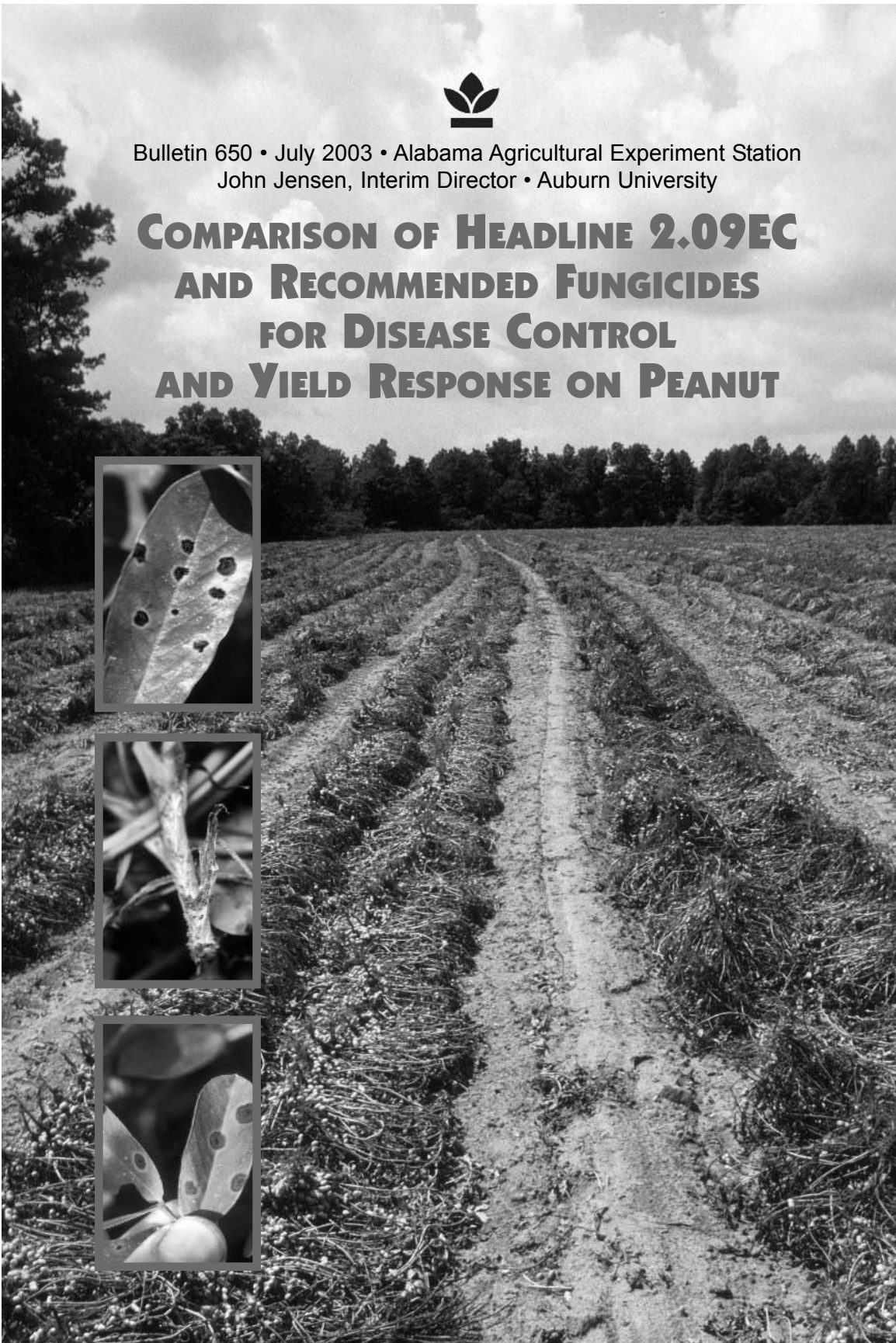
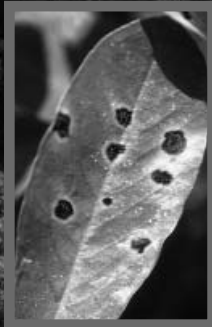




Bulletin 650 • July 2003 • Alabama Agricultural Experiment Station  
John Jensen, Interim Director • Auburn University

# **COMPARISON OF HEADLINE 2.09EC AND RECOMMENDED FUNGICIDES FOR DISEASE CONTROL AND YIELD RESPONSE ON PEANUT**



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First Printing 1M, July 2003

The authors thank Amy Greene for her assistance in editing this manuscript.

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# COMPARISON OF HEADLINE 2.09EC AND RECOMMENDED FUNGICIDES FOR DISEASE CONTROL AND YIELD RESPONSE ON PEANUT

A. K. Hagan, H. L. Campbell, K. L. Bowen, and L. Wells

## INTRODUCTION

**P**eanut (*Arachis hypogaea* L.) is an important agronomic crop in Alabama, Florida, and Georgia. Value of Alabama's 190,000-acre peanut crop annually exceeds \$120 million. However, early leaf spot caused by the fungus *Cercospora arachidicola* Hori, late leaf spot caused by the fungus *Cercosporidium personatum* Berk. & Curtis, and white mold caused by the soil-borne fungus *Sclerotium rolfsii* Sacc. can greatly reduce the profitability due to lower yields and lower nut quality (9). Fungicides applied for the control of these diseases account for as much as 25 percent of the peanut production budget on many farms.

Early leaf spot and late leaf spot are potentially the most destructive diseases on peanut across the Southeast. Currently, early leaf spot is the more common and damaging of the two leaf spot diseases on Alabama's peanut crop. Prior to the introduction of efficacious leaf spot fungicides, harvesting operations started as soon as the crop was defoliated and often before the pods fully matured. Although losses due to early and late leaf spot are a small percentage of Alabama's total peanut crop, failure to control these diseases with timely fungicide applications in isolated fields may reduce expected yields by 50 percent (16).

White mold damage increases in a particular field as the number of years between peanut crops declines, and fields cropped to peanut every other year or in those in continuous peanut production typically suffer the heaviest losses (4). In addition, peanut yields sharply decline as the incidence of this disease increases (4). In isolated Alabama peanut fields, pod losses can

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Hagan and Bowen are professors and Campbell is a research associate in the Department of Entomology and Plant Pathology. Wells is superintendent at the Alabama Agricultural Experiment Station Wiregrass Research and Extension Center.

exceed 40 percent or more of anticipated yield (3). Crop rotation, the most effective weapon against white mold, is not widely used by peanut producers due to the absence of profitable alternative crops, the lack of fresh tillable land in many peanut-producing Alabama counties, and poorly structured farm programs (3,12). When used according to label directions, fungicide programs that include applications of Folicur 3.6F, Abound 2.08SC, or Moncut 70DF typically reduce white mold incidence by 60 to 70 percent and may increase pod yield by 1000 to 1500 pounds per acre (10). Although the peanut cultivars 'Southern Runner', 'Florida C-99R', and 'Georgia Green' are less sensitive than 'Florunner' to white mold, none have a high level of resistance to this disease (4,11). When white mold was controlled on the above cultivars, sizable yield gains have consistently been obtained with Folicur 3.6F, Abound 2.08SC, or Moncut 70DF programs (5,11).

Headline 2.09EC (pyraclostrobin) is a new broad-spectrum strobilurin fungicide that recently was registered for the control of leaf spot diseases, peanut rust, white mold, and *Rhizoctonia* limb rot on peanut (1). This fungicide is rapidly absorbed by leaf tissues and has demonstrated translaminar movement through layers of the leaf but is not redistributed throughout the plant like a true systemic fungicide (2,15). Selected rates of Headline 2.09EC have superior activity against early and late leaf spot diseases, as well as white mold (13). Most notably, the level of leaf spot control obtained with this fungicide applied at three-week intervals was comparable or better than that obtained with recommended fungicides applied at two-week intervals (7,13). The extended residual activity of Headline 2.09EC against early leaf spot disease provides an opportunity to reduce the number of fungicide applications typically required for effective season-long disease control on peanut (13).

The objective of this study was to assess the impact of application rate and treatment interval on the effectiveness of Headline 2.09EC as a component in a fungicide program for the control of early leaf spot and white mold on peanut.

## METHODS

In 1999, 2000, 2001, and 2002, peanut (*Arachis hypogaea*) cv. 'Georgia Green' was planted at six seed per foot of row in an irrigated field at the Wiregrass Research and Extension Center, Headland Alabama. Planting dates were May 18, 1999, May 19, 2000, May 17, 2001, and May 23, 2002. Test areas were in a peanut-cotton-peanut or peanut-corn-peanut rotation a minimum of 10 years. The soil type was a Dothan fine sandy loam (fine-loamy, siliceous, thermic Plinthic Palendults) with less than 1 percent organic matter.

The test areas were heavily infested with *S. rolfssii* and significant white mold damage had been observed on previous peanut crops.

Plot areas were prepared for planting with a moldboard plow and disk harrow. Optimal soil fertility and pH were maintained according to the results of a soil fertility assay conducted by the Soil Testing Laboratory at Auburn University. Broadleaf and grass weeds were controlled by lightly incorporating a pre-emergence application of a tank-mixture of 1 quart per acre of Sonalan HFP and 1.5 pints per acre of Dual Magnum. At five days after seedling emergence (ground cracking), a single broadcast application of 5.5 fluid ounces per acre of Gramoxone Max, 1 pint per acre of Butoxone 200, and 1 pint per acre of Basagran 4EC were made. For the remainder of each production season, escape weeds were pulled by hand. At planting, Temik 15G at a rate of 5 pounds per acre was applied in-furrow to control thrips. Plots were irrigated with a center pivot system with approximately 1 inch of water on July 31, August 8, August 21, and September 1, 1999; on June 7, June 15, June 28, July 22, August 12, August 18, and August 29, 2000; on July 16, 2001; and on August 10, August 24, and September 12, 2002.

Individual plots consisted of four 30 foot-rows spaced 3 feet apart. Broadcast applications of all fungicides were made with a tractor-mounted four-row boom sprayer with three TX-8 hollow cone nozzles per row that were calibrated to deliver an approximate 15 gallons per acre of spray volume.

In 1999, Bravo Ultrex at 1.4 pounds per acre was applied first in all programs, second in the recommended Folicur 3.6F program, and once or twice at the end of the two-week Folicur 3.6F and Headline 2.09EC programs, respectively (Table 1). A full-season seven-spray program of 1.4 pounds per acre of Bravo Ultrex was included. Four applications of 7.7 fluid ounces per acre of Headline 2.09EC and 0.45 pint per acre of Folicur 3.6F were made at two- and three-week intervals and three applications were made on a four-week schedule. Four applications of 4.6 fluid ounces per acre Headline 2.09EC were made at two- and three-week intervals.

In 1999, a total of seven, five, and four fungicide applications were made to the plots treated on a two-week, three-week, and four-week schedule, respectively. Applications were scheduled at two-week intervals on June 14 (1), June 29 (2), July 12 (3), July 27 (4), August 10 (5), August 23 (6), and September 7 (7); at three-week intervals on June 14 (1), July 2 (2), July 27 (3), August 16 (4), and September 7 (5); and at four-week intervals on June 14 (1), July 12 (2), August 10 (3), and September 7 (4).

For the 2000 trial, all programs consisted of seven applications of selected fungicides made at two-week intervals (Table 2). Headline 2.09EC

**TABLE 1. IMPACT OF APPLICATION RATE AND TREATMENT INTERVAL OF HEADLINE 2.09EC AND OTHER RECOMMENDED FUNGICIDES ON THE CONTROL OF EARLY LEAF SPOT AND WHITE MOLD ON 'GEORGIA GREEN', WIREGRASS RESEARCH AND EXTENSION CENTER, 1999**

Fungicide program	Application			Early leaf spot severity <sup>2</sup>	White mold hits/100 ft of row <sup>3</sup>	Yield lb/ac
	Rate	Sequence <sup>1</sup>	Interval wks			
Bravo Ultrex	1.4 lb	1 to 7	2	5.0 <sup>1</sup>	35.3	3070
Bravo Ultrex Headline 2.09EC	1.4 lb 4.6 fl oz	1,6,7 2 to 5	2	3.0	26.7	3350
Bravo Ultrex Headline 2.09EC	1.4 lb 7.7 fl oz	1,6,7 2 to 5	2	2.8	19.4	3568
Bravo Ultrex Folicur 3.6F	1.4 lb 0.45 pt	1,2,7 3 to 6	2	4.0	18.3	4387
Bravo Ultrex Headline 2.09EC	1.4 lb 4.6 fl oz	1 2 to 5	3	4.0	25.6	3122
Bravo Ultrex Headline 2.09EC	1.4 lb 7.7 fl oz	1 2 to 5	3	4.5	23.2	3557
Bravo Ultrex Folicur 3.6F	1.4 lb 0.45 pt	1 2 to 5	3	4.5	14.3	4045
Bravo Ultrex Headline 2.09EC	1.4 lb 7.7 fl oz	1 2 to 4	4	3.8	23.5	3972
Bravo Ultrex Folicur 3.6F	1.4 lb 0.45 pt	1 2 to 4	4	6.3	25.6	3205

<sup>1</sup> Application sequence refers to the placement of the application(s) of a specific fungicide treatment in a fungicide program.

<sup>2</sup> On September 23, early leaf spot severity was assessed using the 1 to 10 Florida leaf spot scoring system.

<sup>3</sup> White mold incidence was estimated immediately after plot inversion on September 29.

was applied in four consecutive applications at 12.2 or 15.2 fluid ounces per acre, as well as alternated at 9.3 or 12.2 fluid ounces per acre with Folicur 3.6F at 0.45 pint per acre or with 1.2 pounds per acre Moncut 50W plus 1.4 pounds per acre Bravo Ultrex. Standard fungicide programs included 1.5 pints per acre of Bravo 720 6F season-long, a four-spray block of Folicur 3.6F at 0.45 pint per acre, and two applications of Abound 2.08SC at 1.15 pints per acre. Bravo 720 6F at 1.5 pints per acre filled out the remaining treatment slots in all of the above programs. In 2000, treatment dates were June 19 (1), June 30 (2), July 17 (3), July 31 (4), August 14 (5), August 28 (6), and September 11 (7).

In 2001, fungicides were applied at either two- or three-week intervals (Table 3). Three or four applications of Headline 2.09EC at 6.4 fluid ounces

**TABLE 2. EFFICACY OF SELECTED RATES OF RECOMMENDED FUNGICIDES OR COMBINATION FUNGICIDE PROGRAMS FOR THE CONTROL OF EARLY LEAF SPOT AND WHITE MOLD ON 'GEORGIA GREEN', WIREGRASS RESEARCH AND EXTENSION CENTER, 2000**

Fungicide program	Application		Early leaf spot severity <sup>2</sup>	White mold hits/100 ft of row <sup>3</sup>	Yield lb/ac
	Rate	Sequence <sup>1</sup>			
Bravo 720 6F	1.5 pt	1 to 7	2.2 <sup>1</sup>	15.1	2759
Bravo 720 6F Headline 2.09EC	1.5 pt 12.2 fl oz	1,6,7 2 to 5	2.3	10.5	3848
Bravo 720 6F Headline 2.09EC	1.5 pt 15.2 fl oz	1,6,7 2 to 5	2.2	8.1	3787
Bravo 720 6F Headline 2.09EC Folicur 3.6F	1.5 pt 9.3 fl oz 0.45 pt	1,6,7 2,4 3,5	2.5	9.7	4009
Bravo 720 6F Headline 2.09EC Folicur 3.6F	1.5 pt 12.2 fl oz 0.45 pt	1,6,7 2,4 3,5	2.3	9.7	3882
Bravo 720 6F Headline 2.09EC Bravo 720 6F + Moncut 50W	1.5 pt 12.2 fl oz 1.5 pt + 1.2 lb	1,6,7 2,4 3,5	2.8	7.5	3687
Bravo 720 6F Folicur 3.6F	1.5 pt 0.45 pt	1,6,7 2 to 5	2.5	10.0	3882
Bravo 720 6F Abound 2SC	1.5 pt 1.15 pt	1,2,4,6,7 3,5	2.7	10.5	3497
Bravo 720 6F Bravo 720 6F + Moncut 50W	1.5 pt 1.5 pt + 1.2 lb	1,2,4,6,7 3,5	3.0	10.9	3824

<sup>1</sup> Application sequence refers to the placement of the application(s) of a specific fungicide treatment in a fungicide program.

<sup>2</sup> On September 26, early leaf spot severity was assessed using the 1 to 10 Florida leaf spot scoring system.

<sup>3</sup> White mold incidence was estimated immediately after plot inversion on October 10.

per acre were made at two-week intervals and at 9.0 fluid ounces per acre every three weeks. Headline 2.09EC at 12.2 fluid ounces per acre plus 1.1 pounds per acre of Moncut 70DF was applied every two weeks. In addition, applications of a tank-mixture of 12.2 fluid ounces and 0.5 pound per acre of Headline 2.09EC and Moncut 70DF, respectively, were made at three-week intervals. Bravo Ultrex at 1.4 pounds per acre filled out the remaining treatment slots in the Headline 2.09EC programs. Three applications of Headline

**TABLE 3. EFFECT OF FUNGICIDE RATE AND TREATMENT INTERVAL OF HEADLINE 2.09EC AND OTHER RECOMMENDED FUNGICIDES ON THE CONTROL OF EARLY LEAF SPOT AND WHITE MOLD ON 'GEORGIA GREEN', WIREGRASS RESEARCH AND EXTENSION CENTER, 2001**

Fungicide program	Application		Interval wks	Early leaf spot severity <sup>2</sup>	White mold hits/100 ft of row <sup>3</sup>	Yield lb/ac
	Rate	Sequence <sup>1</sup>				
Bravo Ultrex	1.4 lb	1 to 7	2	4.5 <sup>1</sup>	26.7	4297
Bravo Ultrex Bravo Ultrex + Moncut 70DF	1.4 lb 1.4 lb + 1.1 lb	1,2,4,6,7 3,5	2	4.8	12.5	4555
Bravo Ultrex Abound 2SC	1.4 lb 1.15 pt	1,2,4,6,7 3,5	2	3.8	15.9	5118
Bravo Ultrex Headline 2.09EC	1.4 lb 6.4 fl oz	1,6,7 2 to 5	2	3.0	18.3	4973
Bravo Ultrex Headline 2.09EC	1.4 lb 6.4 fl oz	1,3,5,7 2,4,6	2	3.3	14.1	5385
Bravo Ultrex Folicur 3.6F	1.4 lb 0.45 pt	1,6,7 2 to 5	2	3.7	12.5	5042
Bravo Ultrex Headline 2.09EC + Moncut 70DF	1.4 lb 12.2 fl oz + 1.1 lb	1,2,4,6,7 3,5	2	3.0	8.9	5513
Bravo Ultrex Headline 2.09EC	1.4 lb 9.0 fl oz	1 2 to 4	3	4.2	12.5	4677
Bravo Ultrex Folicur 3.6F	1.4 lb 0.45 pt	1 2 to 4	3	4.8	17.8	4129
Bravo Ultrex Headline 2.09EC + Moncut 70DF	1.4 lb 12.2 fl oz + 0.5 lb	1 2 to 4	3	3.8	11.7	4662
Bravo Ultrex Headline 2.09EC Bravo Ultrex + Moncut 70DF	1.4 lb 6.5 fl oz 1.4 lb + 1.1 lb	1,7 2,4,6 3,5	2	3.0	10.5	5612

<sup>1</sup> Application sequence refers to the placement of the application(s) of a specific fungicide treatment in a fungicide program.

<sup>2</sup> On September 20, early leaf spot severity was assessed using the 1 to 10 Florida leaf spot scoring system.

<sup>3</sup> White mold incidence was estimated immediately after plot inversion on October 5.

2.09EC at 6.4 fluid ounces per acre were alternated with two applications of 1.4 pounds per acre Bravo Ultrex plus 1.1 pounds per acre Moncut 70DF and bracketed at the beginning and end of the program by an application of 1.5 pints per acre of Bravo 720 6F. The treatment interval for this program was two weeks. Programs consisting of three or four applications of 0.45 pint per



**TABLE 4. EFFECT OF FUNGICIDE RATE AND TREATMENT INTERVAL OF RECOMMENDED FUNGICIDES ON THE CONTROL OF EARLY LEAF SPOT AND WHITE MOLD ON 'GEORGIA GREEN', WIREGRASS RESEARCH AND EXTENSION CENTER, 2002**

Fungicide program	—Application—		Early leaf spot severity <sup>2</sup>	White mold hits/100 ft of row <sup>3</sup>	Yield lb/ac
	Rate	Sequence <sup>1</sup>			
Echo 720 6F	1.5 pt	1 to 7	5.2	23.3	3872
Echo 720 6F	1.5 pt	1,2,4,6,7	4.8	10.8	4574
Echo 720 6F + Moncut 70DF	1.5 pt + 1.1 lb	3,5			
Echo 720 6F	1.5 pt	1,2,4,6,7	4.3	18.8	4638
Abound 2SC	1.15 pt	3,5			
Echo 720 6F	1.5 pt	1,2,4,6,7	3.8	16.3	4179
Headline 2.09EC	6.0 fl oz	3,5			
Echo 720 6F	1.5 pt	1,6,7	4.5	23.0	4191
Folicur 3.6F	0.45 pt	2 to 5			

<sup>1</sup> Application sequence refers to the placement of the application(s) of a specific fungicide treatment in a fungicide program.

<sup>2</sup> On September 20, early leaf spot severity was assessed using the 1 to 10 Florida leaf spot scoring system.

<sup>3</sup> White mold incidence was estimated immediately after plot inversion on October 5.

acre of Folicur 3.6F, which were made at two- and three-week intervals, respectively, were also included. Depending on treatment interval, one or three applications of Bravo Ultrex at 1.4 pounds per acre filled the slots in the treatment list for the fungicide programs described previously. Two mid-summer applications of Abound 2SC at 1.15 pints per acre were alternated with 1.4 pounds per acre of Bravo Ultrex every two weeks. In the seven-application program described previously, Bravo Ultrex at 1.4 pounds per acre filled in the remaining three treatments. A full-season program with seven applications of Bravo Ultrex at 1.4 pounds per acre applied at two-week intervals was also included. In 2001, application dates for fungicides applied at two-week intervals were June 19 (1), July 3 (2), July 18 (3), August 1 (4), August 16 (5), August 28 (6), and September 11 (7) and at three-week intervals on June 19 (1), July 10 (2), July 31 (3), August 21 (4), and September 11 (5). Seven and five fungicide applications were made to the plots treated at two- and three-week intervals, respectively.

For the 2002 field trial, the application interval in all fungicide programs was two weeks (Table 4). In mid-summer, two application of Headline 2.09EC at 6.0 fluid ounces per acre were separated by an application of Echo 720 6F (chlorothalonil) at 1.5 pints per acre. The first two and last two treatments in this Headline 2.09EC program were applications of Echo 720 6F at

1.5 pints per acre. Recommended Folicur 3.6F, 1.15 pints per acre Abound 2SC, and Echo 720 6F alone programs were also included. Two mid-summer applications of Echo 720 6F plus Moncut 70DF at 1.5 pints per acre and 1.1 pounds per acre, respectively, were separated with one application of 1.5 pints per acre of Echo 720 6F. The remaining four treatments (the first two and the last two) in the seven-application program described previously were of Echo 720 6F alone at 1.5 pints per acre. In 2002, application dates were June 24 (1), July 1 (2), July 22 (3), August 5 (4), August 19 (5), September 3 (6), and September 17 (7).

Early leaf spot was rated using the 1 to 10 Florida leaf spot scoring system (6), where 1 = no disease, 2 = very few leaf spots in lower canopy, 3 = few leaf spots in lower and upper canopy, 4 = some leaf spots in lower and upper canopy with light defoliation (less than 10 percent), 5 = leaf spots noticeable with some defoliation (less than 25 percent), 6 = leaf spots numerous with significant defoliation (less than 50 percent), 7 = leaf spots numerous with heavy defoliation (less than 75 percent), 8 = numerous leaf spots and severe defoliation (less than 90 percent), 9 = very few leaves heavily spotted with severe defoliation (less than 95 percent), and 10 = plants defoliated or dead. The hull scrape method of estimating pod maturity was used to determine the optimum digging date (17). Incidence of white mold in the windrow was determined immediately after the peanuts were inverted by counting the number of disease hits where one hit was defined as the number of consecutive symptomatic plant(s) in less than 1 foot of row (14). Plots were dug with a two-row digger/inverter on September 29, 1999, October 10, 2000, October 5, 2001, and October 9, 2002. Peanuts were harvested with a two-row combine approximately three to five days after plot inversion. Pods were dried to approximately 10 percent moisture and weighed.

## RESULTS

**1999**—When applied at two-week intervals, the 4.6- and 7.7-fluid-ounces-per-acre Headline 2.09EC programs gave better control of early leaf spot than Bravo Ultrex alone (Table 1). At both rates of Headline 2.09EC, symptoms were limited to light spotting of the leaves in the lower and upper canopy, compared to moderate leaf spotting and light defoliation on the peanuts treated season-long with Bravo Ultrex. Also, the level of disease control provided by the 4.6- and 7.7-fluid-ounces-per-acre Headline 2.09EC programs was similar to that given by the recommended Folicur 3.6F program. Surprisingly, the level of early leaf spot control provided by Headline 2.09EC at 4.6 fluid ounces per acre did not noticeably decline as the interval between applications was lengthened from two to three weeks but did decline at the

higher rate of the same fungicide. Early leaf spot severity on peanuts treated with 7.7 fluid ounces per acre of Headline 2.09EC at three- and four-week intervals did not greatly differ. When applied at three-week intervals, the level of early leaf spot control provided by the recommended Folicur 3.6F program did not decline compared with Folicur 3.6F applied at two-week intervals, but an increase in leaf spotting and defoliation was seen at the four-week treatment interval with this same fungicide.

Reductions in the incidence of white mold were obtained with all Headline 2.09EC and Folicur 3.6F programs, compared to Bravo Ultrex alone (Table 1). When applied at two- and three-week intervals, Headline 2.09EC was slightly less effective than Folicur 3.6F in reducing the incidence of white mold but gave similar control of this disease when applied at four-week intervals. Both rates of Headline 2.09EC applied at two- and three-week intervals proved equally effective against white mold. When applied at two- and three-week intervals, the recommended Folicur 3.6F program also gave better control of white mold than the same fungicide applied on a four-week schedule.

In 1999, yield response to the Headline 2.09EC programs was slightly higher than for the season-long Bravo Ultrex program and was lower than those recorded for the Folicur 3.6F programs (Table 1). Except for the 7.7 fluid ounces per acre rate applied at four-week intervals, yield of the Headline 2.09EC programs was similar to those obtained with standard seven-spray Bravo Ultrex program. In contrast, sizable yield gains were obtained with Folicur 3.6E applied at two- and three-week intervals compared with the standard Bravo Ultrex program. When applied on a two- and three-week schedule, Folicur 3.6F-treated peanuts yielded considerably higher than those sprayed with the 4.6-fluid-ounces-per-acre rate of Headline 2.09EC at the same schedule. When applied on a two-week schedule, yield gains obtained with Folicur 3.6F were superior to those noted with Headline 2.09EC at 7.7 fluid ounces per acre on the same schedule but were similar at the three-week treatment interval for both programs. For the peanuts treated with Folicur 3.6F every four weeks, yield was lower than for the peanuts treated on the same schedule with Headline 2.09EC.

**2000**—The 2000 growing season was among the driest ever recorded at the Wiregrass Research and Extension Center. Rainfall total for April through August was 5.8 inches, which is significantly less than the 24.8 inch historical average for that five-month period. As a result of the extended drought, overall pressure from early leaf spot was exceptionally low. No symptoms of late leaf spot were noted. The incidence of white mold was also lower in 2000 than in the previous year.

Although differences in early leaf spot severity were noted among the fungicide programs, symptoms, as indicated by disease ratings of 2.2 to 3.0,

were restricted to light spotting in the lower and sometimes upper plant canopy (Table 2). The Bravo 720 6F plus Moncut 50W program had a higher early leaf spot rating than did the programs with a block of four applications of Headline 2.09EC at 15.2 fluid ounces per acre or those with two applications of Headline 2.09EC at 12.2 fluid ounces per acre and Folicur 3.6F at 0.45 pint per acre. Otherwise, early leaf spot ratings for all remaining fungicide programs were similar.

When compared with Bravo 720 6F alone, all fungicides reduced the incidence of white mold (Table 2). Programs with four applications of Headline 2.09EC at 12.2 fluid ounces per acre and 15.2 fluid ounces per acre were as effective in controlling white mold on peanut as the recommended Folicur 3.6F, Abound 2SC, and Bravo 50W plus Moncut 50W programs. Also, programs of two applications of Headline 2.09EC at 9.3 or 12.2 fluid ounces per acre alternated with Folicur 3.6F or Bravo 720 plus Moncut 50W gave the same level of white mold control as the programs that included four applications of Headline at 12.2 fl or 15.2 fluid ounces per acre.

The level of white mold control given by Headline 2.09EC alone or when alternated with Folicur 3.6F, Abound 2SC, or Moncut 50W was reflected in significantly higher yields than for those obtained with Bravo 720 6F alone (Table 2). Yields in plots treated with both rates of Headline 2.09EC alone or when alternated with Folicur 3.6F or Moncut 50W were not appreciably different. In addition, yield gains in the Headline 2.09E-treated plots were similar to those that were obtained with the recommended Folicur 3.6F, Abound 2SC, and Moncut 50W programs.

**2001**—While rainfall totals for April and May were well below the historical average, precipitation levels for the remainder of the production season were sufficient for high peanut yields and considerable disease development. As indicated by a disease rating of 4.5, moderate leaf spotting and a low level of defoliation attributed to early leaf spot were noted on the peanuts treated season-long with Bravo Ultrex alone (Table 3). When compared with the standard seven-application Bravo Ultrex program and Bravo Ultrex plus Moncut 70DF, those programs that included three or four applications of Headline 2.09EC at 6.4 fluid ounces per acre, Headline 2.09EC plus Moncut 70DF, and Headline 2.09EC at 6.4 fluid ounces per acre alternated with Bravo Ultrex plus Moncut 70DF at two-week intervals gave superior early leaf spot control. All three Headline 2.09EC programs gave better or the same level of leaf spot control as was recorded with the recommended Abound 2SC or Folicur 3.6F programs. When applied at three-week intervals, 9.0 fluid ounces per acre of Headline 2.09EC and the recommended Folicur 3.6F programs were as effective in controlling early leaf spot as the standard Bravo

Ultrex program, but the Headline 2.09EC plus Moncut 70DF program provided better disease control.

When compared to the Bravo Ultrex standard, sizable reductions in white mold incidence were noted in the plots treated with Headline 2.09EC alone, tank mixed with Moncut 70DF, or when alternated with Moncut 70DF, Folicur 3.6F, Abound 2SC, or Bravo Ultrex plus Moncut 70DF (Table 3). Three or four applications of Headline 2.09EC made at two-week intervals controlled white mold as well as recommended rates of Bravo Ultrex plus Moncut 70DF, Abound 2SC, and Folicur 3.6F. Programs that included two applications of Headline 2.09EC plus Moncut 70DF and the alteration of Headline 2.09EC and Bravo Ultrex plus Moncut 70DF gave better control of white mold than four applications, but not three applications, of the 6.4-fluid-ounces-per-acre rate of Headline 2.09EC. Incidence of white mold in the plots receiving three applications of 9.0 fluid ounces per acre of Headline 2.09EC at three-week intervals did not differ significantly from that of peanuts treated with the same fungicide at two-week intervals. Also, the level of white mold control did not decline when the treatment interval with Folicur 3.6F was increased from two to three weeks and the number of applications was reduced from four to three.

When compared with the standard Bravo Ultrex program, yield was higher in the plots treated at two-week intervals with three or four applications of Headline 2.09EC (Table 3). Yields that greatly exceeded those obtained with the standard Bravo Ultrex program were also noted in plots treated with Abound 2SC, Folicur 3.6F, Headline 2.09EC plus Moncut 70DF, and alternated with Headline 2.09EC with Bravo Ultrex plus Moncut 70DF. Yield gains observed where 6.4 fluid ounces per acre of Headline 2.09EC was alternated with Bravo Ultrex plus Moncut 70DF were above those obtained with the program containing four but not three applications of the same rate of Headline 2.09EC. Yield increases, which were obtained with the three- or four-application Headline 2.09EC programs, were similar to those noted with the recommended Abound 2SC and Folicur 3.6F programs. Peanuts receiving three Headline 2.09EC applications at two-week intervals had higher yields than those treated at the same schedule with Bravo Ultrex plus Moncut 70DF.

On a three-week treatment schedule, yield of peanuts treated with three applications of Headline 2.09EC at 9.0 fluid ounces per acre was considerably lower than that reported in the plots receiving three applications of Headline 2.09EC at 6.4 fluid ounces per acre every two weeks (Table 3). Despite a similar level of white mold control, peanuts treated at two-week intervals with Folicur 3.6F or Headline 2.09EC plus Moncut 70DF yielded higher than those

treated with the same fungicide or a Headline 2.09EC tank-mixture on a three-week schedule.

**2002**—The Headline 2.09EC program gave the best control of early leaf spot (Table 4). The level of leaf spot control provided by the recommended Folicur 3.6F and Abound 2SC programs was slightly better than that obtained with the fungicide program that included two mid-summer applications of Echo 720 6F plus Moncut 70DF. The highest early leaf spot severity ratings were noted in the plots treated season-long with Echo 720 6F alone.

As expected, the highest white mold hit counts were recorded in the Echo 720 6F-treated plots (Table 4). Surprisingly, little difference the level of white mold control was found between the Echo 720 6F and the recommended Folicur 3.6F program. In addition, the white mold ratings for the recommended Abound 2SC program were only slightly below those obtained for Echo 720 6F alone. The Headline 2.09EC program gave better control of white mold than did the Folicur 3.6F program. When compared with the other fungicide programs, the Echo 720 6F plus Moncut 70DF program provided the best control of white mold on ‘Georgia Green’ peanut.

The combination of lower early leaf spot and white mold damage obtained with recommended Folicur 3.6F, Abound 2SC, Echo 720 6F plus Moncut 70DF, and Headline 2.09EC programs resulted in yield gains of at least 300 to nearly 800 pounds per acre above the yield of the Echo 720 6F-treated peanuts (Table 4). Despite having the lowest early leaf spot and intermediate white mold damage ratings, the Headline 2.09EC program produced a considerably lower yield than the Abound 2SC and Echo 720 6F plus Moncut 70DF programs. Yields for the Folicur 3.6F and the Headline 2.09EC programs were similar. Highest yields were obtained with the Abound 2SC and Echo 720 6F plus Moncut 70DF programs.

## DISCUSSION

In both 1999 and 2001, contrast analysis indicated that two-week intervals between fungicide applications allowed less early leaf spot development than did applications made on a three- or four-week schedule (data not shown). Application interval did not have a noticeable impact on white mold incidence or on yield in 1999. In 2001, yield increased when fungicide applications were made at two-week rather than at three-week intervals. Although optimum early leaf spot control was maintained in 1999 when the 7.7-fluid-ounces-per-acre rate of Headline 2.09EC was applied at two-week intervals, contrast analyses showed that white mold control and yield did not decline when application intervals were lengthened to three weeks. When the 6.4-fluid-ounces-per-acre rate of Headline 2.09EC was applied at two-week inter-

vals in 2001, yield was higher compared to the 9.0-fluid-ounces-per-acre rate of the same fungicide applied every three weeks.

Further analyses of the 1999, 2001, 2002 data suggest that Headline 2.09EC gave better early leaf spot control than the recommended Folicur 3.6F and Abound 2SC programs. In 1999, Headline 2.09EC was less effective in controlling white mold and had lower yield gains than did the Folicur 3.6F programs. In the following year, no differences in white mold control or yield response between the Headline 2.09EC and Folicur 3.6F programs were seen. While no difference in white mold control with Headline 2.09EC and Folicur 3.6F were noted in 2001, peanuts treated with Headline 2.09EC had higher yields than peanuts receiving applications of Folicur 3.6F. The level of white mold control and yield response for all Headline 2.09EC and Abound 2SC programs in 2000 and 2001 was similar, but the Abound program gave better disease control and yield response in 2002. All Headline 2.09EC programs gave better control of early leaf spot and white mold than was obtained with the standard Bravo Ultrex, Bravo 720 6F, or Echo 720 6F programs in 1999, 2001, and 2002 but not in 2000. Yield gains were also consistently higher with Headline 2.09EC compared with the standard Bravo Ultrex, Bravo 720 6F, or Echo 720 6F programs. For the 2000 study, the level of leaf spot control and yield response obtained with the Headline 2.09EC plus Moncut 50W program was similar to that provided by the Moncut 50W program. In contrast, the Headline 2.09EC plus Moncut 70DF program provided better early leaf spot control and had a higher yield than the Bravo Ultrex plus Moncut 70DF program in 2001. Similar white mold control was given by all of the programs that included applications of Moncut 70DF in 2000 and 2001.

Portillo et al. (13) noted that the effectiveness of Headline 2.09EC for the control of several destructive diseases of peanut is equal to or superior to that of registered fungicides. In this study, Headline 2.09EC clearly had superb activity against early leaf spot and proved as effective in controlling white mold on peanut as currently recommended fungicide programs.

When applied on a two-week schedule at rates from 4.6 to 15.2 fluid ounces per acre, Headline 2.09EC consistently gave better control of early leaf spot than the standard seven-spray chlorothalonil (Bravo Ultrex, Bravo 720 6F, or Echo 720 6F) program or those programs that included applications of Bravo Ultrex plus Moncut 70DF. On the peanut cultivar 'Georgia Green', Culbreath and Brenneman (7) also obtained a similar result in their comparison of Bravo WeatherStik [720 6F] and Headline 2.09EC programs for the control of early leaf spot. In all three years, the level of early leaf spot control provided by Headline 2.09EC when applied over a range of application rates at two-week intervals was at least equal to and sometimes better

than the level of control maintained with the recommended Folicur 3.6F and Abound 2SC programs.

As previously noted (7), Headline 2.09EC applied at three-week intervals was as effective in controlling early leaf spot as recommended rates of Bravo Ultrex, Folicur 3.6F, and Abound 2SC applied on the shorter two-week interval. When applied at four-week intervals in 1999, Folicur 3.6F was less active against early leaf spot than the 7.7-fluid-ounces-per-acre rate of Headline 2.09EC applied on the same schedule. Our data support the conclusion of Portillo et al. (13) that the superior efficacy of Headline 2.09EC (pyraclostrobin) at three- and four-week spray intervals raises the possibility that the total number of fungicide applications can be reduced without sacrificing control of early leaf spot or pod yields. The enhanced residual activity of Headline 2.09EC against early leaf spot may make a weather-based disease advisory such as AU-Pnut a more attractive and possibly less costly option for scheduling fungicide applications than the traditional two-week calendar spray program. However, contrast analysis showed that Headline 2.09EC was most effective in controlling early leaf spot when applied at less than three-week intervals.

In three of four years, the level of white mold control obtained with Headline 2.09EC programs was usually equal to that provided by the recommended Folicur 3.6F, Abound 2SC, and Bravo Ultrex/Echo 720 6F plus Moncut 70DF programs. In a previous study, this fungicide alone or when alternated with other registered fungicides proved as effective as recommended fungicide programs in controlling white mold in peanut (13). Most notably, Headline 2.09EC at rates of 4.6 and 7.7 fluid ounces per acre in 1999 and 6.4 fluid ounces per acre in 2001 was as effective as Folicur 3.6F, Abound 2SC, or Bravo Ultrex plus Moncut 70DF programs in controlling white mold. In 2001, alternate applications of Headline 2.09EC or of Bravo Ultrex plus Moncut 70DF or application of a tank-mixture of Headline 2.09EC plus Moncut 70DF gave better control of white mold than Headline 2.09EC alone. Differences in the level of white mold control noted between these treatments in 2001 were not observed in 2000 due to low disease pressure. In 2001, application number did not have a noticeable impact on the efficacy of the 6.4-fluid-ounces-per-acre rate of Headline 2.09EC against white mold. Frequent showers in July and August 2001, which facilitated the redistribution of Headline 2.09EC from the foliage to soil surface around the collar and vines, may have enhanced the effectiveness of the three-application program against white mold.

Despite significant reductions in the severity of early leaf spot and/or white mold in 1999, the 4.6- and 7.7-fluid-ounces-per-acre Headline 2.09EC programs failed to increase yield above that for the peanuts treated with



Bravo Ultrex alone. In the following two years, the combination of early leaf spot and white mold control provided by the Headline 2.09EC programs was reflected in higher yields compared with those of the Bravo Ultrex or Bravo 720 6F standard. In addition, yield gains recorded in both years with Headline 2.09EC at 6.4, 12.2, and 15.2 fluid ounces per acre when applied at two-week intervals were usually comparable to those obtained with the recommended Folicur 3.6F, Abound 2SC, or Bravo Ultrex plus Moncut 70DF programs. Typically, alternating Headline 2.09EC with Folicur 3.6F or Moncut 70DF, as well as applications of the Headline 2.09EC plus Moncut 70DF tank-mix combination did not increase yield above that in the plots treated with selected rates of Headline 2.09EC alone. However, tank mixing or alternating fungicides with different modes of action has been suggested by FRAC (Fungicide Resistance Action Committee) as a strategy for reducing the risk of control failures resulting from a decline in sensitivity to triazole or strobilurin fungicides in fungal plant pathogen populations (8).

The efficacy data supporting the registration of Headline 2.09EC (pyraclostrobin) for the control of early leaf spot and white mold on peanut is incomplete. While the treatment rates that have been screened here are within the rate range listed on the federal label, the number of applications of Headline 2.09EC often has exceeded the maximum of three specified on the product label under FRAC guidelines. While Culbreath and Brenneman (7) noted the efficacy of Headline 2.09EC over a range of treatment rates for the control of early leaf spot, the numbers of applications of this fungicide in the programs evaluated in that study were not specified. As a result, Headline 2.09EC programs that include two or three applications at current label rates may not prove as effective in controlling early leaf spot and white mold as some of the programs evaluated in this study. To insure effective white mold control, particularly under intense disease pressure, Headline 2.09EC may have to be alternated or tank-mixed with non-strobilurin fungicides such as Folicur 3.6F, Moncut 70DF, or Artisan 3.6E (propiconazole plus flutolanil).

Sizable yield increases were obtained in all three years with recommended rates of Folicur 3.6F, as well as with Abound 2SC in the 2000 and 2001 trials, compared with those yields recorded for the standard Bravo Ultrex program. In previously published reports, the impact of application rate or treatment interval on the yield of Headline 2.09EC-treated peanut was not addressed, nor was the yield response to Headline 2.09EC and other recommended fungicide programs compared (7,13).

As previously noted (1,7,13), the effectiveness of Headline 2.09EC for the control of early leaf spot and white mold on peanut was equal and in some cases superior to that demonstrated by recommended fungicides. Despite significant reductions in the incidence of these diseases, Headline 2.09EC failed

to consistently increase pod yields in all years above those recorded for the standard, season-long Bravo Ultrex program. When compared to Folicur 3.6F, however, Headline 2.09EC was less consistent in minimizing white mold incidence or improving peanut yield. As a result, Headline 2.09EC may be best adapted for use on a peanut cultivar that is partially resistant to white mold. Further studies are needed to clearly establish the optimum application rate for effective control of both early and late leaf spot and white mold, as well as increasing peanut yield with two and three application programs specified on the federal label of Headline 2.09EC. Additional information must be collected about the impact of treatment interval on the efficacy of Headline 2.09EC against early leaf spot and white mold and the impact of peanut cultivar selection, particularly those cultivars resistant to multiple diseases, on the performance of this fungicide.

### SUMMARY

When applied at two-week intervals, programs that included two, three, or four applications of Headline 2.09EC at rates ranging from 4.6 to 12.2 fluid ounces per acre gave better control of early leaf spot than the recommended season-long Bravo Ultrex (chlorothalonil) program and were at least as efficacious against this disease as Folicur 3.6F and Abound 2SC. The level of early leaf spot control provided by 4.6 to 9.3 fluid ounces per acre of Headline 2.09EC applied every three weeks and by Bravo Ultrex at the recommended two-week interval was similar. In all four years, incidence of white mold on peanut treated with Headline 2.09EC alone, tank-mixed with Moncut 70DF, or alternated with Folicur 3.6F was significantly below damage levels recorded in plots treated with Bravo Ultrex alone and was usually comparable to the level of disease control obtained with recommended Folicur 3.6F, Moncut 70DF, or Abound 2SC programs. Compared to Bravo Ultrex alone, yield of the Headline 2.09EC-treated peanuts was greater and generally did not greatly differ in most years from the yields recorded with the Folicur 3.6F, Moncut 70DF, or Abound 2SC programs. While Headline 2.09EC often gave similar white mold control over a range of treatment intervals, the most consistent yield gains were obtained when this fungicide was applied every two weeks.

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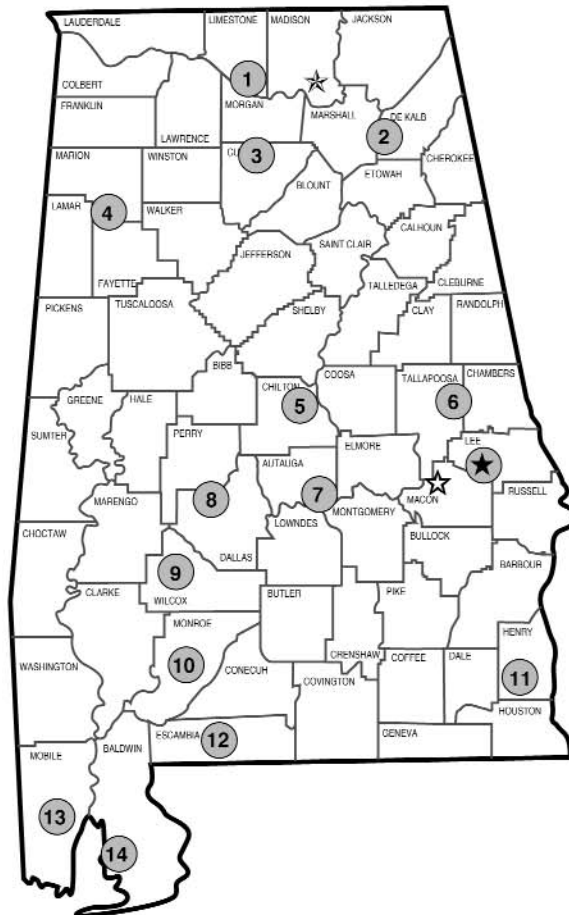
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## Alabama's Agricultural Experiment Station AUBURN UNIVERSITY

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### Research Unit Identification

- ★ Main Agricultural Experiment Station, Auburn.
- ★ Alabama A&M University.
- ★ E. V. Smith Research Center, Shorter.

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