poultry house would be a totally enclosed, insulated house for the brooding period with open curtains during the remainder of the growout.

For curtain sidewall houses that are currently being built in Alabama, the portion of the house energy losses that can be attributed to curtain area on houses using single curtains and half-house partial-area brooding is approximately 66% of the total for the house. The use of double curtains reduces this portion of the total house energy loss due to the curtain area to 48%. This has the potential to reduce the overall heat loss from the house during the first three weeks by some 35%.

A study of this concept was conducted by the AAES during four 48-day cold weather trials at the AU Poultry Research Unit to show the overall effect on energy use when using double curtains as compared to single curtains on poultry houses. While every effort was made to operate the systems in a manner similar to that used in industry, the size and type of house used in

the demonstration prohibited the utilization of partial house brooding. Because partial house brooding was not used, total energy consumption was higher than would be expected in a typical commercial house. Comparisons of the relative amounts of energy used and relative energy savings can be made, however.

Two houses were equipped with single curtains, and two houses were equipped with double layers of curtain material. The curtain material for the house containing double curtains was installed as shown in the figure. Air was allowed to enter the house by passing upward through the air space between the two curtains. This method of installation allows recovery of a portion of the heat loss through the curtain material and prevents condensation of moisture between layers of curtain material, which has been a problem when double curtains with closed bottom edges have been used. One curtain was installed outside the building, and the second curtain was installed inside. The building wall was constructed using 3.5 X 3.5-inch posts, thus a 3.5-inch air space existed between the curtains. The outer curtain was held away from the wall at the lower edge by a series of 0.5-inch tubes.

During early brooding periods when ventilation requirements are lowest, air flow was through the lower opening and up between the two curtain layers. A 1.5-inch

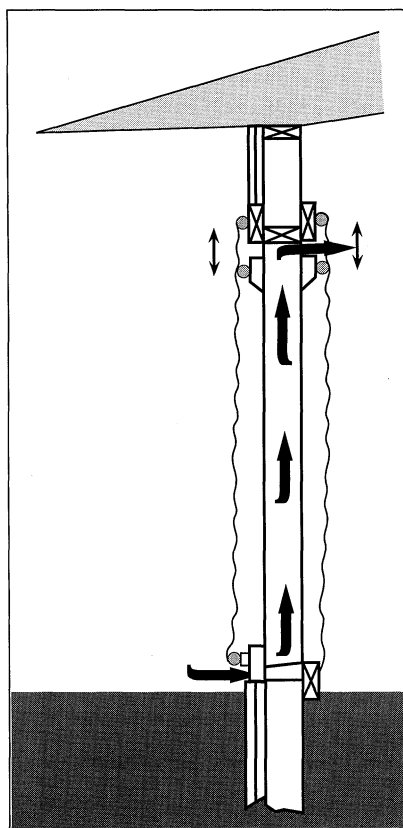
slot opening was established at the top of the inside curtain. Both curtains could be lowered, and ventilation air passed through a 1.5-inch opening at the top of each curtain when ventilation requirements increased. The inner curtain opening could be closed completely when needed. Both curtains can be lowered completely to provide a four-foot opening for warm weather operation. The table summarizes the gas usage for the two types of curtain material for the four trials.

Overall gas usage for the four trials was reduced from 1,118 gallons for single curtain houses to 881 gallons for double curtain houses. Use of double curtains gave an average gas usage reduction of 21%.

This research indicates maximum benefit of double curtains will be obtained by installation in the wall sections of the primary brooding area and should not be required for the entire house. It also indicates reduction in gas usage, resulting from the use of double curtains, will depend on house construction and time of year the birds are grown. The most effective use of double curtains is during the first three weeks of production,

and in most cases their use will be justified only in the partial house brooding area.

Koon and Flood are Associate Professors and Trumbull is former Research Associate of Agricultural Engineering; Brewer is Head of Poultry Science.



Cross sectional view of double curtain construction on poultry house.

GAS USAGE FOR THE FOUR TRIALS, GAL. LP			
Trial	Single curtain	Double curtain	Pct. reduction
Trial 1	466	357	23
Trial 2	208	187	10
Trial 3	238	180	25
Trial 4	204	156	24

TRANSMISSION OF PHYTOPHTHORA ROOT ROT IN AN EBB AND FLOW SUBIRRIGATION SYSTEM

Increasing concern about water quality has prompted the floriculture industry to increase scrutiny of fertilization and irrigation practices to help reduce the potential for groundwater contamination from greenhouse runoff. Ebb and flow subirrigation is one method of controlling runoff, but recent AAES research indicates plant spacing is critical in reducing the spread of disease with this system.

Ebb and flow subirrigation is a closed production system



Peppermint Cooler vinca growing on an ebb and flow bench; closest row inoculated with *Phytophthora parasitica*.

These spores would be discharged along with the runoff in traditional irrigation systems, but with the subirrigation system, they are contained and recirculated. The movement of the root rot pathogen *Phytophthora parasitica* from diseased to healthy plants in the subirrigation system was studied in an AAES project.

Five-week-old seedlings of Peppermint Cooler vinca were transplanted into three-inch pots. Six rows of plants were placed on 4 X 6-foot ebb and flow benches. The first row placed along the drain of each bench was inoculated with the pathogen to serve as an inoculum source for the five nontreated rows. Separate benches were used to space pots at two distances — 7/16 and 1 5/8 inches. Plants from nontreated rows were harvested at two-week intervals, and root samples were tested for evidence of *Phytophthora*. Solution from irrigation tanks also was tested. Plants were grown on

By week six, root samples from 60% of

nontreated plants spaced at 7/16 inch (Group 1) displayed infection by *Phytophthora*, while 30% of those spaced at 1 5/8 inches (Group 2) exhibited pathogen growth. Disease killed all of the inoculated plants, and *Phytophthora* spores were detected in one of four water tanks used.

The pathogen moved from the inoculated row to the fifth row of nontreated plants on all benches by week six — a total distance of 17 inches

in Group 1 and 23 inches in Group 2. However, only 13% of infected plants in Group 2 exhibited severe root injury, compared to 36% of those infected at the closer spacing. Severe injury means at least 25% of the root system is harmed.

The pre-packaged Canadian sphagnum peat and perlite medium used in this study was steam pasteurized to allow for more accurate detection of *Phytophthora* by eliminating existing pathogens. However, pasteurization of Canadian peat is not recommended in commercial production because beneficial, disease-suppressing microorganisms also are destroyed.

Sanitation of production areas and disinfection of equipment reduce chances of a disease outbreak, but other measures may become necessary once a pathogen is established in an ebb and flow system. Chemical pesticides are commonly used in conventional production systems, however there are currently no fungicides or pesticides registered for recirculation.

Strong is Graduate Research Assistant, Deneke and Behe are Assistant Professors of Horticulture; Bowen is Assistant Professor of Plant Pathology.

MOVEMENT OF PHYTOPHTHORA PARASITICA TO NONTREATED VINCA SPACED AT TWO DISTANCES ON EBB AND FLOW BENCHES

Spacing between pots	Cumulative infection of nontreated plants		
	Week 2	Week 4	Week 6
In.	Pct.	Pct.	Pct.
Group 1, 7/16	6	23	60
Group 2, 1 5/8	0	10	30

that collects runoff and returns it to a tank for recirculation. As the surface of a leak-proof floor or bench is slowly flooded, irrigation water flows around and beneath potted plants. Water is transported up through the growing medium by capillary action. After the water is turned off, the runoff is used for the next irrigation. This labor-saving system conserves water and fertilizer, decreases groundwater contamination potential, and reduces incidence of foliar disease.

A possible drawback is the spread of root disease in the recycled liquid. Some bacteria and fungi produce spores that move freely in water and can cause large crop losses.

NITROGEN RATES AND WITHIN-ROW SPACINGS AFFECT COLLARD YIELDS

In recent years, seed companies have introduced new hybrid collards that are higher yielding than traditional open-pollinated varieties. One hybrid, Blue Max, exhibited the greatest yield stability in trials conducted in the Southeast.

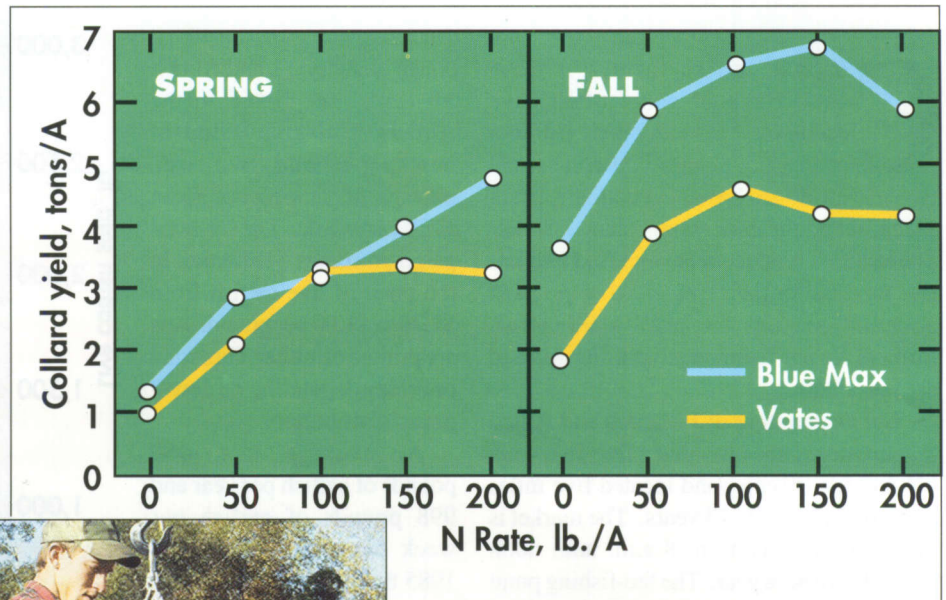
Because of the increased cost of hybrid seed and the convenience of obtaining quality transplants, collard establishment has shifted from direct seeding to the use of transplants. However, the effects of within-row spacing and nitrogen (N) fertilizer rate on collards produced from transplants has not been addressed. An AAES study focused on these factors in the production of Blue Max and Vates, a less expensive, open-pollinated variety, grown in a sandy loam soil.

Field experiments were conducted in the spring and fall of 1990 on a Norfolk/Orangeburg sandy loam soil at the E.V. Smith Research Center, Shorter. Treatments included N rates of 0, 50, 100, 150, and 200 pounds per acre supplied as ammonium nitrate. One-row plots were used with plant spacings of 6, 9, and 12 inches. Rows were four feet apart.

Potassium and phosphorous were broadcast and incorporated at rates determined by the Auburn University Soil Testing Laboratory. Half of the N was broadcast at planting; the remainder was band-applied 30 days after planting. Weeds, nematodes, and other pests were controlled according to the Vegetable Pest Control Guide ANR-2. Plants were harvested once each season at the 21-leaf stage.

Fall yields were 4.6 tons per acre, while spring yields were 2.8 tons per acre, as shown in the figure. Collards usually grow better in the fall when temperatures are cool.

However, season, N rate, and cultivar interacted in their effects on yield. In the spring, Blue Max yield increased proportionately as N rates increased, but the



An AAES study confirmed the high yield potential of Blue Max, a hybrid collard variety.

the 12-inch spacings.

Results of these experiments confirm the superior yield potential of Blue Max, a hybrid, compared to an open-pollinated cultivar. Blue Max responded to the addition of more than 100 pounds of N per acre.

In the fall, the yield difference between varieties when no fertilizer was applied is additional evidence of the hybrid's potential. Blue Max may have the capacity to produce high yields when planted as a double crop without additional fertilizer.

The similar reductions in yield of both varieties with increased within-row spacing suggests the crop's response to plant spacing is similar for hybrid and open-pollinated collards.

In addition to confirming the yield potential of Blue Max, the results of this experiment establish a benchmark for N application at 100 pounds per acre on Alabama sandy loam soils. It also suggests that high yields of standard and hybrid collards may be obtained at within-row spacings of nine inches and a four-foot row spacing.

Dangler is Assistant Professor of Horticulture and Wood is Assistant Professor of Agronomy and Soils.

highest Vates yield was obtained at 100 pounds of N per acre. Highest fall yields of both varieties were obtained with 100 pounds of N per acre. However, Blue Max yielded more at all rates of N application.

The superiority of Blue Max was especially evident in the control plots, where N was not applied. The hybrid yielded approximately 100% more than Vates in these plots. However, it should be noted that Blue Max produces bluish-green leaves that some consumers may find objectionable.

Yields of both collard varieties decreased from 4.0 to 3.6 tons per acre as the within-row spacing increased from six to nine inches. Yields did not decrease further at

ADVERTISING INCREASES THE SALE OF LIVE CATFISH

Channel catfish farmers with a small area of water often have problems marketing their fish to a processing plant because the small quantities harvested do not warrant purchase by the processing plant. Small-scale catfish producers have to find alternative markets for their fish. Two of the most attractive markets for small-scale catfish farmers are fee-fishing and live-fish sales to area residents.

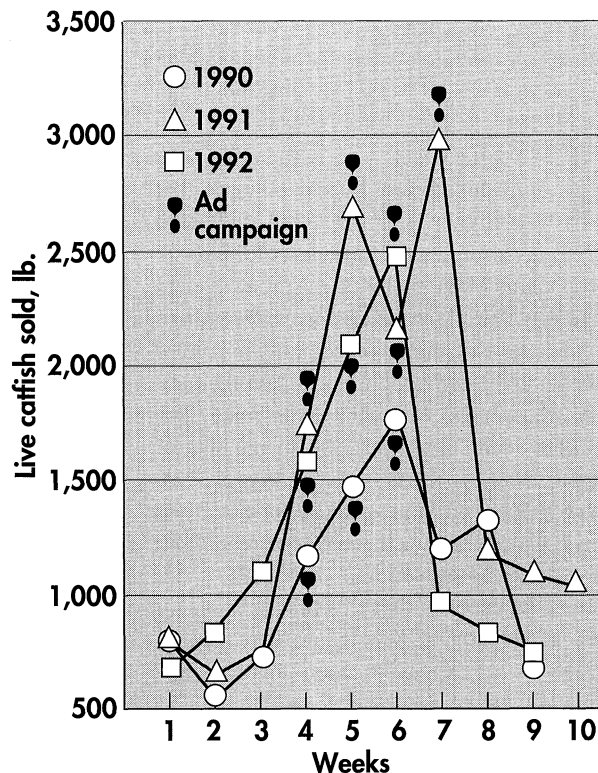
The Department of Fisheries and Allied Aquacultures has operated a live-fish market and fee-fishing pond located five miles north of Auburn for 13 years. The market is open on Saturday from 8 a.m. until noon about 47 weeks a year. The fee-fishing pond is open during the same time period about 32 weeks a year.

Channel catfish raised in AAES research ponds are harvested in the fall and early winter and stored in holding ponds until they are sold. Enough fish must be stored to satisfy consumer demand until the following year's fish are large enough to harvest in September. Often 40,000 to 50,000 pounds of fish, 8,000 to 10,000 pounds per acre, are in holding ponds during the winter. Holding ponds that contain over 5,000 pounds of fish per acre by the end of March often have disease outbreaks that can result in high fish mortality. To reduce fish mortality, the weight of fish in the holding ponds is reduced to levels that permit the maintenance of a healthy aquatic environment.

Live channel catfish are sold for \$1.20 per pound while catfish are sold to the processing plant for \$0.60 to \$0.70 per pound. Thus, profits are higher if excess fish in holding ponds can be sold through the live-fish market or to fee fishers rather than to a processing plant. To increase catfish sales, a three- to four-week advertising campaign is conducted be-

tween January 14 and March 31. Ads are printed in the Auburn University student newspaper and two area newspapers at a cost of about \$150 per week. The ad campaign promotes a reduction in the price of live catfish from \$1.20 to \$1.00 per pound. Ads are printed on either Thursday or Friday depending on newspaper distribution.

An average of 47,060 pounds of catfish per year and 998 pounds of catfish per week have been sold from 1985 through 1992, as shown in the table. Advertisements in local newspapers increased live catfish sales in 1990, 1991, and 1992 (see figure). An average of 1,468, 2,388, and 2,047 pounds per week of live catfish were sold during the periods of newspaper advertisements in 1990, 1991, and 1992, respectively. The weight of catfish sold during promotions increased 37, 50, and 47% over the weekly averages for 1990, 1991, and 1992, respectively (see table). Live catfish sold three weeks before and three weeks after the ad campaign at \$1.20 per pound generated average weekly incomes of \$927 and \$1,216, respectively. Average weekly income received from live catfish sold for \$1.00 per pound during the



The weight of live channel catfish sold before, during, and after advertisement campaigns in 1990, 91, and 92.

ad campaigns was \$1,968. Even with the \$150 per week advertisement costs deducted from the \$1,968 earned weekly during ad campaigns, average weekly income increased \$891 and \$602 compared with income earned before or after the promotion, respectively.

Additionally, advertising appears to have a residual effect on catfish sales after the promotion is ended, as shown in the figure. An average of \$289 more catfish were sold during the three weeks after the ad campaign compared to the three weeks before the ad campaign.

Newspaper advertisements to promote a reduction in the price of live catfish are a promising method to raise catfish sales, reduce inventory in catfish holding ponds, and increase income.

Lovshin is Professor and Beam is Senior Research Associate of Fisheries and Allied Aquacultures.

THE INFLUENCE OF ADVERTISEMENTS ON LIVE-CATFISH SALES FROM THE AAES					
Year	Sale weeks per year	Yearly sales	Average weekly sales	Average weekly sales during ad campaign	Percent increase
		Lb.	Lb.	Lb.	
1985	48	47,511	990	-	-
1986	41	46,907	1,114	-	-
1987	48	42,510	886	-	-
1988	48	46,656	972	-	-
1989	46	42,180	917	-	-
1990	50	46,280	926	1,468	37
1991	49	57,948	1,183	2,388	50
1992	48	46,489	969	2,047	47
Avg.	47	47,060	998	1,968	45

ROTATING SOYBEAN CULTIVARS MAINTAINS YIELDS

Rotation with a nonhost crop, particularly corn or sorghum, has been recognized as a valuable tool in the management of soybean cyst nematode. Soybean cultivars that are resistant to soybean cyst nematode also have been used as a management tool. Continued monoculture of resistant cultivars, however, led to the development of new races of soybean cyst nematodes that were able to reproduce on and reduce the yield of previously resistant cultivars. AAES research suggests that rotating resistant and susceptible varieties may provide a way to grow a soybean monoculture and maintain acceptable yields.

In Alabama, soybean yield losses in 1992 due to soybean cyst nematodes, were estimated to be 110,000 bushels, worth \$600,000. Reducing the loss by a small percentage should have a beneficial effect on net returns to the soybean producer.

An AAES study was conducted at the Sand Mountain Substation, Crossville, to determine the effects of various soybean cropping sequences on soybean yield and soybean cyst nematode numbers. The rotation included soybean cultivars that were susceptible and resistant to cyst nematode. Cropping sequences included continuous monoculture with the same soybean cultivar using Essex (a susceptible cultivar), Forrest (resistant to soybean cyst race 3), or Bedford (resistant to soybean cyst races 3 and 14). These plots were compared to plots in a two-year rotation of Essex-Forrest, Forrest-Essex, Essex-Bedford, Bedford-Essex, Forrest-Bedford, Bedford-Forrest, Essex-corn, Forrest-corn, or Bedford-corn.

Soybean yields were lower when cultivars were not rotated compared to cultivar

rotation and rotation with corn (see figure). Yield of Essex was lower when the previous crop was Bedford rather than Forrest. Corn in the rotation had the greatest positive benefit on soybean yield. There was a one to two bushel per acre increase in yield when resistant cultivars were rotated with susceptible ones, while there were two to four bushel per acre increases when soybeans were rotated with corn.

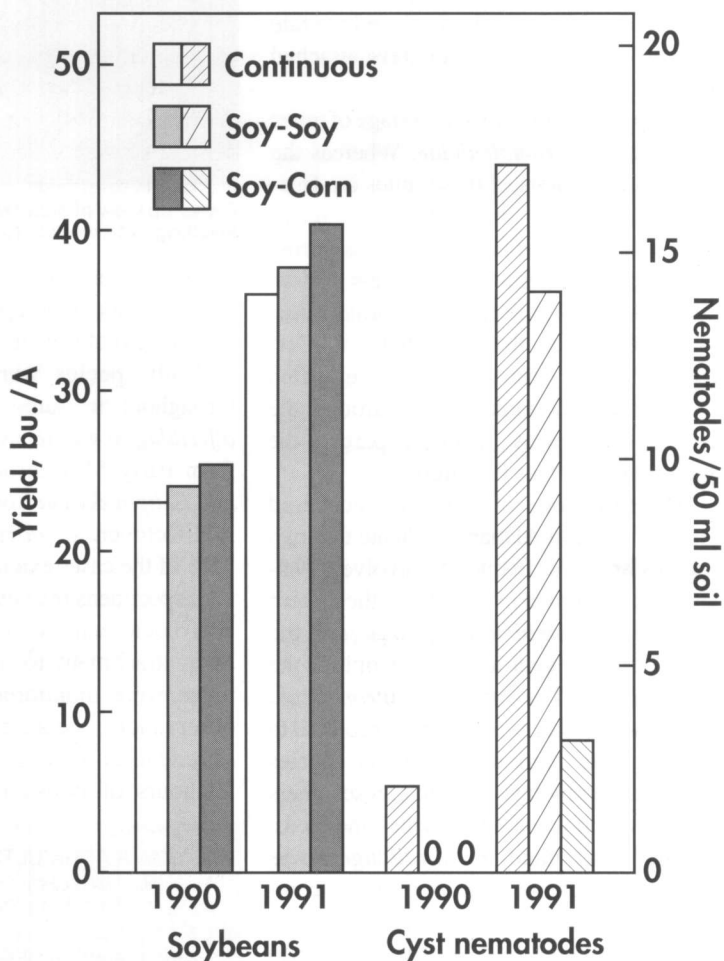
Soybean cyst nematode larvae and cyst counts were highest for continuous Essex and continuous Forrest soybeans.

Larvae and cyst counts were higher in the Forrest and Bedford cultivars when following Essex.

Based on these findings, it appears that soybean production practices that include corn in the rotation are the best means to sustain soybean yield. However, planting continuous soybeans in soybean cyst nema-

tode-infested soil is feasible when resistant cultivars are rotated with susceptible ones.

Edwards is Adjunct Associate Professor of Agronomy and Soils and Soil Scientist with the USDA-ARS National Soil Dynamics Lab; Weaver is Professor and Thurlow is Associate Professor Emeritus of Agronomy and Soils; Eason is Superintendent of the Sand Mountain Substation.



Yields and nematodes counts from various treatments including continuous (nematode susceptible soybeans), soy-soy (resistant and susceptible rotation) and soybean and corn rotations.

WHICH CHIGGERS ATTACK HUMANS IN ALABAMA?

Most people have encountered chiggers, or “red bugs,” and experienced the intense itching their bites can cause, but little information is available regarding the species of chiggers involved. During the past 15 years, researchers with the AAES collected information that helped determine the species that attack humans and the fate of those chiggers once they have attached to an unsuspecting host.

Chiggers are the tiny larval stage of mites of the family *Trombiculidae*. Whereas the nymphs and adults of these mites are free-living, the larvae are parasitic on many vertebrate hosts including mammals, birds, reptiles, and amphibians. Chiggers seldom cause much discomfort to their normal hosts. However, when they attach to atypical hosts such as humans, their bites often cause skin reactions, usually around the ankles, wrists, waist, and other parts of the body where clothes fit snugly.

Identifications of chiggers recovered from humans in Alabama indicate that two species are most frequently involved. Neither has a common name. One is the eastern form of *Eutrombicula alfreddugesi*, the most pesky chigger infesting people in the eastern U.S. The other is *Eutrombicula lipovskyana*, which has not been reported to bite humans. Although the latter species was found crawling on people, researchers are not sure if it actually attaches and feeds. On the other hand, *E. alfreddugesi* was clearly responsible for most of the discomforting chigger bites experienced.

A third species, *E. splendens* — known to attack humans in areas bordering marshes and swamps — was not recovered, which is probably due to limited collections from these particular habitats.

E. alfreddugesi was found mainly in relatively dry upland areas of pine, mixed hardwoods, and second-growth sites dominated by various plants, such as blackberry and honeysuckle. In contrast, *E. lipovskyana* was found in low-lying deciduous woods with damp, shaded ground cover and an



Close-up view of skin reaction to chigger bites with associated redness, swelling, and vesicle formation.

abundance of decaying logs and stumps. Both habitats support populations of lizards, which are preferred hosts of these chiggers.

Both species were generally active throughout the summer and early fall. *E. alfreddugesi* was recovered in human cases from early May through mid-September and *E. lipovskyana* from early July through mid-October. *E. alfreddugesi* comprised 75% of the cases examined and 76% of the total specimens recovered and identified.

To determine what happens to chiggers after attachment to a person, individual mites were monitored. In one series of observations, the attachment sites of 25 *E. alfreddugesi* were circled with ink within 12 hours of infestation. Each mite was

examined daily thereafter. Within the first 36 hours, nine had died while still attached at their original sites; another nine had detached and either dropped off or moved to another, undetermined location. Of the remaining seven attached mites, only two were still alive by the fourth day. None survived to day five. Even the few chiggers that did manage to feed did not appear to survive on this host.

Whether the mites survived or not, their bites caused intensely itchy skin lesions, often culminating in fluid-filled vesicles at the point of attachment. These observations indicate that few, if any, of the chiggers that attach to humans successfully complete their feeding and go on to develop into nymphs. However, unless the chiggers are killed or removed within a few hours, their bites typically cause a localized, sometimes severe, skin irritation even after the mites have died or detached.

Mullen is Professor of Entomology.

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