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ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY

HIGHLIGHTS OF AGRICULTURAL RESEARCH

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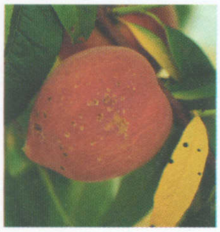

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ON THE COVER: AAES researcher loads feed into planter for cotton planting date study. See related story on page 14.

from the Director

Happy Holidays to everyone reading this message. The holiday season allows us to look forward to the coming New Year, and also review the events of a year gone by.

As the history of Auburn University agriculture is written, 1997 will be remembered as a time of change and perhaps turmoil beyond most "normal" years. Out of this change, we trust that a stronger Alabama Agricultural Experiment Station (AAES) will emerge as we focus our efforts on more cooperative research, better involvement of our clientele in AAES programs, and increased extramural support for programs.

The future of AAES will be shaped in part by a Search Committee for a new AAES Director (and Dean of the College of Agriculture) to take my position by Oct. 1, 1998. Also, a new Dean of the School of Forestry soon will be named to replace Dr. Emmett Thompson, who retires in early 1998. Emmett, we congratulate you and thank you for your years of service. Your leadership will be missed by AAES. We also congratulate Dr. Tim Boosinger, who is completing his first year as Dean of the College of Veterinary Medicine, where the AAES supports animal health research.

An AAES Faculty/Industry Council composed of agribusiness and AAES faculty representatives will meet in mid-December to further guide our research directions. This Council will be active for a number of years, and your input and ideas are welcome by its members. A list of members may be obtained by calling our office at (334) 884-2237.

An agricultural bond issue from the agriculture, forestry, and veterinary medicine sectors of Alabama also will influence the future of the AAES. If passed by the legislature and general referendum in 1998, this bond issue will provide new and renovated buildings for AAES-related programs on the Auburn and Alabama A&M University campuses.

Finally, the history of the AAES is truly being written and recorded by the best. Ms. Leigh Stribling, new Associate Editor in the Office of Research Information, will be chronicling 1997 for the AAES through our annual report. We welcome her to AAES. And Dr. Joe Yeager and Mr. Gene Stevenson are spearheading an effort to better document the full history of Auburn agriculture.

Again, Happy Holidays from all of us at AAES.

Winter 1997 Volume 44 Number 4

A QUARTERLY REPORT OF RESEARCH PUBLISHED BY THE ALABAMA AGRICULTURAL EXPERIMENT STATION, AUBURN UNIVERSITY

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Toxic Fescue Smears Forage-Fed Beef

Amy Simonne, David Bransby, and Nancy Green

TOXIC FESCUE could be largely responsible for the poor image of forage-fed beef in the United States. This is the conclusion drawn from a recent AAES study which indicated that a consumer taste panel could distinguish clearly between beef from cattle that were grazing toxic fescue, compared to beef from animals grazing other forages, or finished on a concentrate diet in the feedlot.

Cattle finished on ryegrass provide beef of similar quality to those finished in a feedlot.

Tall fescue (*Festuca arundinacea*) is the most widely grown improved pasture species in the United States. It occupies about 35 million acres, and supports approximately 10 million brood cows. However, 95% or more of these pastures are infected with an endophytic fungus, *Neotyphodium coenophialum*. Fescue that is infected with this fungus is more tolerant of stress, but it is somewhat toxic to animals and causes reduced weight gain and reproductive levels in beef animals, especially in late spring and summer.

Other signs of toxicity include elevated body temperatures, long hair coats, excess salivation, reduced time spent grazing, and more time spent in shade and water. Despite these animal disorders, cattle producers are reluctant to replace infected fescue pastures with alternate forages because it is costly to do this, profit margins are mostly low, and no other forage species is as hardy and widely adapted. Consequently, infected fescue will remain a very important forage in beef production for the foreseeable future.

Although forages form the base of cow-calf production in the United States, beef animals typically spend three to six months in a feedlot

Toxic Fescue, continued on page 4

Panel members were asked to rate flavor/aroma, juiciness, tenderness, taste, and overall preference

Toxic Fescue, continued from page 3

on high-grain concentrate diets prior to processing and distribution into the retail market. The feedlot phase of production is usually the most expensive. Furthermore, this phase is strongly influenced by the price of corn, which tends to fluctuate widely with corn yield, thus affecting price of cattle and the risk associated with cattle production, even at the cow-calf level. Unfortunately, feedlots also cause serious environmental hazards and are in question regarding animal welfare in many cases.

As an alternative to beef from animals finished in a feedlot, forage-fed beef has been considered and evaluated in many studies. This production option is used widely in other countries because of the relatively high cost of grain in most other parts of the world. However, in almost every study conducted in the United States, taste panels have been able to distinguish between beef from animals finished in a feedlot and forage-fed beef. Specifically, beef from animals finished in feedlots has been almost exclusively preferred.

Careful examination of procedures used in these studies suggested that this distinction was partly due to the fact that cattle on feedlot diets were processed at a higher level of finish, and were usually heavier than those from forage diets. Therefore, an AAES study was conducted to examine this by taking both feedlot and forage-fed animals to a similar level of finish prior to processing [see *Highlights of Agricultural Research*, Vol 42(4), Winter 1995]. In this case cattle on the forage fed diet had grazed Marshall annual ryegrass (*Lolium multiflorum*), and a consumer taste panel could not distinguish clearly between steaks obtained from feedlot cattle and those obtained from animals finished on pasture.

Since results from this study differed from those of most other studies that compared feedlot and forage-fed beef, additional research was conducted to investigate possible explanations. One obvious difference between this study and others was the difference in the forage species. Because tall fescue is so widely grown in the United States, a second experiment was initiated to investigate the possible effects of infected fescue on forage-fed beef.

In this experiment Angus or Angus x Hereford steers grazed infected or fungus-free Kentucky 31 fescue, or were fed a high-concentrate diet in the feedlot. Five animals were assigned to each treatment, and finished weights were 1,016, 1,046, and 1,058 pounds respectively. Ribeye steaks from these animals were evaluated by a volunteer consumer panel of 80 people ranging in age from 18 to 60 years. Panel members were regular meat consumers, and most had participated in the previous study.

Meat samples were oven-broiled to an internal temperature of 158°F, as in the first study. Panel members were asked to rate flavor/aroma, juiciness, tenderness, taste, and overall preference of the steaks on an unstructured line scale. Data from both experiments were combined in a pooled analysis.

Steak from cattle that had grazed infected fescue was rated inferior in all attributes except aroma. With regard to juiciness, tenderness, taste, and overall preference it was rated distinctly lower than beef from animals out of the feedlot or from diets containing ryegrass (see table). In relation to juiciness and tenderness it was distinctly inferior to beef from animals that had grazed fungus-free fescue, but this difference was not clear in relation to taste and overall preference.

Results from this study show that infected fescue could be largely responsible for the poor image of forage-fed beef obtained in other similar experiments. Further research is needed to determine how long it takes after cattle are moved from infected fescue to an alternate diet before the negative effects on the meat are eliminated.

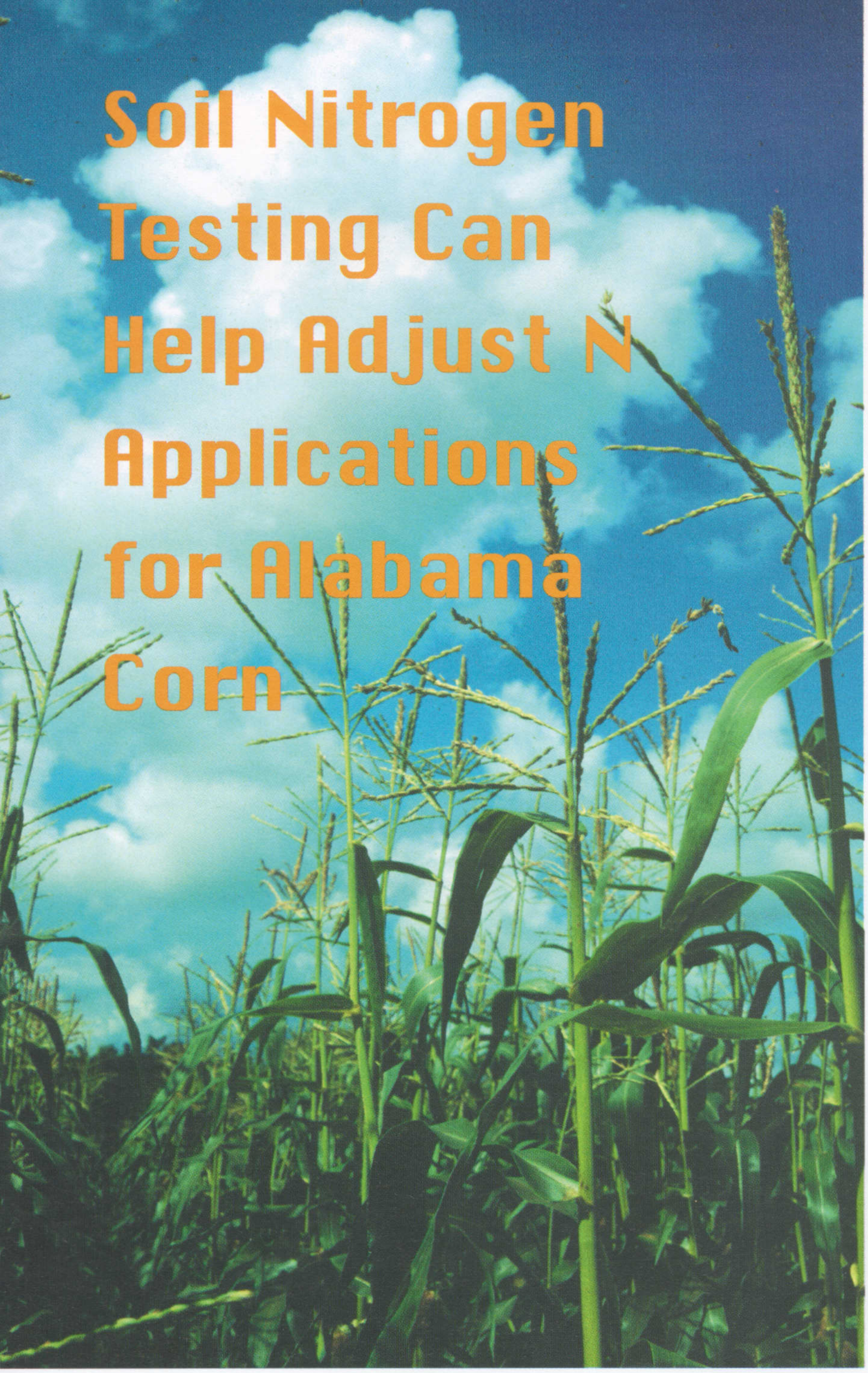
Consumer Response to Ribeye Steaks from Various Finishing Diets

Treatments	Aroma	Juiciness	Tenderness	Taste	Overall preference
Feedlot	6.80	7.35	7.88	8.44	8.33
Ryegrass	6.97	6.65	7.12	7.58	7.75
Ryegrass+hay	6.29	6.35	6.69	7.61	7.38
Fungus-free fescue	6.94	6.61	6.51	6.97	7.07
Fungus-infested fescue	6.63	5.35	5.30	5.81	5.58

The maximum full scale of score was 14 cm.

Simonne is a Post Doctoral Fellow of Nutrition and Food Science; Bransby is a Professor of Agronomy and Soils; and Green is a former Professor of Nutrition and Food Science.

Soil Nitrogen Testing Can Help Adjust N Applications for Alabama Corn



Charles C. Mitchell

NITROGEN APPLICATIONS for Alabama corn is hit or miss. Current standard recommendations are based on long-term research throughout the state, but general recommendations fail to take into account variations due to weather, rainfall, manure applications, residual soil nitrogen, and situations where all the nitrogen may be applied prior to planting. To compensate for these uncertainties, growers may apply more nitrogen than is needed by the crop, resulting in increased production costs and potential for nitrates leaching into groundwater or running off in surface water.

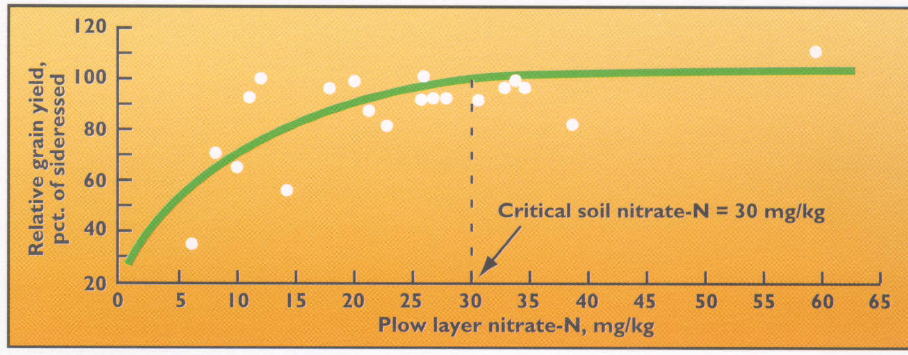
Several techniques have been used in Alabama and in other parts of the United States to fine-tune nitrogen applications. Multiple or split nitrogen applications help. Fertigation is useful where growers irrigate. Some growers take whole plant samples early and monitor the ear leaf nitrogen at tasseling. The chlorophyll meter has shown promise for identifying nitrogen deficient corn at side dressing time and especially at silking. All of these are useful tools, but each has its own limitations. Most tend to encourage over-application of nitrogen fertilizers.

Soil nitrogen testing has not proved very useful in the humid eastern U.S. because most nitrogen fertilizers are mobile in the soil. They don't stay around long following heavy rainfall. However, organic-based nitrogen fertilizers, such as manures, will leave some residual organic nitrogen in the soil. The presidedress soil nitrate test (PSNT) has proved helpful in the northeastern and midwestern U.S., especially where animal manures have been applied to the soil. It has not been extensively evaluated in the deep South.

The PSNT involves taking a soil sample just prior to side dressing the corn crop with nitrogen. The soil is tested for nitrate-N either by a laboratory with a very quick turn-around time or with portable equipment. The decision to sidedress the crop is made based upon the concentration of nitrate-N in the soil. It has worked in Ohio, Pennsylvania, Vermont, Tennessee, and other states when the primary nitrogen source has been animal manures. An AAES project in cooperation with the Alabama Cooperative

Soil Nitrogen, continued on page 6

The presidedress soil nitrate test (PSNT) is run on samples taken just prior to sidedressing corn with nitrogen. Plots in the background received broiler litter at planting. Those in the foreground received no N at planting.



The PSNT was effective at predicting the need for sidedress N applications in these on-farm sites in North Alabama. Non-irrigated yields ranged from 50 to 210 bushels per acre on these on-farm tests in 1992-1994.

Soil Nitrogen, continued from page 5

Extension System and supported by the Alabama Wheat and Feed Grain checkoff program has evaluated the PSNT and the chlorophyll meter in 20 on-farm tests in North Alabama and in a field experiment at E.V. Smith Research Center in Central Alabama.

All sites involved manure applications, mainly poultry broiler litter, because manured fields are most likely to have significant carryover of residual nitrogen. In North Alabama, the PSNT predicted the need for sidedress N on most of the 20 growers' fields where it was evaluated in 1992 through 1994.

A critical value for applying sidedress nitrogen to corn at the V6 growth stage (six leaves) is about 30 parts per million (ppm) of nitrate-N (see figure). This is a little higher than that used by other states (20 to 25 ppm). The PSNT in North Alabama also showed that much of the nitrogen in broiler litter was lost if it was applied more than one month prior to planting corn. In these cases, additional, sidedress fertilizer nitrogen was needed for the crop. Manure applications more than one month ahead of planting corn is not a recommended practice!

All broiler litter on the experiment at E.V. Smith Research Center was applied just ahead of planting and incorporated using a field cultivator. Residual broiler litter was that which was applied the previous spring; no additional fertilizer was applied to the current crop under residual broiler litter.

Although the PSNT seemed to do a reasonable job of predicting the need for sidedress nitrogen in North Alabama, data from 1995 through 1997 on a fine sandy loam of the Coastal Plain at E.V. Smith Research Center in Shorter indicate that the PSNT is not a reliable measurement of residual soil N on these soils. Sandy soils, a warmer climate, and slightly higher rainfall contribute to greater nitrogen losses in Central and South Alabama. The PSNT found no N carryover in the soil from broiler litter applied the previous year although corn grain yields (see table) and leaf nitrogen analysis indicate that some residual effect was present. The PSNT can detect some N carryover from high rates applied at planting, but the amount detected is very small compared to concentrations reported from the Northeast, Midwest, and North Alabama.

Although chlorophyll meter readings from corn at the V6 and at early silking stage are not presented in this report, these tests continue to show that the chlorophyll meter has promise for detecting late-season N deficiencies.

Mitchell is a Professor of Agronomy and Soils.

Corn Grain Yield and PSNT Soil Nitrate Concentrations at E.V. Smith Research Center, 1995-1997

Treatment	1995 Corn grain yield	1995 PSNT No$_3$-N 0.8 in.	1995 PSNT NO_3-N 8-16 in	1996 Corn grain yield	1996 PSNT NO_3-N 0-8 in	1996 PSNT NO_3-N 8-16 in	1997 Corn grain yield
	bu./acre	ppm	ppm	bu./acre	ppm	ppm	bu/acre
No N	24	6	4	57	5	4	64
Am. nit. at 60 lb. N/a	43	6	5	140	5	4	112
Am. nit. at 120	50	9	9	140	8	7	130
Am. nit. at 180	47	11	8	126	8	7	126
Am. nit. at 240	53	23	13	110	10	13	132
B.L. at 120	43	6	4	108	11	4	118
B.L. at 180	55	7	6	108	6	5	112
B.L. at 240	59	10	11	134	7	7	135
Residual B.L. at 120	30	5	4	75	4	4	69
Residual B.L. at 180	39	6	5	103	4	4	76
Residual B.L. at 240	54	5	5	121	4	4	83

Am. nit. = ammonium nitrate; B.L. = broiler litter; rates are in pounds N per acre per year; residual B.L. are rates applied in previous years. All ammonium nitrate N was applied in equal, split applications. Broiler litter contains an average of 60 lb. N, 60 lb. P_2O_5, and 40 lb. K^2O per ton; therefore, the rates used correspond to approximately two, three, and four tons per acre, respectively.

JUNE RAINFALL CRITICAL FOR OPTIMUM COTTON YIELD

Scott Jackson, Charles Mitchell, and Ellen Bauske

MANY STUDIES have been done on the effects of annual precipitation on cotton yields. Few have investigated the correlation between monthly rainfall and yields. Recent AAES research indicates irrigation in late spring or early summer may be critical to cotton production.

All parts of Alabama receive an average of more than 50 inches of rainfall annually, making this one of the highest rainfall areas in the country. However, rainfall distribution during the growing season often results in short-term droughts or excessively wet periods in many parts of the state. Due to the absence of large frontal weather systems during the summer months, most rainfall in Alabama during this period is attributed to isolated thundershowers.

Identifying critical periods when rainfall may have a particularly significant effect on cotton yield could help producers with future decisions regarding planting, irrigation, field operations, etc. Although only 5% of Alabama's cotton land is irrigated, interest in irrigation is growing.

Annual yields from standard fertilized treatments on long-term cotton fertility experiments were studied at four locations in Alabama's Coastal Plain: Auburn (1978-1994), Brewton Experiment Field in Brewton (1992-1996). Wiregrass Substation in Headland (1992-1996), and Prattville Experiment Field in Prattville (1992-1996). Long-term yield and weather records on file at Auburn University, and data from the Alabama Weather Information Service (AWIS), were used in the study. Statistical correlations were run to determine any trends or significant relationships between monthly rainfall and annual cotton yields.

June rainfall was significantly correlated with cotton yields at all locations (see figure). Rainfall totals for other months of the growing season showed less significant correlation with cotton yield. Cotton yields at Prattville showed highly significant dependency on both June and July rainfall. In June in most of Central and South Alabama, cotton is squaring. Dry weather during this critical period will slow down vegetative growth. Reducing early growth would mean a lower and later potential yield, due to the stunted size of the cotton plant. The plant would resume vegetative growth during better weather, but probably set the resulting squares at a less favorable time of the season.

June is normally a dry month and has a high evapotranspiration rate.

June Rainfall, continued on page 8

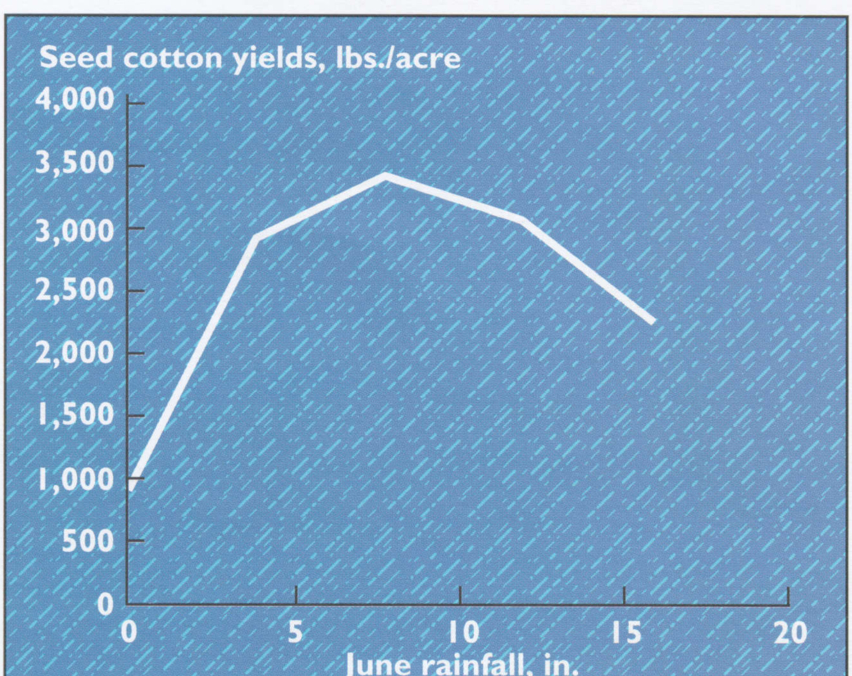
June Rainfall, continued from page 7

High evapotranspiration rates can aggravate drought conditions. The month of May is normally drier than June, which would tend to set up a moisture deficit in the soil as June begins. Plentiful rainfall during this period, which would help offset the detrimental effects of high evapotranspiration rates as well as any soil moisture deficit, appears to be critical in establishing a healthy plant with high yield potential.

A possible explanation for the high correlation at the Prattville location may be the soil. The Prattville soil has a higher clay content than any of the other study sites. Even though clayey soils tend to have a higher water holding capacity, under extreme drought conditions the matrix or structure of the clay may hold water so tightly that the plant cannot extract and utilize the existing moisture in the soil. Thus a soil with a high clay content with more actual water in the soil than a sandy soil may have less actual available water for the plant.

A similar phenomenon has been observed by researchers on North Carolina's Coastal Plain. A lack of high correlation in July and August may be due to excess rainfall in these months, in some years, which may actually reduce yields. A good example of this is Hurricane Danny in Baldwin County in July 1997, where high rainfall totals were accompanied by destructive winds. In some years excessive rainfall in July and August may lead to excessive vegetative growth and boll rot. Each farm is different and an analysis of local conditions would be needed, but from the results of this study it appears that when rainfall is not sufficient during this critical period, which for Alabama usually falls in June, irrigation may be a viable alternative at some locations.

Jackson is a Graduate Research Assistant and Mitchell is a Professor of Agronomy and Soils; and Bauske is a former Extension Specialist.



June rainfall and seed cotton yields at all locations from 1978 to 1996.

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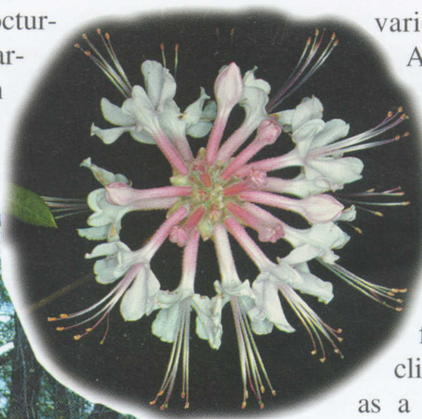
*Clockwise from above: flower bud of rhododendron showing typical sign of borer attack; complete blooms of **R. austrinum** from undamaged flower buds; complete blooms of **R. canescens** from undamaged flower buds; native Alabama rhododendron (**R. canescens**) in full bloom.*

"BORING" CUTWORM: AL PEST OF NATIVE DRONS

L.L. Hyche and D.W. Speake

NATIVE RHODODENDRONS grow naturally in many areas of Alabama woodlands and several species bloom in spring, providing welcome patches of color to a countryside not yet recovered from winter. The attractiveness of these shrubs in full bloom has made them favorite candidates for "domestication" and adaptation to urban and suburban landscapes. However, cultivation of these native plants has led to a previously unknown pest.

For several years, growers of native rhododendrons in East-Central Alabama have been concerned about "borer" damage to flower buds. Damage has been most common on three spring-blooming species, *Rhododendron canescens*, *R. austrinum*, and *R. alabamensis*, under culture locally as ornamentals. Undamaged buds normally produce full and complete blooms; damaged buds shrivel and die, or produce incomplete, ragged blooms with only a few flowers. Preliminary studies by AAES researchers have identified the nocturnal pest as the variegated cutworm (*Peridroma saucia)*[1].



Peridroma saucia is one of Alabama's most common cutworms and is known to feed on a wide variety of plants. In Alabama, the species is most commonly associated with vegetable, forage, and field crops. Its habits are variable, however, and reportedly include a tendency to climb and feed in the manner of climbing cutworms. It is as a climbing cutworm that the variegated cutworm causes damage to rhododendrons.

Damage to flower buds begins to appear most years during the first half of February (as early as Jan. 28 in 1994). Larvae sometimes feed initially on the bud surface, but

[1]This species was identified by Paul Estes, Associate Professor Emeritus of Entomology.

Cutworm, continued on page 10

Cutworm, continued from page 9

subsequently, and typically, bore into the bud. Thereafter, feeding is primarily on developing flower parts within the bud. The bud is not usually totally consumed, but its bloom potential is destroyed, or nearly so. The cutworm feeds and damages buds at night. Larvae have been collected from buds in the evening after dark and in early morning prior to sunrise, but have been found only rarely during daylight hours. Larvae apparently rest in duff, litter, or soil beneath plants during the day, and climb stems at night to feed.

The variegated cutworm may complete three or four generations per year in Alabama. Adults are known to become active and lay eggs in early spring. However, cutworms collected from rhododendron buds in February and early March were 1/2 to 1 1/4 inches long, too large to be from a new, early spring generation. Consequently, these were apparently overwintering larvae from a late summer or fall generation of the previous season. When full-grown, the larva of the variegated cutworm is about 1 3/4 inches long. Color varies from light to dark brown to dark gray. The most conspicuous identifying characteristic is a series of light spots along the midline of the back.

As noted, the variegated cutworm is usually found in various forage and field crops. While its habits and food plants are known to vary, its presence on rhododendron was heretofore unknown. Its habit of feeding on flower buds makes it a serious pest of some species of common native rhododendrons.

Hyche is an Associate Professor of Entomology; and Speake is Professor Emeritus of Zoology and Wildlife Sciences and noted rhododendron grower.

Clockwise from above: typical incomplete blooms that developed from borer-damaged buds; hollow bud showing complete destruction of developing flowers; mid-stage larva feeding in typical manner on a flower bud, specimen is about one-inch long; fully grown larva of the variegated cutworm, specimen is about 1 3/4 inches long.

Recycled Waste Paper Pellets Provide Weed Control in Container Production

Dee R. Smith, Charles H. Gilliam, James H. Edwards, and John M. Olive

Weed control in container production is an ongoing problem in the nursery industry. Controlling weeds is necessary to maintain quality and aesthetics of the plants produced, but hand weeding and herbicide application is costly and/or labor intensive.

Typically granular herbicides are broadcast with a cyclone spreader over the top of container grown plants. This method of application results in a portion of the herbicide falling between pots. Container nurseries normally irrigate daily during the growing season and much of the herbicides that fall between the pots can be washed away with irrigation and rain, which threatens nearby surface water.

An organic material being considered as a nonchemical alternative method of weed control in container production is recycled waste paper (Tascon, Inc.). The waste paper is ground, then compressed using pelletizing equipment to form pellets about 3/16 x one inch. To develop the crumble product pellets are put through a granulator with variable pressure plates.

A trial was conducted at the Ornamental Horticulture Substation in Mobile in August 1995, with two plant species: Girard's Rose and Fashion azalea. The two paper products, recycled paper crumble and recycled paper pellets, were applied at one of two depths,

Top of page: recycled waste paper products–pellets on the left and crumble on the right; above: grower trials have demonstrated that pellets applied at a 1 inch depth will suppress weeds.

0.5 or one inch. Phosphorus was applied to the recycled waste paper products in the pots as triple superphosphate, at either 0 or 7.5 ppm, based on the dry weight of the paper products.

Addition of P was based on previous work that had demonstrated sensitivity of some bedding plants to aluminum (Al) in the recycled paper.

Other treatments included fabric disks (Texel Corp., Quebec, Canada), and a fabric disk with Spinout (Griffin, Corp.), Rout 3G (Scott's Co., Marysville, OH) applied at recommended rates, and a nontreated control.

With all mulch treatments, 30 prostrate spurge seeds were placed either under the mulch or on top of the mulch. Azaleas were repotted into three gallon containers in May 1996, remulched with the recycled waste paper treatments, and a treatment of Rout 3G herbicide reapplied.

Recycled waste paper pellets applied to a depth of one inch completely suppressed spurge germination through the 1995 growing season, regardless of whether spurge seed were sown on top of the mulch or under the mulch (see table). In contrast, recycled crumble

Pellets, continued on page 12

Pellets, continued from page 11

provided poor spurge control at both depths and when spurge were sown on top of the mulch, there was increased spurge growth compared to when the seed were sown under the crumble mulch. With recycled crumble there was greater spurge number per pot at 30 days after treatment (DAT) with the half-inch depth than with any other mulch depth.

An application of recycled paper pellets to control weeds is beneficial for barbed or spiny plants that are difficult to weed.

Better weed control from use of recycled pellets probably results from two factors. First, the pellets are three times the density of the crumble product, thus creating a greater barrier for weed seed germination under the mulch. Second, the recycled waste paper pellets absorb approximately three times their weight in water within a few days after application. As water is absorbed the pellets swell, forming an interlocked mat of bonded pellets, of which the surface becomes relatively smooth.

Results from the fabric disk showed limited spurge control was obtained with any treatment. There was a seed placement effect at 30 DAT with spurge number and at 75 DAT with fresh weight where seed placement under the fabric resulted in less growth than seed placed on top of the fabric (see table). Spurge also emerged around the container circumference and in the slit where the fabric disk fits around the plant. Seed placement affected spurge germination at 30 DAT and spurge fresh weight at 75 DAT with the greatest amount of spurge occurring when seed were placed on top of non-Spinout treated fabric. Rout herbicide provided excellent spurge control.

Recycled pellets continued to provide excellent spurge control after the plants were repotted in May 1996. With Girard's Rose azalea at 60 DAT, recycled pellets provided greater spurge control (spurge number) than recycled crumble (1.0 vs 3.8), and the one-inch depth provided greater control than the half-inch depth (1.5 vs 3.3); data for Fashion azalea followed a similar trend.

Both cultivars of azaleas grown with recycled waste paper mulch were generally similar in size to non-treated control plants and Rout-treated plants. No treatment produced a negative effect on plant growth when comparing effects of recycled paper treatments on Girard's Rose. At 550 DAT, all recycled paper treatments effects were similar with Girard's Rose to plants grown with Rout and the non-treated control plants.

When comparing effects of recycled paper treatments on Fashion azalea at 240 DAT, crumble grown plants were similar at half and one-inch depths (22.4 vs 23.6). Plants grown with pellets were smaller at one inch than those grown at a half inch (19.5 vs 24.3). The pelleted mulch appeared to retain greater water than the crumble mulch. Since all treatments were watered similarly with overhead irrigation, the growth suppression with recycled pellets may be related to excess moisture.

Fashion azalea at 550 DAT showed the only response to additional phosphorous (P). Those plants grown with P were larger than those without P. The pH of the waste paper pellets is 6.8 and crumble is 7.0. Medium solution pH gradually became more acidic with all treatments over the course of the study; ranging from 5.6 - 6.6 at seven DAT to 4.9 - 6.0 at 240 DAT. These levels are within acceptable ranges for container grown nursery crops. Soluble salts (seven and 30 DAT) were affected by additional P and mulch. At seven DAT,

Mulch Control of Prostrate Spurge in Container Grown Plants

Treatment[2]	Depth (inches)	P-level[3] (ppm)	Initial			After repotting[1]		
			Spurge #/pot		Spurge fresh wt.	Spurge #/pot	Spurge #/pot	Spurge fresh wt.
			30 DAT[4]	75 DAT	75 DAT	30 DAT	60 DAT	60
Pellet/su[5]	0.5	0.0	1.0	3.3	2.6	0.25	2.3	3.1
Pellet/su	0.5	7.5	0.8	0.8	12.9	0.37	1.4	10.6
Pellet/su	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pellet/su	1.0	7.5	0.0	0.7	1.3	0.0	0.25	0.03
Crumble/su	0.5	0.0	10.1	18.8	22.7	1.9	4.0	5.6
Crumble/su	0.5	7.5	4.7	9.8	51.7	5.5	5.5	23.0
Crumble/su	1.0	0.0	2.5	8.5	9.2	1.4	2.0	3.5
Crumble/su	1.0	7.5	2.6	6.8	36.8	2.5	3.6	56.2
Pellet/st[6]	1.0	0.0	0.0	0.3	0.0	—[7]	—	—
Pellet/st	1.0	7.5	0.0	0.2	0.0	—	—	—
Crumble/st	1.0	0.0	9.2	21.6	12.7	—	—	—
Crumble/st	1.0	7.5	8.0	17.3	46.2	—	—	—
mulch			***	***	***	***	***	***
depth			***	**	**	NS	**	NS
seed placement			***	***	NS	—	—	—
phosphorus			*	**	***	*	NS	**
mulch*depth			**	NS	NS	NS	NS	NS
mulch*seed[8]			***	***	NS	—	—	—
mulch*P			NS	*	***	*	NS	*
Fabric disk/su			0.3	9.5	3.5	—	—	—
Fabric disk/st			5.8	8.3	25.3	—	—	—
Fabric disk+spin out/su			0.8	1.3	7.1	—	—	—
Fabric disk+spin out/st			2.6	4.6	11.3	—	—	—
fabric disk			NS	**	NS	—	—	—
seed placement			**	NS	**	—	—	—
fabric disk*seed			**	NS	**	—	—	—
Rout[9]			0.0	3.5	0.0	0.25	1.6	9.5
Control[10]			12.0	20.5	26.8	5.3	8.1	59.1

[1] Plants were repotted May 7, 1996, and retreated.
[2] Only significant affects were included in the statistical model statement.
[3] P source was triple superphosphate; mg L-1 (ppm) based on pounds of recycled paper per pot.
[4] DAT = days after treatment
[5] su = seed applied under the mulch
[6] st = seed applied on top of the mulch
[7] Treatment not included
[8] Mulch/seed interaction based on 25 mm depth only.
[9] Rout 3G herbicide applied at three pounds a.i. per acre.
[10] Non-mulched control

pellets with added P had medium solution soluble salt levels of about 2.0 s/mmhos. Pellets with no P and crumble with added P and no P had soluble salt levels of 0.87, 0.88, and 0.46 s/m, respectively. A similar trend occurred at 30 DAT; however, medium solution salt levels had dropped, ranging from 0.43 to 0.26 s/m.

Research indicates recycled waste paper in the pelleted form provides superior weed control compared to the crumble form. The one-inch depth is necessary to provide adequate weed control. Repotting and reapplying the mulch to three-gallon container-grown azaleas had no apparent negative effect on azalea growth at any time during the study. While plant quality was not rated, plant appearance for all plants was reflected in good foliar color.

Two environmental issues are addressed with the use of recycled waste paper: a reduction in chemical use to control weeds and an alternative application for a post consumer by-product that would otherwise be disposed of in landfills.

Smith is a former Research Assistant and Gilliam is a Professor of Horticulture; Edwards is a USDA Agronomist; and Olive is Superintendent of the Ornamental Horticulture Substation.

Is Planting Cotton Before May Risky Business in North Alabama?

Lee Norfleet, Wayne Reeves, Charles Burmester, and Dale Monks

COTTON GROWERS in northern Alabama are challenged by a limited growing season in which to make a profitable crop. Although growers are aware of recent AAES research that demonstrates the benefit of using small grain cover crops with no-tillage, this system can increase management demands of the grower. Farmers are faced with the dilemma of producing sufficient cover crop residues to improve soil quality and conserve soil water but still manage to plant large acreages in a timely manner so that the cotton has sufficient time to produce a crop before fall frosts. Recent USDA and AAES research provides useful information for growers to make a better informed decision regarding this challenge.

Producers who use a winter cover crop as a conservation practice and to reduce compaction in no-till and conventional tillage systems usually kill the cover in late February to mid March. This prevents cover crops from producing large amounts of biomass necessary to provide weed control, moisture conservation, and to maintain or improve topsoil. USDA and AAES researchers have found that for cotton growers in North Alabama to realize the full benefit of cover crops, they need to utilize weather and soil climate data and plant by the thermometer and not the calendar.

Long-term weather data, critical cotton growth stages (see Table 1), and a computer program designed to generate long-term estimates of climate and crop growth from past data were used in this study to develop optimum planting dates for cotton in the Tennessee Valley. The combination of well established cotton physiology data with average climate and soil temperature illustrates:

(1) how late cotton can be planted and still have enough days to mature;

(2) how early planting may cause poor germination and seedling disease;

(3) synchronization of planting date with seasonal rainfall and critical growth periods; and

(4) the benefits of using cover crops and the ability for letting cover crops grow longer into spring without jeopardizing optimal planting dates.

The long-term weather data was generated by the Erosion Productivity Impact Calculator (EPIC) program. This program uses measured weather data from established stations and statistically generates weather patterns for 100 or more years. Periods of drought, intense rainfall, and abnormal temperatures are all estimated based on their past occurrences. Stations located in Muscle Shoals, Huntsville, and Bankhead Locks in Alabama supplied the weather data for this research. The daily average for soil temperature, maximum and minimum air temperature, rainfall, and root zone soil moisture was generated for a 100-year period in North Alabama from these locations. This data was used to develop average dates of frost (see Table 2), soil temperature at four inches, weekly rainfall patterns (see the figure), and growing degree days (DD60s). Dewey and Decatur silt loam soils were used in the simulations.

Cotton's base temperature for growth is 60°F. Below this temperature, plant growth is hampered and seedlings tend not to germinate. Daily heat units or DD60s are calculated by

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Cotton Planting, continued from page 15

adding the maximum and minimum temperatures for each day, dividing by two, and subtracting the base temperature of 60°F. For example:

[(86max + 60min) / 2] - 60base = 13 DD60s.

Once planted, cotton germinates readily under favorable moisture conditions and temperatures above 60°F. Research from Texas in the 1960s reported a 10-day average soil temperature above 60°F is needed before the start of planting. Lower soil temperatures had emergence rates of less than 40%. The 10-day average rule of thumb has since been used successfully for many years. Research in Mississippi showed an average temperature of 68°F was optimum for a good rate of germination. Other studies have found three-day averages of 65°F to be an optimum temperature to begin planting. Table 2 shows that for the 60° rule, planting should not start until after April 10 in the Tennessee Valley and the probability for optimum temperatures for planting doesn't occur until after May 1.

After planting, 50 DD60s are necessary for seedling emergence. With soil temperatures approaching 70°F and adequate moisture, emergence may occur in five to six days. Soil temperatures nearer 60°F may cause emergence to take 15 days or more due to the slower accumulation of DD60s. Delayed emergence affects plant stands and yield. Studies have shown survival rates of seedlings that emerged on the fifth, eighth, and twelfth day after planting to be 87, 70, and 30%, respectively, corresponding to relative yields of 100, 46, and 29%. Others have shown field emergence to be 50, 72, and 77%, when 10, 20, and 30 DD60s accumulated in the first five days after planting. On average in North Alabama, 10 DD60s do not occur until April 7, 30 DD60s do not accumulate until April 22, and 50 DD60s, the optimum required for rapid emergence, do not occur until May 1.

The Average Weekly Rainfall chart for 100-year simulations indicates a rainy period normally occurs in late June and early July (see figure). Depending on cultivar, it takes 700 to 800 DD60s to reach the bloom period (see Table 1). Peak bloom is the most critical period for water requirement and first flower signals the beginning of a rapid rise in the need for moisture. By planting around the first of May or when soil temperature averages 65°, the cotton plant can still develop its early blooms in time with these summer rains since on average 700 to 800 DD60s do not accumulate until this early July period. Moisture reserves from spring rains are normally adequate until the summer rains arrive, especially if past residues are managed and cover crops used.

The end of effective bloom is calculated by subtracting 750 DD60s (amount needed to mature a boll) from the average date of first 32°F freeze. Aug. 16 is about 750 DD60s before the average date of first fall frost on Oct. 30, allowing the last bolls to develop. Total DD60s accumulated before harvest increases to around 2,000 instead of the values in Table 1 due to temperature and moisture stresses slowing development and "wasting" DD60s during the bloom period.

Table 1. Estimated Minimum DD60s Required for Selected Development Stages for Selected Variety Types[1]

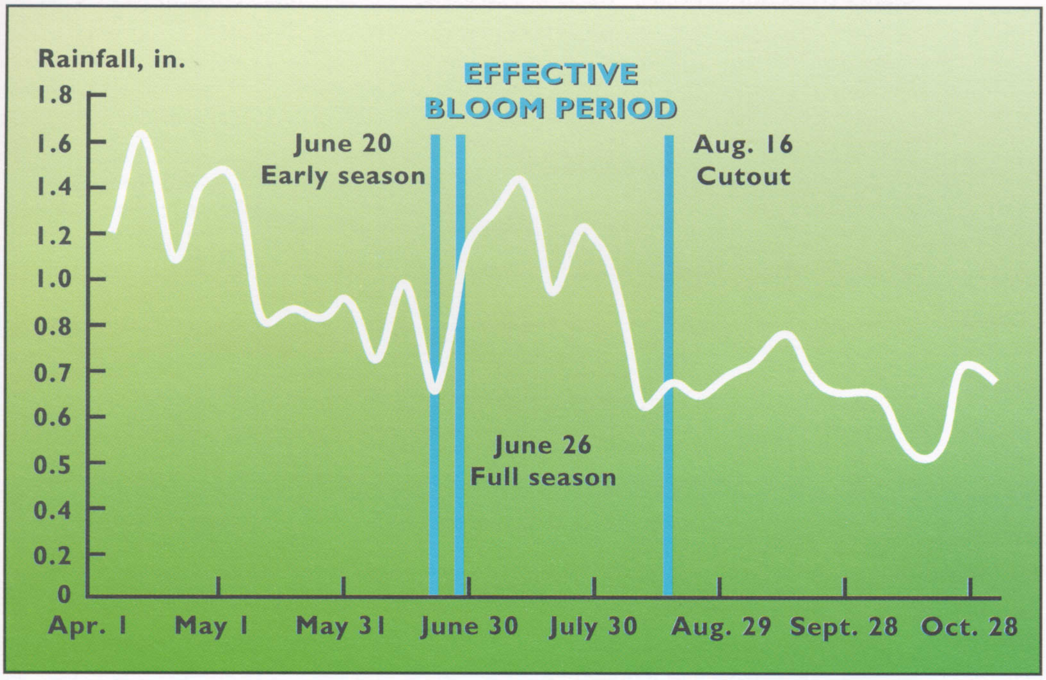
Development landmark	Very early	Early	Medium
Germination	50	50	50
Planting to 1st square	50 (350)	400 (400)	400 (400)
1st square to early bloom	350 (700)	400 (800)	400 (800)
Early bloom to cutout	350 (1,050)	450 (1,250)	550 (1,350)
Cutout to harvest	500 (1,550)	500 (1,750)	500 (1,850)

[1]Information compliments of Dr. David Guthrie, Stoneville Pedigreed Seed Company, Stoneville, MS.
Number in ( ) is cumulative DD60 total.

Table 2. 100-Year Simulated Average Dates Using the EPIC Program on Conventionally Tilled Decatur Silt Loam[1]

Temperature benchmark	Date
Last spring frost	April 4
First day of positive DD60s	April 1
First day DD60 >10	April 7
Soil temperatures at 4 inches	
10-day average >60°F begins	April 10
4 days > 62°F begins	April 10
3 days > 65°F begins	May 1
Optimum germination temperature	
68° F >3 days begins	May 4
First fall frost	Oct. 30

[1]Corresponds with published data from extension, NRCS soil survey reports, and other literature.



The Average Weekly Rainfall chart for 100-year simulations indicates a rainy period normally occurs in late June and early July.

For the cotton plant to optimally produce during this period (first bloom to Aug. 16), 0.3 inch of water daily or 2.1 inches per week are needed to prevent any moisture stress. The rainfall chart shows that 0.7 to 1.5 inches per week are from summer rains; unless irrigated, the rest must come from water stored in the soil and that is if all rain goes into the soil and is then available to the plant. Therefore, management practices to control runoff and increase soil organic matter and available water holding capacity are vital to overcoming this shortfall. The best way to control runoff and increase soil organic matter is through the use of cover crops, regardless of the amount of tillage. In conservation tilled systems, research at the Tennessee Valley Substation in Belle Mina has shown that cover crops ameliorate the compaction problems inherent in North Alabama soils. In addition, research has shown yield increases and improved weed control through the use of properly managed winter cover.

Killing the cover crop in February or early March does not allow the crop to get the early spring growth spurt from the rising temperatures of March and early April. Empirical data and EPIC simulations show that covers killed at this time yield only about 1,500 pounds per acre biomass and give about 50% coverage. A 100-year simulation of a winter rye cover showed that by moving the cotton planting date to late April or early May and killing the cover crop three weeks prior to planting, residue inputs from cover crops can double. These simulations correspond well with research conducted at the Tennessee Valley Substation and as much as 4,500 pounds residue dry matter per acre can be expected in North Alabama with this management scheme.

Weather and soil climate data simulated for 100 years indicate planting cotton in the Tennessee Valley before May 1 may be risky. Cotton growers should plant by the thermometer, not the calendar. Low soil temperatures and slow accumulation of growing degree days (DD60s) can cause yield reductions from poor germination and disease. Soil conditions tend to be optimum for germination around late April to early May. By delaying the planting date a couple of weeks or more from the regional norm of April 15, growers are able to get the full benefit of their cover crop dollar with biomass production doubling when the cover grows through March.

Planting when soil temperatures are around 65°F allows for rapid germination and cotton reaches its effective bloom period in time for the normal summer rainfall peaks, which tend to occur in late June and early July. This later planting date still gives the plant enough DD60s to mature before the first frost (Oct. 30). Additional measures to ensure boll maturation include using early maturing varieties, managing to reduce stress from nutrient deficiencies and insect control, and reducing drought stress by increasing soil water storage and availability with conservation systems leaving adequate residue from cover crops.

Norfleet is a Soil Scientist of USDA-NRCS Soil Quality Institute; Reeves is an Agronomist of USDA-ARS-NSDL; Burmester is an Extension Research Cotton Specialist; and Monks is an Associate Professor of Agronomy and Soils.

New Chemical May Provide Answer to Control of Bacterial Spot of Peach

Lee Campbell, Bill Moss, Jim Pitts, Bobby Boozer, Jim Bannon, and Mark Wilson

Bacterial spot, caused by *Xanthomonas campestris pv. pruni*, is a serious disease of peach that affects leaves, twigs, and fruit. This disease may cause severe defoliation, which will reduce fruit size and will weaken the tree if it occurs early in the summer. The most serious economic impact results from fruit infection, which may render the entire crop unmarketable in years when bacterial spot is severe.

AAES researchers have obtained moderate levels of control of bacterial spot on peaches using an experimental product CGA-245704, which is currently being developed by Novartis Crop Protection Inc.

Bacterial spot occurs in the United States in all peach growing regions east of the Mississippi River but is more prevalent in areas where the environment is warm and humid, such as Alabama. Cultivars introduced into the Southeast from California (where bacterial spot does not occur), especially the cultivar O'Henry, are most susceptible to bacterial spot. Previous AAES research has shown that the use of some common fungicides may even increase incidence of bacterial spot on susceptible cultivars.

CGA-245704 induces systemic resistance in the plant by activating natural defense mechanisms that result in disease control. CGA-245704 is being tested for bacterial spot in peaches because copper bactericides have been relatively ineffective in controlling bacterial spot, since they are limited to dormant or early season use because of phytotoxicity.

Field trials were conducted at the Chilton Area Horticulture Substation (CAHS) in Clanton and the E.V. Smith Research Center (EVS) in Shorter in the summer of 1997. Peach

Table 1. Severity and Incidence of Bacterial Spot on Fruit

Treatment	Disease rating[1]	Reduction	Infected fruit[2]	Reduction
		Pct.	Pct.	Pct.
Nontreated control	2.56	–	97.2	–
CGA-245704	1.98	23.0	74.4	24.2

[1]Ratings were made from 25 fruit per replicate (250 fruit) and based on 1 (<25% surface covered) ; 2 (26-50%); 3 (51-75%); 4 (>75%).
[2]Represents the number of fruit on which lesions appeared.

Bacterial spot of peach on young fruit of cultivar O'Henry.

cultivar O'Henry was used at both locations since any product that provides moderate spot control on this cultivar likely will give excellent spot control on less susceptible cultivars. During the trial, daytime temperatures averaged 79.9°F at EVS and 78.2°F at CAHS and rainfall was 19.3 inches at EVS and 23.3 inches at CAHS.

CGA-245704 was applied to peach foliage weekly at recommended rates (0.24 pounds active ingredient per acre) beginning at first leaf bud break and continuing to fruit harvest. Thirteen applications were made to leaves and young developing fruit. Disease incidence and severity ratings were made on May 29, June 5, and June 27 at CAHS and June 5, July 3, and July 9 at EVS. Severity ratings represent the mean number of lesions per leaf and were based on a sample of 30 leaves per replicate with five replications.

Trees in field trials at CAHS were bearing fruit for the first time and trees at EVS were not yet bearing. Twenty-five fruit per replicate per treatment were harvested on July 1 at CAHS. Ratings were based on the percentage of fruit surface covered by lesions: 1 = less than 25% of fruit surface covered, 2 = 26-50% covered, 3 = 51-75% covered, and 4 = greater than 75% covered. Only fruit in category 1 would be considered marketable.

Disease severity ratings on foliage showed that over three sampling periods CGA-245704 significantly reduced severity of bacterial spot compared to the nontreated control. This was also reflected in the fruit ratings where 29% of the infected fruit was rated 1 in the CGA-245704 treatment compared to the nontreated control in which only 4% of the infected fruit had a rating of one. Hence, the use of CGA-245704 resulted in 25% more marketable fruit in this trial.

These results show that CGA-245704 provides partial control of bacterial spot. This finding is consistent with the results of an independent study in North Carolina in which CGA-245704 reduced the incidence of spot on fruit and foliage in moderately susceptible cultivars (D.F. Ritchie, NCSU).

Based on preliminary AAES research results, CGA-245704 offers hope that this disease may be controllable, allowing the introduction of new California varieties. Ongoing research will assess the benefits of combining CGA-245704 with oxytetracycline (Mycoshield™) on spot incidence and severity, and on weight and number of marketable fruit. It is hoped that when this product is available on the U.S. market, researchers will have established the appropriate rate and frequency of application to be used by peach growers.

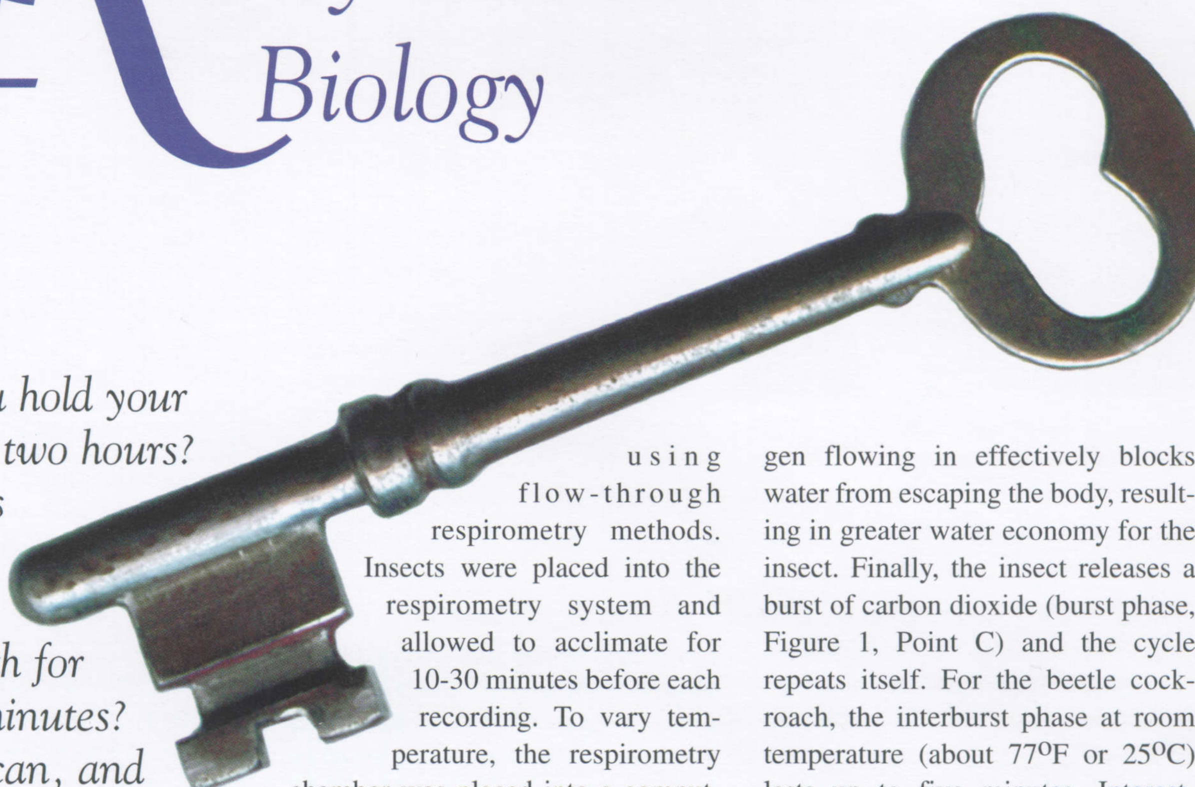
Campbell is a Research Specialist and Moss is a Graduate Student of Plant Pathology; Pitts is Superintendent and Boozer is Area Horticulturist at the Chilton Area Horticulture Substation; Bannon is Director at the E.V. Smith Research Center; and Wilson is Assistant Professor of Plant Pathology.

Table 2. Severity of Bacterial Spot on Foliage

	Test 1- CAHS						Test 2- EVS					
	Disease severity rating #1		Disease severity rating #2		Disease severity rating #3		Disease severity rating #1		Disease severity rating #2		Disease severity rating #3	
Treatment	Mean[1]	Reduction	Mean	Reduction	Mean	Reduction	Mean	Reduction	Mean	Reduction	Mean	Reduction
		Pct.		Pct.		Pct.		Pct.		Pct.		Pct.
Nontreated	1.9	–	2.2	–	2.4	–	2.4	–	2.1	–	3.0	–
CGA-245704	1.6	16.0	1.5	43.2	1.6	9.5	1.9	25.6	1.7	28.1	20	35.4

[1]Represents the mean number of lesions per leaf from 30 leaves per replicate row.

Respiration Patterns Play Key Role in Pest Biology



Can you hold your breath for two hours? Some ticks can! Can you hold your breath for even 15 minutes? Fire ants can, and even longer!

Many insects and other arthropods such as ticks exhibit a discontinuous pattern of respiration. From the animal's perspective, periodic release of respiratory gases decreases the amount of body water lost during exhalation and aids respiration in high carbon dioxide, low oxygen nests and tunnels. Of particular interest from a pest control perspective, periodic respiration can prevent rapid inhalation of fumigants and other insecticides.

Respiration patterns of the beetle cockroach, *Diploptera punctata*, and red imported fire ant, *Solenopsis invicta*, were examined using flow-through respirometry methods. Insects were placed into the respirometry system and allowed to acclimate for 10-30 minutes before each recording. To vary temperature, the respirometry chamber was placed into a computer-controlled incubator. Dry, carbon dioxide-free air was pulled through a respirometry chamber containing the insect and into a carbon dioxide analyzer. Air flow was regulated with a mass-flow controller and the concentration of carbon dioxide in the air stream was recorded at one second intervals with a computer.

Discontinuous gas exchange can be broken down into three distinct phases. During the closed phase, the insect is not releasing any carbon dioxide (Figure 1, Point A). Following the closed phase, some carbon dioxide escapes from the insect (Figure 1, Point B). It is during this time that the insect is taking oxygen into the body, and the oxygen flowing in effectively blocks water from escaping the body, resulting in greater water economy for the insect. Finally, the insect releases a burst of carbon dioxide (burst phase, Figure 1, Point C) and the cycle repeats itself. For the beetle cockroach, the interburst phase at room temperature (about 77°F or 25°C) lasts up to five minutes. Interestingly, only motionless cockroaches that assume a resting posture respire discontinuously. The interburst period of the red imported fire ant is temperature sensitive (Figure 2) and ranged from about 40 minutes at 50°F (10°C) to almost one minute at 104°F (40°C). Respiration patterns of native subterranean termites *Reticulitermes sp.* and the Formosan subterranean termite, *Coptotermes formosanus*, have also been examined. At room temperature, workers and soldiers respire continuously (Figure 3). These results are interesting because subterranean termites live in closed nests with low levels of oxygen and high concentrations of carbon dioxide; exactly the condi-

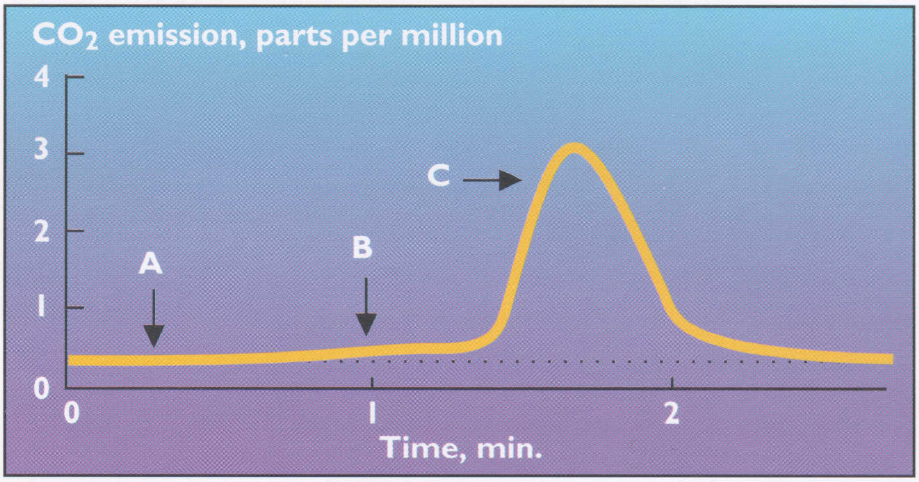


Figure 1. Burst and interburst periods of a discontinuous pattern of respiration.

tions for which the discontinuous pattern is thought to be adaptive.

These studies have found discontinuous gas exchange patterns in a variety of important pests including cockroaches, fleas, red imported fire ants, and several other species. The presence of discontinuous gas exchange in pest species may help to explain control failures when fumigants and other volatile insecticides are used. Further research by AAES personnel has demonstrated that exposure to contact insecticides eliminates the discontinuous pattern of respiration making the insect more susceptible to desiccation and possibly easier to control. These studies highlight the importance of understanding the basic biology and physiology of pest species to advance modern pest control.

Appel is a Professor and Vogt and Shelton are Graduate Research Assistants in the Department of Entomology.

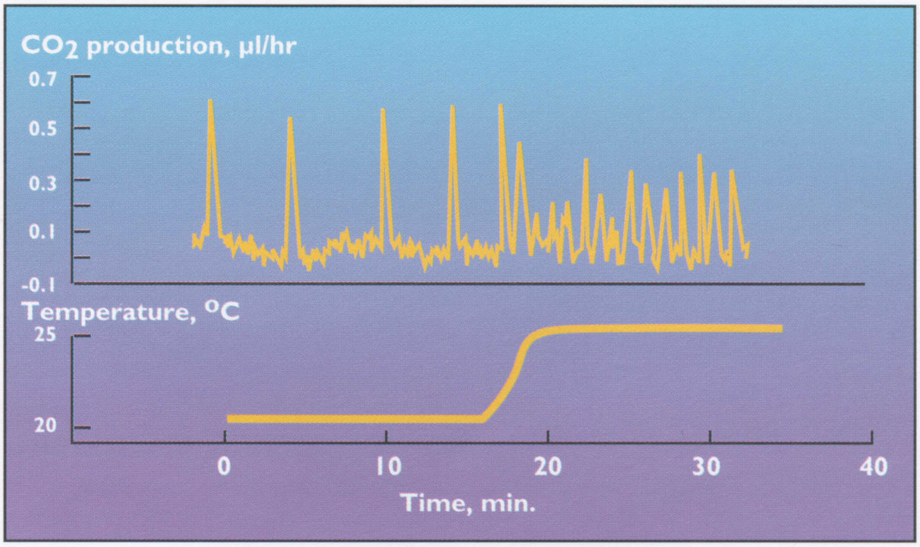


Figure 2. Interburst periods decrease with increasing temperature in red imported fire ants.

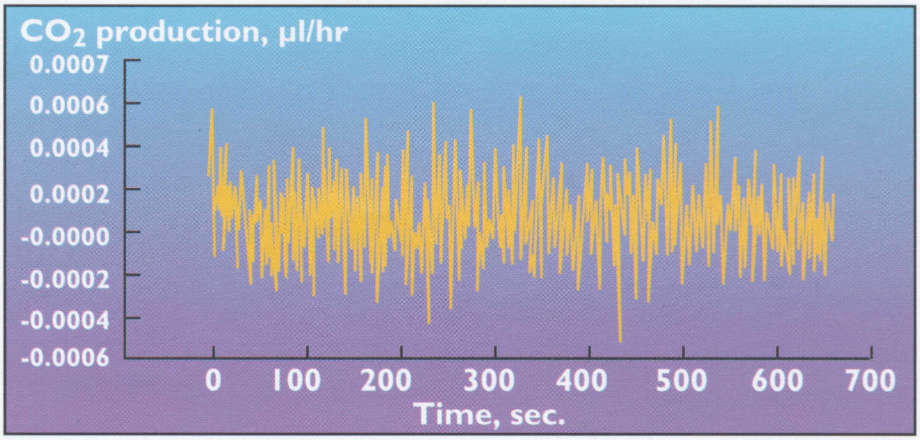


Figure 3. Continuous respiration pattern in eastern subterranean termite worker at 72°F.

Wetlands Improve Effluent Quality from a Channel Catfish Intensive Culture System

Stanislaus Sonnenholzner, Kyung H. Yoo, Michael P. Masser, John Martin, and Michael Wilcox

MOST CATFISH CULTURE effluents are discharged without previous treatment, prompting increasing environmental concerns due to the potential impact on receiving waters. Constructed wetlands have become popular as an effective technique to abate pollution from agricultural sources. The similarity of the fish waste constituents to other agricultural wastes suggest that constructed wetlands can be used to treat fish effluents. Current research at Auburn University's Fisheries Station show that catfish effluents from an intensive culture system called in-pond raceway (IPR) can efficiently be treated with constructed wetlands.

Experimental set-up of constructed wetland system.

Water quality impairment in aquaculture systems is driven primarily by feed input. Nitrogen, phosphorus, and organic matter contained in noneaten feed and feces accumulate during the grow-out period. These nutrients can cause over-fertilization, or eutrophication, of nearby streams, causing oxygen depletion, and subsequently pollution problems.

Researchers in the AAES have been studying a catfish culture system called IPR since 1991. The system produces fish at high densities, is adaptable to any type of pond, and construction characteristics allow easy feeding, observation, and harvesting. Probably the most remarkable feature of the IPR is the incorporation of a device at the end of the raceway that promotes settling of solid wastes before they enter the pond. Settled solids are then pumped into a treatment system. Constructed wetlands are used to reduce the nutrients and organic matter from these effluents.

Constructed wetlands can be conceived as a series of interactive components, i.e. water, substratum, microbial biota, flora, and fauna. Bacterial transformations and physicochemical processes are considered the major mechanisms of pollutant removal in the system. Although plants can absorb large quantities of nutrients, plant uptake is only a temporary storage mechanism, since nutrients incorporated in tissue are released back to the system after their death. The main role of vegetation is to provide a substrate for microbial growth and for transmission of oxygen through the air spaces of stems and leaves to the root zone. Excess oxygen not used by root respiration becomes available for microbial respiration, which is required to drive biochemical processes including oxidation and decomposition of organic matter and nitrification.

To evaluate the effectiveness of constructed wetlands in treating IPR

Wetlands, continued on page 24

Wetlands, continued from page 23

effluents, a set of nine plywood boxes filled with gravel and planted with either cattail/soft rush or water hyacinths was constructed. Two experiments were conducted during June-September 1996 and 1997. Water samples were collected on a weekly basis from the inflow and outflow of each wetland system and chemically analyzed to determine percent reduction in biological oxygen demand (BOD), total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP). Each experiment had a control box filled with gravel without plants and the water is periodically recirculated for additional oxygen supply. Air entrainment occurred as bottom water reached the surface. Water inflow in each wetland was 76 and 81 gallons per day for 1996 and 1997, respectively. Hydraulic retention time was two days in each wetland system. The percent reductions in concentration of selected water-quality parameters after the effluent passed through the wetlands are presented in the table.

Percent Reductions in Concentrations of Selected Water Quality Parameters After Constructed Wetlands

	1996			1997		
	Nonplanted	W. hyacinth	Cattail/rush	Nonplanted	W. hyacinth	Cattail/rush
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
BOD	89.1	94.8	94.4	93.6	92.6	94.6
TSS	93.1	94.9	96.2	95.1	92.1	97.6
TN	27.3	68.5	60.7	66.6	80.5	80.2
TP	28.3	60.7	60.9	4.2	37.4	62.3

Nonplanted systems performed similar to planted systems in reducing BOD and TSS, but planted wetlands were more efficient in removing phosphorus and nitrogen from the IPR effluent. Reduction of total nitrogen in planted wetlands ranged between 60 to 81% as compared to 27 to 67% in nonplanted systems. Planted wetlands removed two to 15 times more phosphorus than nonplanted systems.

Although most catfish farmers in Alabama do not need discharge permits under current regulations, changes in effluent regulations are expected in the future. Therefore, studying alternative cost-effective production systems that minimize impact on the receiving water quality should be beneficial for the future success of the catfish industry. The use of constructed wetlands to treat fish production effluents is viable and effective as supported by this study.

Sonnenholzner is a Graduate Research Assistant of Fisheries and Allied Aquacultures; Yoo is an Associate Professor of Agricultural Engineering; Masser is an Associate Professor and Martin and Wilcox are Graduate Research Assistants of Fisheries and Allied Aquacultures.

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