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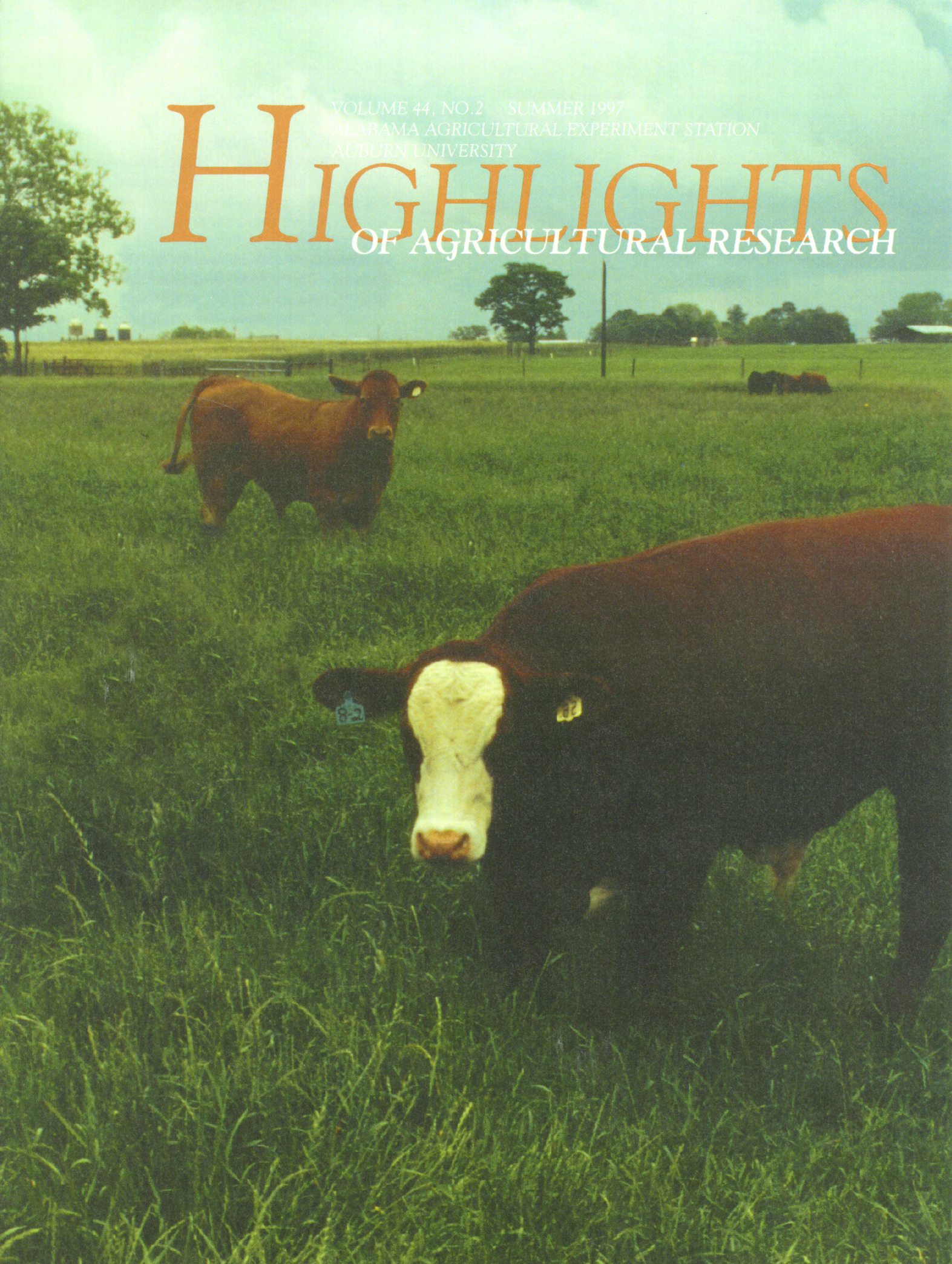
ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY

HIGHLIGHTS OF AGRICULTURAL RESEARCH



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ON THE COVER: AAES tests show that Marshall annual ryegrass produces more animal weight than Gulf. See related story on page 12.

from the Director

PARTNERSHIPS...

The last issue of Highlights was the Annual Report for the Alabama Agricultural Experiment Station. That report documents a partnership that AAES has with Auburn University to carry out research to supporters of agriculture, forestry, and related agribusiness in Alabama. It also emphasizes the federal and state partnership that supports AAES research.

Another important partner with AAES is the user of our information, the agricultural producer. In this case, the "user" benefits from our work, but at the same time, our project leaders benefit directly and immeasurably from the feedback and financial support that comes from these clientele who use AAES-generated research data. This is a "partnership" that is alive, well and working mutually for everyone involved.

In our annual report, we listed all research projects supported by state and federal tax dollars. Since some of these projects are also supported by gift, grant, and contract funds, I plan to also list some of special research areas supported by these outside dollars. At this time, we acknowledge proudly that producers through the following organizations provide well over $500,000 directly for agricultural research at AU:

Alabama Catfish Producers
Alabama Cattlemen's Association
Alabama Cotton Commission
Alabama Peanut Producers Association
Alabama Soybean Producers
Alabama Wheat and Feed Grain Committee
Cotton, Inc.

There are many others who partner with AAES, but this is a list of our closest partners who determine each year how much to set aside from their dollars for programs at AU. Our thanks to these partners at this time. We plan to publish a project list soon and will include a list of many others who support ag research at AU.

James E. Marion

Summer 1997 Volume 44 Number 2

A Quarterly Report of Research Published by the Alabama Agricultural Experiment Station, Auburn University

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Lupin Silage~ An Alternative Forage

Surasak Kochapakdee, Pete Moss, J.L. Lin, Wayne Reeves, and Paul Mask

Alabama's growing season is ideally suited to double cropping, but corn silage, a major forage for dairy diets, needs to be planted earlier than the date which many winter crops are harvested. However, whole plant lupin, a winter legume, can be removed sufficiently early as silage to allow most summer crops to be planted. Research at AAES indicates that lupin silage can be used in place of corn silage in dairy diets without depressing milk yield and composition if diets are adequately balanced.

A typical double cropping system in Alabama often involves a cool season small grain such as wheat and warm season annual such as soybean that can be planted in June. Winter crops unduly delay planting corn and preclude temperate corn being double cropped. Therefore, some unconventional crops such as tropical corn and hybrid pearl millet may be more desirable because they can be planted later than temperate corn. Lupin, another unconventional crop, is a winter legume which may have agronomic advantages. Ensiling such crops may provide better double cropping options as ensiling removes crops earlier than if used for grain production. However, the economic values of such silage will depend upon their use in livestock rations. A study was conducted to compare the lactation responses of dairy cows receiving these unconventional silage-based diets to those fed conventional temperate corn silage-based diets. This was one aspect of a larger double cropping system approach which involved AAES departments and the USDA-ARS.

Approximately 55 tons each of corn, tropical corn, millet and lupin were ensiled into polyethylene bags during May-August 1995 at optimum maturity stages for the different crops. A lactation study was subsequently conducted at the E.V. Smith Research Center from January to April, 1996. Ten lactating Holsteins were assigned to each of six (three temperate corn and one each of tropical corn, millet, and lupin) silage-based diets. Cows

Effect of Silage on Dairy Cow Performances[1]

Silage-based diet	DMI	MY	BF	MP	BUN
	lb./day	*lb./day*	*pct.*	*pct.*	*mg/dl*
Temperate corn	49.9a	67.8a	3.5a	2.9ab	19.7ab
Tropical corn	43.6b	59.0b	3.8b	3.0b	18.6a
Millet	37.8b	57.9b	3.7ab	2.8a	21.1b
Lupin	43.1b	62.7ab	3.6ab	2.9ab	18.4a

[1]DMI = dry matter intake, MY = milk yield, BF = butterfat, MP = milk protein, BUN = blood urea nitrogen.
Means within column with different superscripts differ ($P < 0.05$).

Lupin Silage, continued on page 4

were maintained in tie stalls and individually fed diets free choice.

The compositions of temperate corn, tropical corn, pearl millet and lupin silage used in the diets were: dry matter (%) 41.4, 30, 30.4, 26; protein (%) 7.1, 8.8, 11.9, 13.9; soluble protein (% of total protein) 44.2, 41.9, 57.4, 55.2; acid detergent fiber (%) 21.3, 31.5, 29.9, 40.7; neutral detergent fiber (%) 41.1, 56.6, 52, 54.6; and net energy for lactation (NEL) (Mcal per pound) 0.70, 0.60, 0.63, 0.52. Diets were formulated to meet requirements for 75 pounds of milk yield per day and contained similar silage content. Other ingredients were varied to obtain an equal amount of protein (15.5 %), NEL (0.73 Mcal per pound), and mineral content. Milk, milk composition, feed intake, body weight and blood samples were collected for 11 weeks.

Weight gains of cows in this study were similar across diets (0.41 - 0.63 pounds per day). Cows fed the temperate corn silage diets consumed more feed than those fed tropical corn, millet, or lupin silage (see table). Although cows on the tropical corn silage or millet silage diet gave less milk, those on the lupin silage diet produced similar milk compared to that from temperate corn diets. Milk fat and milk protein were similar for all treatments. Blood urea nitrogen from cows fed millet silage was higher than that on other diets. Since blood urea nitrogen is considered to be an indicator of protein status, this may reflect poor protein utilization of millet silage. However, this did not affect milk protein content. Data on digestibility and utilization of these diets are being analyzed and the results will explain the differences on lactation performances among different diets.

Results from this study suggest that lupin silage may be used in dairy diets based on similar milk production and milk composition to that from conventional temperate corn silage-based diets. Further evaluation is needed to determine the economic value of production per acre when the entire double-cropping system is utilized. Research is also being conducted at AAES to develop improved varieties of disease-resistant lupin for the Southeast.

Kochapakdee is a Graduate Student, Moss is a Professor, and Lin is a Research Associate of Animal and Dairy Sciences; Reeves is an Adjunct Associate Professor USDA-ARS National Soil Dynamics Laboratory; and Mask is a Professor of Agronomy and Soils.

Moving Air Repels

People don't like air blowing in their face, and neither do cockroaches!

Research by the Alabama Agricultural Experiment Station has shown that all stages of the German cockroach, the most common insect pest of home and commercial kitchens, can be repelled with moving air.

German cockroaches are important pests because they infest food and contaminate it with saliva and fecal material. Cockroaches can also transmit several pathogens and parasites, and their body parts and feces are potent human allergens.

A variety of tactics such as insecticidal baits, sprays, and dusts are used to control German cockroach infestations. Repeated use of the same insecticide often results in resistance making it more difficult to control these pests with insecticides. There are few non-insecticidal tactics available for development of integrated pest management (IPM) programs for cockroaches. Development of a nontoxic method to repel cockroaches could aid control by forcing cockroaches out of preferred and difficult to treat areas.

Moving air has been utilized to exclude house flies from the entrances of food-processing and storage facilities (air curtains). Utilizing moving air to augment German cockroach control could reduce the amount of insecticide applied by moving cockroaches out of hiding places and onto insecticide deposits.

To test the repellency of moving air, an electric version of the classic Ebeling choice box was developed (Figure 1). The electric choice box consisted of two parallel plastic pipes with an access hole between them. One pipe was painted black and equipped with a fan and restrictor plate to adjust air flow between 0 and 4.75 meters per second. Household forced air conditioning and heating systems produce air velocities of 4-5 meters per second at the vent register.

Cockroaches

Art Appel, Donny Oswalt, Lane Smith, and Joe Koon

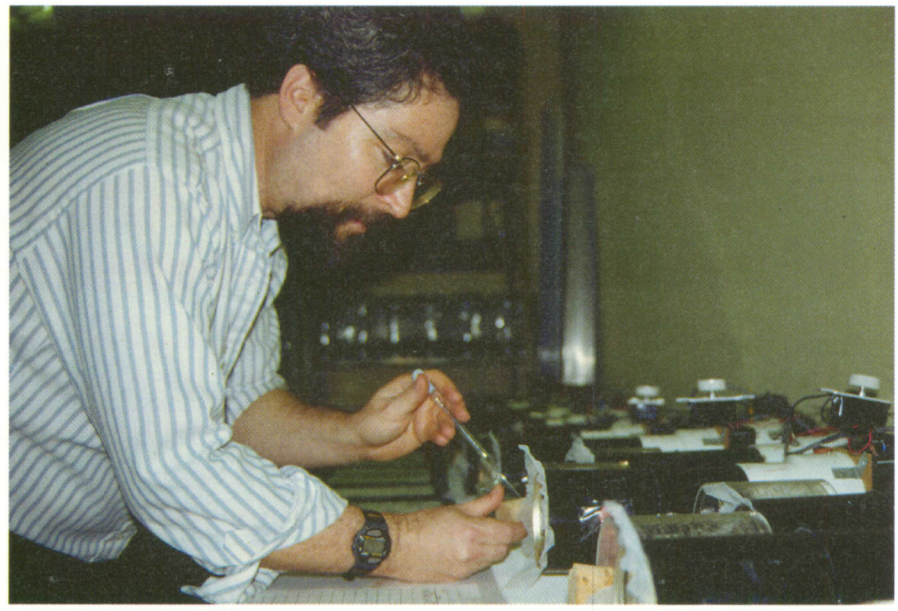


Figure 1. Appel prepares electric choice boxes for cockroach study.

Therefore the range of air velocities tested are quite relevant to air flows found in typical Alabama homes. The other pipe was clear and supplied with a piece of dry dog food and a cotton water wick.

Cockroaches could choose to enter the dark pipe (where they would normally hide) and be exposed to an air flow or remain in the light and in still air. Repellency in this study was therefore relative to that of light.

Adult or immature cockroaches were placed into the electric choice boxes and allowed to select the dark (with moving air) or light side. Choice boxes were run for five days in a room where lights were turned on for 12 hours per day. The position (light or dark side) and condition (living or dead) of each cockroach in each box was recorded approximately 10 a.m. each morning (four hours after the lights were turned on).

All stages of the German cockroach were repelled by flowing air. Repellency increased with increasing air velocity between one and about 3.75 meters per second, reaching almost 90% at 3.75 meters per second (Figure 2). Air velocities below one meters per sec were not detected by most stages; and velocities above 3.75 meters per second did not increase repellency because the cockroaches could not discriminate greater velocities.

In tests with simulated kitchen cabinets, cockroaches were moved from their preferred resting places at the top of the cabinet to the bottom of the cabinet (Figure 3) in response to moving air. If cockroach populations can be moved out of preferred resting areas, they might be directed to insecticidal baits placed on the bottom of cabinets and beneath stoves and refrigerators. In addition, air flow could prevent infestations by repelling cockroaches from sheltered locations to areas that could not support population growth. In conclusion, strategic redirection of air flow into potential cockroach resting places could provide another low toxicity tool for control of German cockroaches.

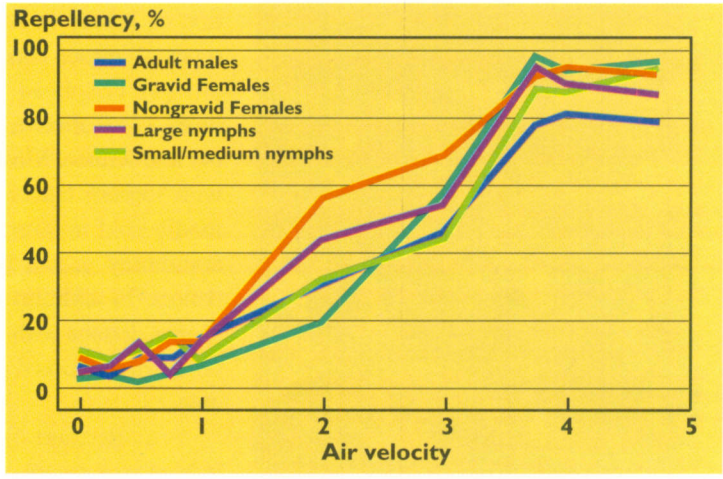
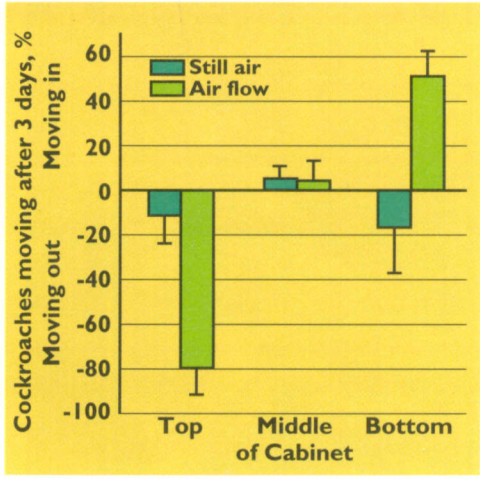


Figure 2, above. Percentage of German cockroaches repelled at various air velocities.
Figure 3, below. Relative change in position of German cockroaches exposed to 4.75 meters per second air velocity in a simulated kitchen cabinet.



Appel is an Associate Professor, Oswalt is a Former Graduate Student, and Smith is Post-Doctoral Fellow of Entomology; and Koon is an Associate Professor of Agricultural Engineering.

Can Tasty Lettuce Be Grown in Alabama?

Amy Simonne, Eric Simonne, John Owen, Larry Wells, and Ron Eitenmiller

IT IS OFTEN SAID that lettuce grown in Alabama is too bitter because of the weather, and that red lettuce is more bitter than green. An AAES study assessing bitterness by sensory evaluation in various types of lettuce revealed that acceptable quality and good tasting lettuce can be grown in Alabama.

Presently, commercial production of lettuce in the United States exceeds 205,000 tons annually, and is mainly located in California. Although lettuce is a popular crop in home gardens, no commercial production of lettuce in Alabama exists. Main types of lettuce commercially available are (1) crisphead (iceberg) [head lettuce], (2) Romaine, (3) butterhead, and (4) leaf lettuce. Most people are familiar with iceberg lettuce because it is commonly sold in stores, but leaf lettuce is commonly grown by many home gardeners. In addition to variation in head shapes, lettuce with different foliage colors from traditional greens also are available.

Because the harvestable part of lettuce is a rosette of leaves, any foliar damage caused by insects, viruses, or fungi reduces marketability. The main objective of lettuce breeding programs is to produce lettuce resistant to several viruses and diseases. Resistant genes from wild *Lactuca* species are often used as sources of resistance to viruses and other diseases. However, incorporating resistant genes from *L. saligna* or *L. virosa* often lead to increased levels of sesquiterpene lactones which are the bitter compounds of the latex of the wild lettuce . Over 500 types of sesquiterpene lactones are present in Compositae plants. Little information exists on the relationship between bitterness and the sesquiterpene lactones levels and the lettuce acceptability.

Commercially available lettuce varieties (Table 1) were grown at the Wiregrass and Piedmont Substations following current fertilization and pest control recommendations. At maturity, lettuce was hand harvested, washed and cut into bite-size pieces similar to those found in tossed salads. Lettuce samples were served one by one to a group of 15 trained panelists. Panelists were trained prior to the tasting session. The training session consisted of providing each panelist with a series of caffeine solutions with increasing bitterness and their corresponding bitterness rating (0% = 0, 0.05% = 2, 0.08% = 5, 0.15% = 10 and 0.20% = 15). Hence, when the trained panelists were used, it was possible to quantify panelist response in numeric scores. Panelists were instructed to calibrate their taste using the caffeine solutions between each sample.

Mean, most frequent, lowest and highest scores for each lettuce variety and growing locations are presented in Table 2. Scores varied considerably between panelists. Although significant differences between varieties were found, 28% (five out of 18) of the entries were given the highest score of seven or less. Most prevalent scores were less than four, suggesting that the lettuce was not bitter or was very little bitter. Although, depending on the individual, bitterness scores of less than seven would be considered acceptable as commented by trained panelists. Panelists did not reject red or purple lettuce. Growing conditions

seemed to affect bitterness scores. This study suggests that it is possible to grow non-bitter, pleasant tasting lettuce in Alabama. Future studies will focus on determining the impact of cultural practices and harvest dates on sensory attributes of lettuce.

A. Simonne is a Post Doctoral Fellow in the Department of Nutrition and Food Science; E. Simonne is an Assistant Professor in the Department of Horticulture; Eitenmiller is a Professor in the Department of Food Science and Technology, University of Georgia; Owen is Superintendent of the Piedmont Substation; and Wells is Superintendent of the Wiregrass Substation.

Table 1. Seed Source, Head Types and Disease Claims of Selected Lettuce Varieties

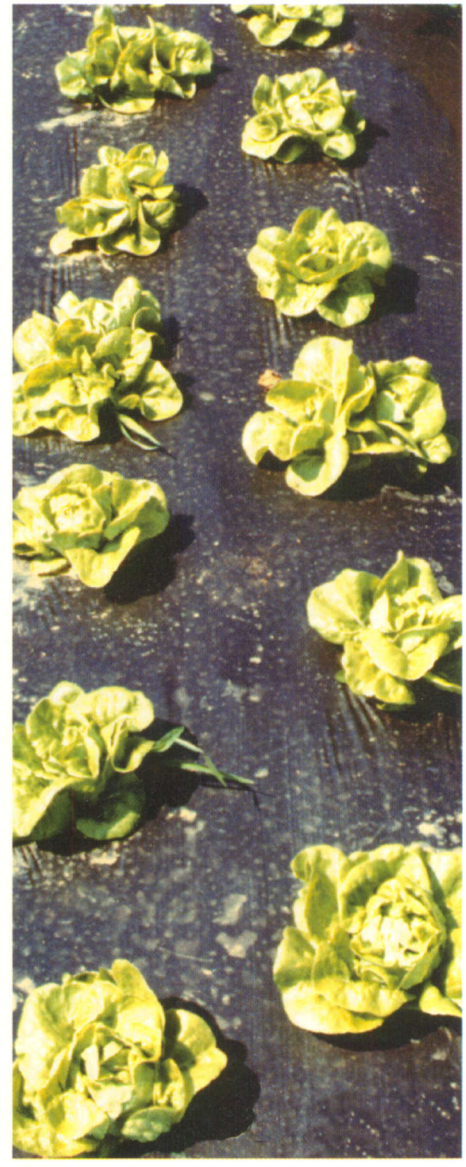
Variety	Seed source	Head type	Leaf color	Disease claims
Big Curly	Vilmorin	Maraichere	Green	.
Brunia	Vilmorin	Oakleaf	Green/Red	.
Cabernet Red	Asgrow	Looseleaf	Red	.
Epic	Sakata	Crisphead	Green	.
Greengo	Asgrow	Looseleaf	Green	.
Legacy	Takii	Crisphead	Green	.
Nancy	SeedWay	Butterhead	Green	.
Nevada	Vilmorin	Batavia	Green	DM,LMV,TB
Optima	Vilmorin	Butterhead	Green	DM,LMV
Parris Island	Stokes	Romaine	Green	TB
Redprize	Ferry-Morse	Looseleaf	Green/Red	TB
Red Salad Bowl	Vilmorin	Oakleaf	Red	.
Salinas 88 Supreme	Sakata	Crisphead	Green	LMV
Sierra	Vilmorin	Batavia	Green/Red	DM,TB,LMV
Slobolt M.I.	Harris Seeds	Looseleaf 'Frisee'	Green	—

LMV = Lettuce Mosaic Virus; TB = Tip Burn; DM = Downy Mildew.

Table 2. Sensory Evaluation of Bitterness in Lettuce Varieties[1]: Bitterness Score

Variety	Type	Location[2]	Mean score (n)	Most frequent	Lowest	Highest[3]
Epic	Head	WS	1.6 (14)	1	0	6
Salinas	Head	WS	1.6 (14)	0	0	4
Nevada	Batavia	PS	2.0 (16)	0	0	9
Red Prize	Leaf	WS	2.2 (14)	2	0	7
Legacy	Head	WS	2.3 (14)	1	0	7
Sierra	Batavia	PS	2.5 (16)	2	0	7
Nancy	Butterhead	WS	2.9 (14)	3	0	10
Red Salad Bowl	Oak leaf	WS	3.2 (14)	0	0	11
Brunia	Oak leaf	PS	3.3 (16)	1	0	10
Cabernet Red	Leaf	WS	3.5 (14)	2	1	13
Parris Island	Romaine	WS	3.6 (14)	3	0	14
Slobolt M.I.	Leaf	WS	3.8 (14)	2	0	10
Optima	Butterhead	WS	4.1 (14)	2	0	12
Optima	Butterhead	PS	4.9 (16)	0	0	13
Greengo	Leaf	WS	5.2 (14)	5	1	15
Nancy	Butterhead	PS	8.4 (16)	4	0	15
Big Curly	Maraichere	PS	9.3 (16)	13	0	15
Slobolt M.I.	Leaf	PS	10.1 (16)	15	1	15

[1] For more details of yield performance of these lettuce varieties, see 1996 Spring Variety Trial Report.
[2] PS = Piedmont Substation; WS = Wiregrass Substation
[3] Highest scores reflect highest levels of bitterness in taste panel evaluation.



WEEDS IN PEANUTS? WHY NOT JUST MOW THEM OFF?

Glenn Wehtje, Larry Wells, Rob Martin, and Ron Weeks

Sporadic clumps of weeds waving above the peanut canopy is a common late-season sight in peanut country. These weeds probably represent a small percentage of the total weed population that somehow managed to escape the weed control program that was used by the grower. Yet, these escapes are easily noticed and often reflect negatively on a grower's ability to control weeds. So why not just mow the weeds and avoid the use of herbicides?

First, much of the competitive ability of weeds is already inflicted on the crop by the time weeds extend above the peanut canopy. Mowing is simply too little too late. Secondly, weed foliage that is thrown onto the peanut canopy during mowing can serve to retain disease-promoting moisture within the canopy.

But in all honesty, mowing may have some validity. Mowing is cheap and non-herbicidal, which is a benefit in the opinion of some. And mowing is being used by some growers. In addition, data to back up the case against mowing does not exist. A review of the literature over the past decades recovered no studies in which mowing was honestly evaluated and compared to herbicides. In contrast, several studies were found (circa 1920-30) in which mowing was recommended as a method for controlling weeds in small grains. Apparently, what support mowing may have had in the past dwindled as herbicides became available from the 1950s.

A recent AAES test evaluated this mowing question. Experiments were established at the Wiregrass Substation. Treatments consisted of weed control inputs (i.e. commonly used herbicides and/or cultivation) that ranged progressively downward from adequate (System 1) to none (System 5). These treatments were then supplemented with either none, one, two, or three mowings. If mowing was beneficial, it should make the performance of the subadequate treatments equal to that of the more adequate systems. Mowing was preformed with a 'Bush-hog' type mower, and was done whenever weeds extended above the peanut canopy by about six inches. Data collected included visual

Table 1. Herbicide and Cultivation Systems for which Mowing was Evaluated as a Supplemental Weed Control Input; 1993-95

Herbicide/ cultivation system	Degree of inputs	Herbicide applications[1]		
		1st application (within 2 wks of emergence)	2nd application (row closure)	Cultivatio
1	adequate	Starfire+ 2,4-DB	Classic +2,4-DB	once
2	marginally adequate	Starfire+ 2,4-DB	Classic	once
3	subadequate	Starfire+ 2,4-DB	None	once
4	subadequate	none	none	twice
5	very subadequate	none	none	none

[1] Typical applications rates were observed for all herbicides, and were follows; paraquat, 11 oz/a; 2,4-DB 1 pt/a, and classic 0.5 oz/a. A nonior surfactant (X77) was included in all herbicide applications at 0.25% v/v.
[2] '+' indicates tank mixture.

weed control at the end of the season, disease occurrence and yield. Net returns were calculated from the yield data.

Without any mowing, System 1 (adequate) was the most effective. Control of bristly starbur sicklepod and Florida beggarweed was at least 80% (data not shown). With this system mowing offered no improvement in control over what was obtained by the herbicides and cultivation alone. Mowing tended to improve weed control in the remaining systems. Generally a single mowing was nearly as effective as either two or three mowings.

Defoliation due to foliar diseases tended to reflect the amount of weed control inputs. Minimum defoliation (31%) occurred in System 1 (adequate weed control inputs, data not shown). Conversely, maximum defoliation (39%) occurred in System 5 (no inputs). This probably can be attributed to uncontrolled weeds interfering with fungicide application. With System 5 in 1994 and 1995, and System 4 in 1994 mowing reduced defoliation. No treatment-induced differences were detected in the occurrence of southern stem rot (often called white mold) in 1995. Southern stem rot was much more prevalent in 1994 than in 1995; and mowing generally increased its incidence.

Yield and net return results from 1993 were different than that obtained in 1994 and 1995. Rainfall during the 1993 growing season (April through August) was 17% less than the long term average. Conversely, rainfall in 1994 and 1995 exceeded the long term average by at least 30%.

In 1993, maximum yield and net return without mowing was obtained with System 1 (3,895 pounds per acre and $98 per acre). Yields of Systems 2-5 generally reflected the degree of weed control inputs, with System 5 (nontreated) yielding the least. Net returns on these systems without mowing were all negative. However, in only one incidence did mowing have a significant beneficial effect on yield and net return in 1993. A single mowing increased the yield of System 3 (subadequate inputs) by 20%; net return increased from -32 to +37 dollars per acre. Two and three mowings resulted in further (though non significant) increases in both yield and net return.

Yields in 1994 and 1995 without mowing also reflected the degree on weed control inputs. System 1 and System 5 having the highest and lowest yields, respectively. Here again, in only one incidence did mowing have a benefit. A single mowing increased the yield of System 5 by 6% and net return by 42%. While mowing was clearly beneficial, this would be generally considered a salvage situation

These results serve to validate the original skepticism against the concept of mowing as a means of weed control. As expected, mowing lessened the visual impact of weeds and rendered the peanut canopy more visible. The impact of mowing on disease occurrence was variable. Leaf spot-induced defoliation was aggravated by the lack of weed control inputs; and in this case mowing served to improve disease control. In contrast, mowing occasionally enhanced the occurrence of southern stem rot. Mowing did improve yield and net return in a few isolated incidences. Yet even with mowing-based improvements, crop performance remained inferior to that obtained with typical weed control systems. Consequently, as a weed control input, mowing can be viewed as marginally effective and somewhat unreliable. A comprehensive, herbicide- and cultivation-based weed control program can easily render mowing unnecessary.

Table 2. Yield and Net Return of Peanuts as Influenced by 0 to 3 Mowings; 1993-5[1]

Year	System[2]	Yield				Net return			
		0	1	2	3	0	1	2	3
		lb./acre				*dollars/acre*			
1993	1	3,895	3,662	3,483	3,580	98	70	43	58
	2	2,927	3,168	3,289	3,435	-36	13	20	42
	3	2,782	3,374*[3]	3,410*	3,556*	-32	37*	47*	56*
	4	2,902	3,241	3,241	3,532	-16	17	10	41
	5	2,105	1,645	1,742	2,347	-183	-293	-270	-143
1994-1995	1	4,182	4,080	3,936	3,996	140	115	97	107
	2	4,086	4,109	4,105	4,037	122	125	124	114
	3	4,177	4,879	3,964	3,719	143	99	113	75
	4	3,951	3,864	3,783	3,869	109	77	61	89
	5	3,796	4,032*	3,704	3,751	78	111*	42	67

[1]Rainfall during the growing season (April through August) was 10.9, 33.1 and 17.1" for 1993, 1994 and 1995, respectively. Long term average for this period is 13.1"
[2]Systems are described in Table 1.
[3] * indicates significant difference between this value and the corresponding value without mowing, according to the appropriate LSD values at the 0.10 level.

Wehtje is a Professor of Agronomy and Soils, Wells is Superintendent of the Wiregrass Substation, Weeks is an Associate Professor of Entomology, and Martin is a Professor of Agricultural Economics and Rural Sociology.

Novel Chemicals Control Bacterial Spot &

Bacterial spot, caused by the pathogen Xanthomonas axonopodis pv. vesicatoria, *is a disease of tomatoes and peppers that can seriously affect yield. The disease is commonly controlled with copper-based bactericides; however, concerns about copper accumulation and contamination of soils and the development of copper resistance in some bacteria are encouraging the development of new bactericides. AAES research is evaluating the effectiveness of reduced-copper and noncopper bactericide formulations that have been developed for the control of bacterial diseases of tomato and pepper.*

Kocide 2000 and Mankocide (Griffin Corp.) are new formulations currently available with reduced copper content (compared to Kocide DF, the most widely used bactericide on the market). The products have 53.8% and 46.08% copper hydroxide, respectively, as compared to 61.45% copper hydroxide in Kocide DF. These were introduced in an effort to reduce environmental contamination without a decrease in disease control.

Recently, copper resistance has developed in the pathogen population. A new noncopper product, CGA-245704 (Ciba Crop Protection, Inc.), is being tested that uses systemic activated resistance (SAR) to control bacterial diseases. SAR refers to the ability of a product to activate the natural defense mechanisms within a plant that will result in disease control.

Field trials were conducted at the E.V. Smith Research Center in Shorter in the summer of 1995 and in the summer and fall of 1996. Pepper cultivar Ranger was used in the field trials in 1995. Tomato cultivar Celebrity was used in summers of 1995 and 1996 and tomato cultivar Agriset 761 was used in fall 1996. During the trial, temperatures averaged 73°F in 1995 and 71°F in summer and 70°F in fall 1996. Rainfall was 7.25, 12.08, and 15.29 inches, respectively, during the same period.

In the 1995 trial, various bactericides (see Table 1) were applied weekly to pepper and tomato plants according to recommended rates. A total of 10 applications were applied to the plants. Disease incidence ratings were made on July 7 and represented the number of infected leaves per

Table 1. Results from 1995 Field Trials

Treatment	Incidence (%)[1]	Severity (%)[2]
Nontreated control	54.6	74.3
GX 261Z	34.2	75.7
GX 306	52.1	73.8
Kocide DF	36.3	78.2
Kocide DF + Manex	43.8	76.7
Fluazinam (0.5 pt./acre)	64.3	70.8
Fluazinam (0.75 pt./acre)	56.7	71.7
Fluazinam (1.0 pt./acre)	44.0	75.9

[1]Incidence represents the percentage of infected leaves per replicate row. 50 leaves were sampled per replicate row (7/13/95).
[2]Severity was calculated from the number of empty nodes on sampled plants (7/28/95).

May Reduce Copper Contamination Problems

H. Lee Campbell, Mark Wilson, and Jan M. Byrne

Bacterial spot on tomatoes.

replicate row. Disease severity (percentage defoliation) was measured on July 13 by counting the number of empty nodes on sampled plants as a proportion of total node number.

In 1995, Kocide 2000 (GX306) and Mankocide (GX261Z) gave control of bacterial spot on pepper comparable to or better than Kocide DF (Table 1). Fluazinam (ISK Biosciences) is an experimental fungicide with activity against bacteria. It is a noncopper based product and it did not provide significant reductions in bacterial spot incidence or severity.

In the 1996 summer trial, bactericides were applied weekly to tomatoes according to recommended rates. A total of 10 applications were made. Disease severity ratings on the foliage were made on June 27 and July 9 and were based on a visual rating of the total percentage of infected foliage on the plant.

In the 1996 fall trial, bactericides were applied to tomatoes weekly according to recommended rates, and nine applications were made. Foliar disease intensity ratings were measured on Oct. 17, Oct. 24, and Nov. 1 and were based on a sample of 30 leaflets per replicate row.

In 1996, Kocide 2000 and Mankocide both gave disease control comparable to or better than Kocide DF alone (Table 2) and the experimental product CGA-245704 reduced incidence and intensity of bacterial spot of tomato in both spring and fall field trials. When applied in combination with Kocide DF and Manex the percent disease reduction provided by CGA-245704 was greater than that provided by CGA-245704 or Kocide DF alone.

These results show that CGA-245704 gives superior control of bacterial spot compared to the currently available bactericides. Because it works by a different mechanism, CGA-245704 might be used in conjunction with copper/maneb to improve disease control. Reduced copper bactericides also gave results comparable to the most widely used bactericide, Kocide DF. As more pathogen races develop copper resistance, the market for new chemical alternatives will continue to grow. Continued research will determine the effectiveness of these products on both tomato and pepper and help determine their future availability to the grower.

Campbell is a Research Specialist, Wilson is an Assistant Professor, and Byrne is a former Research Assistant of Plant Pathology.

Table 2. Results from 1996 Field Trials

Treatments	Foliar ratings % Disease reduction				Fruit incidence % Disease reduction	
	Spring[1]	Fall[2]	Spring[3]	Fall[4]	Fall[5]	Fall[6]
Nontreated control	———	———	———	———	———	———
Kocide + Manex	44.3	38.6	6.7	58.9	64.1	9.3
Kocide DF	36.7	N/A	>1	N/A	N/A	N/A
Kocide 2000	24.6	N/A	14.5	N/A	N/A	N/A
Mankocide	37.2	N/A	11.2	N/A	N/A	N/A
Actigard (.03 lbs. a.i./acre) every 7 days	17.5	N/A	18.1	N/A	N/A	N/A
Actigard (.06 lbs. a.i./acre) every 7 days	28.4	60.2	16.5	62.6	50.0	27.4
Actigard (.06 lbs. a.i./acre) every 14 days	6.7	N/A	10.8	N/A	N/A	N/A
Actigard + Kocide/Manex	N/A	67.0	N/A	70.7	67.4	17.3

[1]Visual ratings disease severity on tomato foliage made 6/27/96.
[2]Reduction in foliar disease intensity measured by samples of 30 leaflets per replicate taken 10/17/96.
[3]Visual ratings disease severity on tomato foliage made 7/9/96.
[4]Reduction in foliar disease intensity measured by samples of 30 leaflets per replicate taken 10/24/96.
[5]Reduction in foliar disease intensity measured by samples of 30 leaflets per replicate taken 11/1/96.
[6]Reduction in disease incidence on fruit, based on percent infected fruit from a complete harvest 11/1/96.

Marshall Ryegrass Dramatically Superior Under Grazing

In grazing experiments at two locations in Alabama, on average, Marshall annual ryegrass produced 52% more animal weight gain than Gulf under grazing. This result is in stark contrast to results from mowing experiments.

Marshall is a variety of ryegrass that was developed and released by Mississippi State University in 1981. It was developed for its excellent cold tolerance, which makes it particularly suited to regions with cold winters. In fact, it is rated by most specialists as the most cold-tolerant variety on the market. However, in warmer regions the plant is not as tolerant to crown rust as Gulf.

Gulf is the first improved variety of ryegrass developed in the United States. It was released by the Texas Agricultural Experiment Station in 1958 for improved yield and improved tolerance of crown rust. However, Gulf ryegrass is low in cold tolerance.

Given the recognized difference in adaptation between these two varieties, market trends indicate that Marshall is the preferred variety as one moves North, but

David I. Bransby, Malcomb Pegues, and Randall Rawls

Left. Marshall (left) and Gulf (right) on Feb. 10, 1997.
Below. Cattle on Marshall (left and middle) at end of study in April 1997. Cattle on Gulf (right) at end of study in April 1997.

Gulf is used more in the Gulf Coast region. Mowing tests in Alabama showed that forage yields for Marshall and Gulf were similar in the South, but Marshall had a large advantage in the North. However, mowing does not

simulate grazing. This means that forage yield differences from mowing experiments do not necessarily reflect animal production differences among different forages when they are grazed.

An AAES study was conducted to compare Marshall and Gulf ryegrass under continuous grazing in both warm and cold environments, and to relate these results to data from past mowing experiments. Stocker steers were grazed on four Marshall and four Gulf ryegrass pastures at the Gulf Coast Station near Fairhope and the Upper Coastal Plain Station near Winfield in winter of 1996-97. Steers weighing about 500 pounds were turned on to the pastures in early December, and were stocked at two animals per acre at Fairhope and 1.67 animals per acre at Winfield. They were weighed every 28 days, and pasture height was measured on weigh days.

At the Fairhope location steer weight gain was 77% greater for Marshall than for Gulf (see Table 1). At Winfield, this advantage was 27%. However, the stocking rate at Winfield was above optimum, so this test served as a comparison of the two varieties under stress conditions. Cattle on Gulf ryegrass at Winfield started to lose weight in February . Therefore, supplemental hay was provided for 34 days. Steers grazing Marshall received no hay, but still gained 27% more than those onGulf. On average, pasture height across both locations was 31% greater for Marshall than for Gulf (5.09 inches and 3.90 inches, respectively).

Of particular interest is the dramatic advantage of Marshall over Gulf in the Gulf Coast region where Gulf is considered to be well adapted. This advantage was evident in the very first 28-day period, and continued to

Table 1. Weight Gain of Steers Grazing Marshall and Gulf Ryegrass in South and North Alabama

Ryegrass variety	Location					
	South			North		
	ADG	Weight gain per steer	Weight gain per acre	ADG	Weight gain per steer	Weight gain per acre
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Marshall	2.65	350	700	1.23	138	230
Gulf	1.50	198	396	0.97	109	181
Actual difference (Marshall minus Gulf)	+1.15	+152	+304	+0.26	+29	+49
Percent difference	+77%	+77%	+77%	+27%	+27%	+27%

Note: 1) In the South stocking rate was two steers per acre and cattle grazed for 132 days, but in the North stocking rate was 1.67 steers per acre and grazing was terminated after 112 days. 2) In the North cattle grazing Gulf were fed hay for 34 days in winter at a rate of 16.9 pounds per head per day, but cattle grazing Marshall ryegrass received no hay.

(see Table 2). This shows that, in this season, the superiority of Marshall was evident throughout the entire season, and not only in the middle of winter. Clearly, Marshall was superior to Gulf in both cold tolerance and tolerance to grazing, and it may also have some other production advantages that have not yet been discovered.

Rust was evident on both varieties in spring. It was more severe on Marshall, but did not seem to affect animal production. However, Jackson ryegrass is a variety that was developed from Marshall, and it has similar cold tolerance but greater tolerance to crown rust. Therefore, if rust is of concern, Jackson can be used as an alternative variety to Marshall. This variety will be included in future experiments for comparison with Marshall and Gulf.

An economic analysis of these preliminary results suggests that Marshall ryegrass was more profitable to graze than Gulf. If animals were contract grazed by a landowner for 35 cents per pound of weight gain, paid by a separate person who owned the cattle, profit from cattle grazing Marshall was nearly five times higher than for Gulf ($126.21 versus $21.71: see Table 3). This occurred despite a $3.90 lower seed cost per acre for Gulf (the analysis assumed a seeding rate of 30 pounds per acre and seed costs of 30 cents per pound for Gulf and 43 cents per pound for Marshall). Therefore, based on this study, an extra $3.90 per acre spent on seed for Marshall ryegrass gave $102.50, or nearly a 27-fold return on investment.

These results suggest that Marshall ryegrass was dramatically superior to Gulf throughout the season, even at the Gulf Coast; the profit advantage was substantially greater than the production advantage; and the advantage of Marshall over Gulf was much greater under grazing than under mowing. In addition, profit from stockers grazing Marshall ryegrass was comparable with many row crops.

Table 2. Change In Steer Weights Over Time for Cattle Grazing Marshall and Gulf Ryegrass at Fairhope

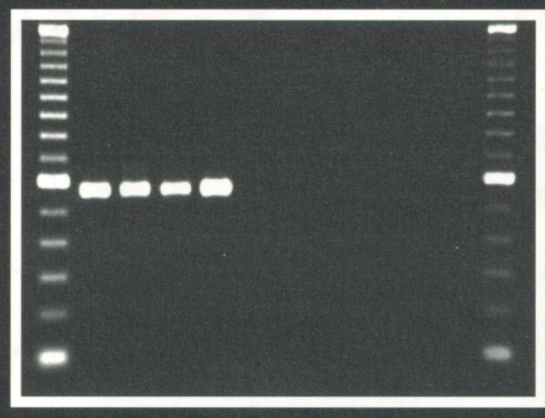
Ryegrass variety	Day					
	0	28	56	84	112	132
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
Marshall	522	612	700	768	852	870
Gulf	522	588	654	691	726	720
Difference (Marshall minus Gulf)	0	+24	+46	+77	+126	+150
	0%	+4%	+7%	+11%	+17%	+21%

Table 3. Stocker Steer Economics for Marshall and Gulf Ryegrass at Fairhope

	Variety of Ryegrass		Difference
	Marshall	Gulf	(Marshall minus Gulf)
Gross receipts (Dols./acre)	245.00	138.60	+106.40
Total costs (Dols./acre)	118.79	114.89	+3.90
Net income per acre (Dols.)	126.21	21.71	+102.50

Bransby is a Professor of Agronomy and Soils, Pegues is an Assistant Superintendent of Gulf Coast Substation, and Rawls is Superintendent of Upper Coastal Plains Substation.

Research Leads to Specific Identification of Human and Veterinary Pathogens



Omar Oyarzabal, Donald Conner, James Barbaree, and Irene Wesley

AAES researchers, working with the U.S. Department of Agriculture's National Animal Disease Center (USDA-NADC) in Ames, Iowa, have developed a rapid, specific procedure for the diagnosis of *Campylobacter fetus*, a bacterium that infects humans and cattle and poses risks to human health and can cause severe economic loses for cattle producers.

C. fetus has been divided into two subspecies: *C. fetus subsp. fetus* and *C. fetus subsp. venerealis*. Although infrequent, human foodborne outbreaks of *C. fetus subsp. fetus* have resulted from the consumption of raw beef, raw milk, and cottage cheese. In a two-year surveillance study, from 1987 to 1989, the Centers for Disease Control and Prevention (CDC) reported 122 human cases of *C. fetus subsp. fetus*. In cattle and sheep, *C. fetus subsp. fetus* is transmitted orally. The organism disrupts the placenta, induces abortion, and produces infertility.

There is no report of human infection due to *C. fetus subsp. venerealis*. This microorganism is regarded exclusively as a venereal pathogen of cattle.

Trade restrictions prohibit the export of bulls carrying *C. fetus subsp. venerealis*. Typically, diagnosis of *C. fetus subsp. venerealis* is accomplished by observing clinical signs of infection or by examining samples of cervical mucus, preputial washings, or intestinal contents of aborted fetuses under a high-powered microscope. Unfortunately, it is easy to confuse *C. fetus subsp. venerealis* with similar nonpathogenic bacteria. Biochemical testing also can be used to detect *C. fetus*, but this method is time consuming and imprecise. Finding a more specific and rapid method to detect *C. fetus* would speed up testing for the bacterium and also help laboratories avoid potential confusion of dangerous organisms with harmless organisms.

AAES scientists joined forces with researchers at USDA-NADC to develop such a test, which uses a polymerase chain reaction (PCR) technique and amplifies DNA to detect both subspecies of *C. fetus*. The PCR technique separates the DNA from Campylobacter-like bacteria. These samples can be used immediately for testing or can be frozen for several weeks for later evaluation. The PCR technique can yield reliable identification of *C. fetus* within three hours after isolation of suspicious colonies on agar plates.

Figure.1 Agarose gel electrophoresis of PCR products from Camphlobacter *and* Arcobacter spp. *M:100-by Marker; 1-4:* C. fetus *showing the 554 bp amplification; 5:* C. hyointestinalis, *6:* C. sputorum, *7: C. jejuni, 8:* C. coli, *9:* A. butzleri, *10:* A.skirrowii *showing no amplification.*

This work provides a powerful tool to investigate a disease that results in both a loss in animal production and a risk in human health. This technique can help expand knowledge of the transmission and epidemiology of this bacterial pathogen.

Oyarzabal is a Graduate Research Assistant and Conner is an Associate Professor of Poultry Science; Barbaree is a Professor of Botany and Microbiology; and Wesley is a Leading Scientist with the Enteric Research Unit, USDA-NADC.

Potassium Fertilizer Placement Effects on Uptake and Root Length Density of Cotton: 3 Year Summary

Greg Mullins, Greg Pate, and Charles Burmester

Late-season potassium deficiency in cotton.

Cotton is the number one row crop in Alabama in terms of acreage planted, with more than 540,000 acres planted to cotton in 1996. A major concern of cotton producers is the appropriate application of potassium (K) fertilizer to ensure the crop is both high yielding and of high quality. Recent AAES studies have shown that traditional surface application of K fertilizer or incorporation of K into the plow layer is sufficient and more cost effective than deep placement of K for cotton production in Alabama.

Potassium fertility in cotton has been a concern of producers since the early 1890s when potassium deficiency symptoms were first identified by G.F. Atkinson of the Mechanical and Agricultural College of Alabama (now Auburn University). Symptoms that initially had been mistakenly attributed to a pathogen and given the name "cotton rust" were finally and correctly attributed to a lack of potash in the soil.

The lack of soil potash decreases lint yield and reduces lint quality. In

response to a recent increase in reports of late season K deficiency throughout the Southeast, researchers in the region have explored ways to increase the amount of K in the plant late in the season, thus avoiding late season K deficiency. These studies focused either on deep placement of K fertilizer in the row or application of K fertilizer as a foliar spray. However, they did not answer many of the basic questions important to the understanding of K uptake and the cotton plant's ability to remove K from the soil.

To answer these questions, three-year studies were initiated by AAES researchers in 1992 at the Tennessee Valley Substation in Belle Mina (Decatur silt loam) and at the Prattville Experiment field in Prattville (Lucedale fine-sandy loam). In the studies, exact placement of K was made at different depths within the soil profile. Treatments were applied by injecting a potassium chloride (KCl) solution into the soil at various depths from the surface to 21 inches. Treatments in which increasing proportions of the soil profile being fertilized were also included as well as banded K and foliar K treatments.

Whole plant weights and K concentrations were determined and used to calculate total K uptake for each treatment.

Results of the two studies averaged over the three-year study (see table) showed total K uptake for surface-applied K and injection of the K solution at a particular depth within the soil profile did not differ. Consistent increases in total K within the plant were observed only among surface application of K and treatments in which an increasing amount of the soil profile was fertilized. Effectively fertilizing the soil to a depth of 21 inches for the Decatur soil and 15 inches for the Lucedale soil, increased K uptake over surface applied K treatments. As the proportion of the soil volume that is fertilized increased, so did the amount of K taken into the plant. No response to banding K fertilizer was observed, however, cotton does not typically respond to K fertilizer applied as a starter.

The Decatur soil did not respond to foliar applications of K but the Lucedale soil did show an increase in total K by foliar treatments when applied in conjunction with 120 pounds of K_2O per acre of soil-applied K. Both soils tested low or medium for soil test K in the topsoil and low for soil test K in the subsoil. No explanation can be given for the response observed on the Lucedale soil and the lack of response observed on the Decatur soil.

Total K Uptake Averaged Over a Three-year Period (1992-1994)

Placement	Total uptake (Lbs. K/acre)	
	Decatur soil	Lucedale soil
Surface	91	57
Injected at 3 inches	89	55
Injected at 9 inches	87	66
Injected at 15 inches	90	57
Injected at 21 inches	81	58
Injected from surface to 3 inches[1]	92	76
Injected from surface to 9 inches	95	78
Injected from surface to 15 inches	99	85
Injected from surface to 21 inches	109	73
Band on surface[2]	83	68
Band at 9 inches	87	63
Band at 15 inches	94	59
Foliar[3] - No soil K	68	62
Foliar + soil K at 3 inches[4]	75	74
Foliar + soil K at 9 inches	85	75

[1] Solution injected in sequential depths relating to the surface; 3, 9, 15, and 21 inches and ending at the specified depth. Each treatment represents an increasing proportion of the soil profile being effectively fertilized. Solutions were adjusted such that a total of 120 pounds K_2O per acre was applied.
[2] Band applications made approximately four inches to the side of the row at the specified depth.
[3] 4.4 pounds of K_2O per acre of foliar K applied four times at two week intervals beginning at early bloom.
[4] 120 pounds of K_2O per acre soil-applied K plus foliar K.

Root length density for each treatment was calculated to determine the effects of K fertilizer placement on root length density and distribution in the soil. Soil cores of 1.25 -inch diameter were taken in four positions (in-row, 5, 10, and 20 inches away from the row). The soil cores were cut into four, six-inch root increments. Root length was determined for each row position and depth increment.

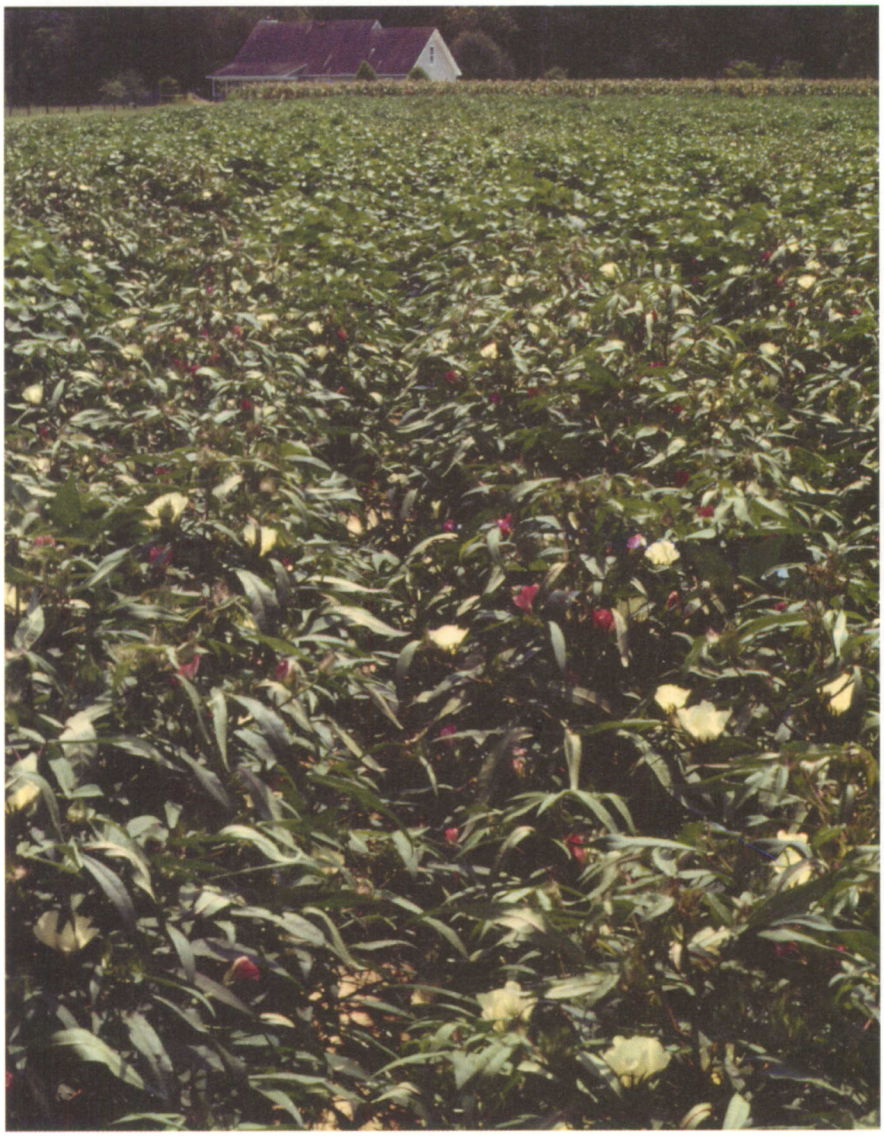
These measurements for both locations failed to reveal any consistent differences among surface applied K and treatments in which K was placed at a single depth. Placement of K fertilizer did not lead to a proliferation of cotton roots around the area treated. Most of the cotton roots are contained in the top 0-12 inches of the soil and close to the row. Root length density data mirrored that of total K uptake in that increases in root length density came only by effectively fertilizing the soil profile to 21 inches for the Decatur soil and 15 inches for the Lucedale soil.

Results from this study show that deep placement of K at a particular depth was not superior to surface-applied K for increasing K uptake or root length density of cotton. Only when a large proportion of the soil profile was effectively fertilized was K uptake and root length density of cotton significantly increased as compared to surface K applications. Deep placement applicators will not be effective on Alabama soils and effectively fertilizing the soil profile down to 15 or 21 inches is not feasible for producers. As such, AAES researchers conclude that surface application of K or incorporation of K into the plow layer is sufficient for cotton grown in Alabama.

Mullins is a Professor, Pate is a former Graduate Research Assistant, and Burmester is a ExtensionResearch Cotton Specialist.

Okra Leaf Cotton Tested for Use in Alabama's Gulf Coast Region

Dennis Delaney, Dale Monks, Michael Patterson, and Malcomb Pegues



Cotton acreage in Alabama's Gulf Coast region has experienced a resurgence in recent years thanks to favorable prices, its value as a rotation crop, and new technologies such as growth regulators and higher capacity harvesting machines.

The Gulf Coast region's deep sandy soils and long growing season are well-suited for cotton production, and frequent summer thunderstorms replenish soil moisture. These same conditions also regularly lead to severe boll rot due to high humidity, excessive vegetative growth, and reduced sunlight and air penetration into the canopy.

An AAES study was conducted at the Gulf Coast Substation, Fairhope, from 1994 to 1996 to determine if an okra leaf cotton might have advantages over conventional leaf cotton by increasing air movement and light penetration to reduce damage from boll rot organisms. Okra leaf cotton is widely grown in Australia, but only rarely in the United States, due to lower yields. Recent research suggests narrow row spacings and higher seeding rates may help close the yield gap between okra leaf cotton and conventional varieties.

Conventional and okra leaf lines of the experimental variety MD51ne, which differ only in the shape of their leaves, were planted in 30- and 36- inch rows, in combination with seeding rates of three or six seeds per foot of row. Plant growth and development was measured by collecting data on plant heights and nodes and their ration (to indicate how rapidly the cotton was growing), and initiation of the first fruiting branch, which indicates earlier maturing and higher value fruit.

Effect of Leaf Shape on Cotton Growth and Yi

Leaf shape	Abscission	Open	Seed cotton yie	
	1994 & 96	1994 & 96	1994	19
	Pct.	*Pct.*	*Lb./a.*	
Conventional	56	42	2,502	2,(
Okra	62	56	2,247	2,

At maturity, abscission (boll shed); percent open, closed and rotten bolls; and seedcotton yields were measured.

There was a varying response of plant height and internode length to leaf shape in 1994 and 1996. Lower seeding rates and closer rows increased number of reproductive nodes in 1994 and 1996. None of the treatments affected first fruiting branch initiation.

Little boll rot was present in any treatment in 1994 or 1996, so that no differences could be measured. Hurricane Erin in August 1995, followed by Opal in October flattened the crop and caused excessive boll rot and shed, obscuring any treatment effects.

Several differences occurred in 1994 and 1996. Closer rows resulted in taller cotton. Okra leaf cotton opened earlier (see table), which would allow farmers to harvest during typically dry fall weather, but it also had higher abscission rates for first-position fruit. Conventional cotton out-yielded okra leaf cotton in 1994 and 1996, while they were equal in 1995 (1,709 pounds of seed cotton per acre).

In conclusion, okra leaf cotton did not decrease boll rot in these tests. Even with closer rows and higher seeding rates, okra leaf cotton often had a lower yield. Higher-yielding okra leaf lines must be developed for okra leaf cotton to find a place on Alabama's Gulf Coast.

Delaney is an Extension Associate, Monks is an Associate Professor, and Patterson is a Professor in Agronomy and Soils. Pegues is Assistant Superintendent of the Gulf Coast Substation.

AAES Research Developing Simple, Inexpensive Tests for Meat Products

Y-H. Peggy Hsieh, Fur-Chi Chen, and Shyang-Chwen Sheu

Hsieh displays AAES-developed test kit used to detect meat species in processed meat products.

By law, processed meat products must be labeled to indicate all species of meat products they contain. This is important for people whose religious practices limit the types of meat they eat, for people who have allergies to certain types of meat proteins, and to ensure that consumers cook meat properly to kill any food-borne pathogens. However, detecting meat that may have been adulterated with undeclared meat proteins is difficult. AAES research, however, has developed monoclonal antibody tests that make species detection in processed meats more rapid and accurate.

Widespread species adulterations have recently been documented among raw and particularly heat-processed ground meat products in Alabama and other domestic retail markets. At best, adulteration is the result of improper handling. At worst, it is an intentional practice of economic fraud.

Although many methods have been developed in the past 20 to 25 years to identify meat species, one of the best methods is the use of enzyme-linked immunosorbent assay (ELISA) tests, which are highly sensitive, specific, and simple to use. However, species-specific antibodies must be used in ELISA tests for accurate meat species detection.

There are two types of species-specif-

Meat Products, continued on page 20

Monoclonal Antibodies Developed to Identify Commonly Used Meat Species in Raw and Cooked Products

Monoclonal antibodies	Subtype	Specificity
2F8	IgG2b	pork, beef, lamb, horse, and deer
3E12	IgG1	chicken, turkey, and duck
5D2	IgG1	chicken and turkey
9C6	IgG1	chicken
5H9	IgG1	pork

Meat Products, continued from page 19

cific anitbodies, polyclonal and monoclonal. Both can be used in the ELISA system. Because monoclonal anti-bodies are biotechnology derived an unlimited supply of well-defined reagents can be ensured. An AAES study initiated in 1993 has focused on the development of monoclonal antibodies for meat species identification in both raw and cooked meats.

So far, this project has produced five monoclonal antibodies (see the table) that are used in ELISA testing to identify species. Results of the test can be visualized in a few minutes by color change (see the photo).

These antibodies represent breakthroughs in several testing issues. For example, some of these antibodies are able to distinguish mammalian meats from poultry, which previously had not been possible. In addition, all the AAES-developed antibodies can be used for both raw and heat processed meat products. The antibodies can be used to determine how much of each meat species is present in a sample and these antibodies can help predict the internal cooking temperature of the precooked meat for food safety concerns. To date, one antibody specific to chicken and one specific to pork have been developed to identify single species. Research on other antibodies and methods for other meat species is on-going.

These research developments will aid in the battle of illegally processed or mislabeled meat products. Use of these monoclonal antibodies will significantly reduce the present cost of the assay by at least 50%. They can be made into convenient kits to rapidly test a large number of samples for multi species in a laboratory setting. Since the test is simple and inexpensive, it can be developed into single field kits for use by inspectors in meat processing plants and stores and by consumers in the home. The tests also have great potential for commercialization and a patent is currently pending on this technology.

Hsieh is an Assciate Professor, Chen is a Graduate Research Assistant, and Sheu is a former Graduate Research Assistant of Nutrition and Food Science.

ERRATUM: This table appeared in the Winter 1996 issue of *Highlights,* "Alabama Tomato Growers Meeting Federal IPM Guidelines," page 7, Vol. 43, No. 3 with an error. The acreage for IPM categories in Georgia was shown as 50. It should have been 100, as shown here. The editors regret any confusion.

Summary of IPM Survey Results

State	No. growers	Avg. farm size, acres	Avg. score	Pct. medium and high IPM categories		Avg. no. appplications		
				Growers	Acreage	Fungicide	Insecticide	Herbicide
Alabama	25	22.1	57.0	65	66	9.7	9.8	2
Georgia	15	69.5	68.0	100	100	14.6	14.2	1.5
Kentucky	29	6.8	65.8	93	99	10.2	7.2	2.1
North Carolina	35	13.3	54.3	66	94	11.6	7.7	1.7
North Florida	12	213.33	74.6	100	100	19.5	16.4	1.9
South Carolina	18	132.2	71.7	94	99	11.8	9.9	18
Tennessee	21	20.6	53.5	67	63	–	–	–

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