On-Farm Evaluations of Reduced Input Fungicide Programs in Peanut Fields with Low, Moderate, or High Levels of Disease Risk

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ABSTRACT

In 2003, 2004, and 2005 standard and reduced input fungicide programs were evaluated throughout the peanut production region of Georgia for control of early leaf spot (*Cercospora arachidicola*), late leaf spot (*Cercosporidium personatum*), and southern stem rot (*Sclerotium rolfsii*). Disease risk was determined for each field based on the cultural practices implemented and ranged from low to high. Six to eight fungicide applications were made in the standard programs, versus three to six applications in reduced programs. Leaf spot ratings were higher for the reduced programs in five of the fourteen trials with substantial defoliation occurring in one trial. Overall, southern stem rot control for the reduced programs was equal to or better than that for the standard program, which could be attributed to the differences in fungicide selection or timing. Pod yields for the reduced programs were equal to or greater than the standard programs in all but one trial. Net returns were higher for the reduced programs in half of the trials; however, the reduced program resulted in lower net returns in one trial in 2004. Our results indicate that reduced input fungicide programs can be used to adequately manage fungal diseases of peanut without compromising yield or profitability, and that the use of cultivars with moderate levels of disease resistance may enhance disease control.

Key Words: *Arachis hypogaea* L., integrated disease management, partial resistance, fungal disease risk, risk index, leaf spot, southern blight, Bravo Ultrex, Tilt, Headline, Abound, Folicur, Artisan.

Peanut (*Arachis hypogaea* L.) is one of the most economically important crops in the southeastern United States with a farm gate value of approximately $835 million (USDA-NASS, 2005). To ensure profitable net returns, producers rely heavily on fungicides to manage a variety of yield-limiting fungal diseases that are made more severe by the warm temperatures, ample precipitation and high humidity in the region. Early and late leaf spot, caused by *Cercospora arachidichola* Hori and *Cercosporidium personatum* (Burk. & Curt.) Deighton, respectively, are the primary foliar diseases, whereas southern stem rot and Rhizoctonia limb rot, caused by *Sclerotium rolfsii* Sacc. and *Rhizoctonia solani* Kühn AG-4, respectively, are the principal soilborne diseases. Combined, the aforementioned diseases are responsible for annual losses in excess of $25 million in Georgia (Kemerait, 2005). To reduce losses, producers make between five and eight fungicide applications per season (Kemerait *et al*. 2005), meaning fungicides are the single greatest expenditure. As producers seek to remain economically competitive, the cost of disease management programs must be addressed.

Economic efficiency in production is even more important after changes in the 2002 U.S. farm bill, which replaced the old quota system with a new marketing loan system. As a result, the in-shell loan price was reduced from $548 to $398/metric ton (Smith, 2002). In addition to lower crop prices and high fungicide expenditures, recent increases in fuel costs have become a significant economic constraint for peanut producers. In response to these factors, less expensive disease management strategies are needed to ensure producers maintain an economically profitable crop.

Integrated disease management involves the use of a range of disease control strategies to achieve a level of disease control that is economically acceptable to producers. Previously, an integrated approach was implemented in 1995 to manage Tomato spotted wilt caused by *Tomato spotted wilt tospovirus* (family: Bunyaviridae) in the southeastern U.S. The spotted wilt risk index uses factors such as cultivar selection, insecticide application, planting date, plant population, row pattern and tillage to minimize losses associated with the virus (Culbreath *et al*. 1999; Brown *et al*. 2003; Brown *et al*. 2005a). According to Brown *et al*. (2005b), peanut yields increased approximately 10% over a 5-year period following the release of the index, and more than 80% of Georgia producers are using some combination of the factors included in the index.

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Many of the factors that comprise the spotted wilt risk index also influence the development of fungal diseases (Brenneman and Hadden, 1996; Monfort *et al*. 2004; Sconyers *et al*. 2005; Cantonwine *et al*. 2006); therefore, a similar integrated approach should be helpful in the management of fungal diseases. A Fungal Disease Risk Index (Kemerait *et al*. 2004; Woodward, 2006) has been developed, using criteria such as cultivar, crop rotation, field history, planting date, irrigation, and tillage. Since its release, this index has been combined with the spotted wilt risk index (Brown *et al*. 2005a) to serve as an educational tool to allow producers to quantitatively measure the risk of each disease on an individual field basis. The index is designed to be used prior to planting, when producers can choose management practices that will help minimize disease risk and related losses. In addition, fungicide use patterns can be adapted to fit specific field situations.

Reduced fungicide programs for peanut disease control have been evaluated (Besler *et al*. 2001; Brenneman and Culbreath, 1994; Culbreath *et al*. 1992; Damicone and Jackson, 1997; Grichar *et al*. 1998; Woodward *et al.* 2008; Woodward *et al.* 2009). However, few studies using integrated approaches for the aforementioned diseases have been conducted. Monfort *et al*. (2004) compared the effects of tillage, cultivar and reduced versus full fungicide inputs on the development of early leaf spot, and reported that leaf spot intensity in reduced-tillage plots treated with four fungicide applications was comparable to the standard seven applications in conventional tillage. Cantonwine *et al*. (2006) evaluated the economic aspects of using integrated approaches to manage leaf spot and tomato spotted wilt. Despite differences in yield over the duration of these studies, net returns were similar for fungicide regimes comprised of four, five and seven applications. Furthermore, the integrated tillage systems they evaluated consistently performed as well as the standard production system. Additional studies are needed to evaluate the potential for implementing such programs in commercial production settings.

The objectives of this research were to a) compare the effects of standard and reduced fungicide programs on disease development in fields with reduced risk, and b) determine the economic benefits of using reduced fungicide programs in fields with low-to-moderate levels of disease risk.

Materials and Methods

Large-Plot Evaluations

Field trials were conducted in 2003, 2004 and 2005 in the peanut growing region of southern Georgia in Dougherty, Lanier, Tift, Macon and Berrien counties. All production practices other than disease management were based on University of Georgia Cooperative Extension recommendations. Descriptions of cultural practices and the fungicide programs for each trial are presented in Tables 1 and 2, respectively. Reduced fungicide programs were derived from standard calendar-based programs according to predicted leaf spot, and stem rot risk as described by Kemerait *et al.* (2004). Treatments (fungicide programs) were arranged in a randomized complete block with four replications. Fungicide applications were made using the collaborating producer's equiptment. Plot dimensions varied by location ranging from 16 to 18 rows wide by the length of the field, averaging 0.8 ha.

Dougherty County Trial. In 2003, two trials were established in an irrigated field in Dougherty Co. near Albany, that had been planted to cotton (*Gossypium hirsutum* L.) the two previous years, but had a history of leaf spot and southern stem rot. Based on these and other cultural practices employed, the field was placed in a modrate risk category for both diseases (Table 1). Two standard and reduced fungicide programs were evaluated at this location and designated trial A and B. Standard A and reduced A consisted of six and four applications, respectively; whereas, standard B and reduced B had seven and five applications, respectively (Table 2).

Lanier County Trials. Similar trials were established in 2003, 2004 and 2005 in commercial peanut fields in Lanier Co. near Lakeland. The field sites for 2003 and 2005 had no history of peanut production; whereas the 2004 location had been planted to cotton the three previous years, but had been planted to peanut three years prior. Due to these attributes, leaf spot risk was low; whereas, stem rot risk was low in 2003 and 2005, but moderate in 2004 (Table 1). The standard program for trial 1 was identical to the Dougherty Co. trial described previously; however, the reduced program differed, having only five fungicide applications (Table 2). Likewise, the standard program for trial 2 was identical to the Dougherty Co. trial; however, the reduced program only had five fungicide applications (Table 2). In 2004, all plots received an additional chlorothalonil application on 1 Oct, due to an extended period of rain late in the season.

Macon County Trials. In 2004 and 2005, field trials were conducted in an irrigated field, in Macon Co. near Oglethorpe. The field was in a 4-year rotation, but had a history of foliar and soilborne diseases, thus leaf spot and stem rot risk were moderate

Table 1. Cultural practices and disease risk levels at field sites for evaluation of reduced input fungicide programs[a].

			Field history[c]						Disease risk level[e]	
Year, location	Cultivar	Rotation[b]	Leaf spot	Stem rot	Planting date	Row pattern	Tillage[d]	Irrigation	Leaf spot	Stem rot
2003										
Doughtery Co.	Ga. Green	2	Yes	Yes	5 May	Twin	Red	Yes	M (50)	H (55)
Lanier Co.	Ga. Green	10+	No	No	14 May	Twin	Red	Yes	L (35)	L (25)
2004										
Lanier Co.	Ga. Green	3	Yes	Yes	24 May	Single	Red	Yes	M (50)	M (50)
Tift Co.	Ga. -01R	4	Yes	Yes	1 May	Twin	Con	Yes	M (45)	M (45)
Macon Co.	Ga. -02C	4	Yes	Yes	6 May	Twin	Con	Yes	M (55)	M (40)
2005										
Lanier Co.	Ga. Green	10+	No	No	25 May	Twin	Red	Yes	L (35)	L (25)
Tift Co.	Ga. -01R	4	Yes	Yes	10 May	Twin	Red	Yes	M (40)	M (45)
Macon Co.	Ga. -02C	3	Yes	Yes	10 May	Twin	Conv	Yes	M (60)	M (40)
Berrien Co. 1	Ga. Green	3	Yes	Yes	26 May	Single	Red	Yes	M (50)	M (50)
Berrien Co. 2	Ga. Green	10+	No	No	24 May	Single	Red	No	L (25)	L (25)

[a]Values were derived from the University of Georgia Fungal Disease Risk Index (Kemerait *et al.* 2004) adapted by Woodward 2006.

[b]Rotation refers to the number of years between peanut crops.

[c]Yes indicates leaf spot or southern stem rot were a problem in previous cropping of peanut.

[d]Con = conventional (deep-plow) tillage; whereas Red = reduced tillage (strip-tillage).

[e]Defines level of disease risk, where L = low, M = moderate, and H = high. Point totals are in parenthesis.

(Table 1). The standard and reduced programs were comprised of seven and five applications, respectively. A description of the two fungicide programs evaluated in these trials can be found in Table 2. In 2004, all plots received an additional application of chlorothalonil 102 days after planting due to rain shortly after the application of azoxystrobin.

Tift County Trials. Trials were conducted in 2004 and 2005 in Tift County, near Omega. Both fields were irrigated and had a history of leaf spot and southern stem rot issues and were classified with moderate risk for leaf spot and stem rot (Table 1). In 2004, the standard program consisted of eight applications and the reduced program had four applications (Table 2). Changes were made to the fungicide programs in 2005. The standard program consisted of eight applications; whereas, the reduced program had six applications (Table 2).

Berrien County Trials. Two trials (Berrien 1 and Berrien 2) were established in Berrien Co. in 2005. The Berrien 1 trial included a 3-year rotation with corn (*Zea mays* L.), was irrigated and was classified as having a moderate risk for southern stem rot and leaf spot; whereas, the Berrien 2 trial was non-irrigated and had been in continuous cotton production for the past 15 years, resulting in low risk designations for both diseases. Fungicide programs for each location were the same, where the standard and reduced program utilized six and four applications, respectively (Table 2).

Disease Evaluations and Harvest

Leaf spot and southern stem rot development were monitored throughout the season, and final assessments were made prior to or at digging. Spotted wilt assessments were based on disease intensity ratings that represent a combination of incidence and severity as described by Culbreath *et al.* (1997). Final leaf spot intensity was rated prior to plants being inverted. Ratings were made using the Florida 1–10 scale, where 1 = no disease and 10 = plants completely defoliated and killed by leaf spot (Chiketa *et al.* 1988). Plants were inverted based on pod maturity (Williams and Drexler, 1981), and the incidence of southern stem rot was determined by counting the number of disease foci exhibiting symptoms of the disease or signs of *S. rolfsii* (Rodriguez-Kabana *et al.* 1975).

Plants were allowed to dry in windrows for 3–7 days, except at the Berrien 2 location, where plants remained in windrows for 14 days due to extended periods of rain. For all county trials, peanuts were harvested with grower-cooperator combines, and yields were determined for each plot. Pods weights from all locations were adjusted to 10% moisture (w/w) based on the moisture content of a 1-kg sample.

Pod Quality, Economic Analysis, and Statistical Comparisions

A 600-g sub-sample of pods was collected from each plot in 2004 and 2005 and graded according to Federal Inspection Service guidelines (USDA-AMS,

Table 2. Schedule and sequence of fungicide applications for comparision of standard and reduced programs in 2003, 2004, and 2005[a].

Location, (year)	Fungicide application schedule[b]											
Program	1.0	1.5	2.0	3.0	3.5	4.0	4.5	5.0	6.0	6.5	7.0	8.0
Dougherty (2003)												
Standard A		Pyr$_{0.16}$		Teb		Teb		Teb	Teb		Chl	
Reduced A		Pyr$_{0.11}$		Teb		Teb		Teb		Chl		
Standard B	C+P		C+P	Azo$_{0.34}$		Chl		Azo$_{0.34}$	Chl		Chl	
Reduced B		C+P		Azo$_{0.22}$		Teb		Azo$_{0.22}$		Chl		
Lanier (2003–2005)[c]												
Standard A		Pyr$_{0.16}$		Teb		Teb		Teb	Teb		Chl	
Reduced A		Pyr$_{0.16}$		Teb			Pyr$_{0.16}$		Teb			
Standard B	C+P		C+P	Azo$_{0.34}$		Chl		Azo$_{0.34}$	Chl		Chl	
Reduced B		C+P		Teb			Azo$_{0.22}$		Azo$_{0.22}$			
Macon (2004&2005)[d]												
Standard		Pyr$_{0.16}$		Teb		Teb		Teb	Azo$_{0.34}$		Chl	
Reduced		Pyr$_{0.16}$		Teb			Teb		Azo$_{0.34}$			
Tift (2004)												
Standard	C+P	Pyr$_{0.15}$		Azo$_{0.34}$		Teb		Pyr$_{0.15}$	Azo$_{0.34}$		Chl	Teb
Reduced		Pyr$_{0.15}$			Azo$_{0.34}$				Azo$_{0.34}$		Teb	
Tift (2005)												
Standard	C+P	Pyr$_{0.19}$		Azo$_{0.34}$		Chl		Teb	Teb		F+P	F+P
Reduced	C+P	Pyr$_{0.19}$		Azo$_{0.34}$					Teb		F+P	F+P
Berrien 1&2 (2005)[e]												
Standard	C+P		C+P	Teb		Azo$_{0.34}$		Teb		Azo$_{0.34}$		
Reduced			C+P		Teb			Teb		Azo$_{0.34}$		

[a]Abbreviations of fungicides: Azo = azoxystrobin (Abound 2.08F, 0.22–0.34 kg a.i./ha), Chl = chlorothalonil (Bravo Ultrex, 1.26 kg a.i /ha), C+P = chlorothalonil + propiconazole (Bravo Weather Stik, 0.84 kg a.i./ha + Tilt, 0.06 kg a.i./ha), F+P = flutolanil + propiconazole (Artisan, 0.84 + 0.17 kg a.i./ha, respectively), Pyr = pyraclostrobin (Headline 2.09EC, 0.11–0.22 kg a.i./ha), Teb = tebuconazole (Folicur 3.6F, 0.23 kg a.i./ha) are presented. Subscripts define fungicide rate.

[b]Fungicide application schedules are 2-week intervals or 1 week apart for intervals of 0.5.

[c]An additional application of chlorothalonil was applied to all plots in these trials in 2004, due to an extended period of rain.

[d]All plots received an additional chlorothalonil application in 2004, due to rain shortly after the application of azoxystrobin.

[e]Two separate trials, evaluating the same fungicide programs were conducted in Berrien county in 2005.

2003). Pod quality was determined by the percentage of total sound mature kernels (%TSMK). Revenue, was calculated as the difference between variable costs and the estimated crop value based on $398/ metric ton and adjusted for grade according to the 2003 Crop Peanut Loan Rates (USDA-FSA, 2003 a; b). Fungicide costs were determined by averaging the product prices from ten pesticide dealers throughout the state and ranging from $21.73 to $74.36 per application depending on product and usage rate. Application costs (totaling $12.35/ha each) included fuel and labor, which were based on Georgia enterprise budgets described by Smith *et al.* (2004). Fixed costs, such as depreciation, insurance and interest on investment were not included in the analysis. The return above fungicide cost, defined as the difference between fungicide costs and the USDA loan crop value, were calculated for each plot. Mean values for leaf spot intensity, stem rot incidence, pod yield and revenue for the respective standard and reduced fungicide programs within a trial were compared by year using Proc T-TEST in SAS (SAS v9.1, SAS Institute, Cary, NC). All subsequent references to significant differences are at P=0.10 unless stated otherwise.

Results

Differences in disease intensity were observed across years and locations. Both leaf spot and southern stem rot were more severe in 2004 than in any other year. Spotted wilt severity was low in 2003 and 2004 and moderate to severe in 2005 at all locations. No differences in spotted wilt incidence between standard and reduced fungicide programs were observed (data not presented). In 2003, early leaf spot was the predominant foliar disease; whereas, late leaf spot was prevalent in the majority of trials in 2004 and 2005. Southern stem rot was the predominant soilborne disease at all locations,

Table 3. Effect of standard and reduced fungicide programs on final leaf spot intensity, southern stem rot incidence, yield and net return (2003–2005).

Fungicide program	Trial[a]													
	Doughtery Co.		Lanier Co. 1			Lanier Co. 2			Macon Co.		Tift Co.		Berrien Co.	
	A	B	2003	2004	2005	2003	2004	2005	2004	2005	2004	2005	1	2
	Final leaf spot intensity[b]													
Standard	2.9	2.9	2.0	4.6	1.5	2.0	2.2	1.4	2.5	2.9	3.2	3.7	2.6	3.6
Reduced	2.7	2.6	2.1	2.7	1.3	2.0	4.2	2.0	2.5	3.0	6.3	4.4	2.8	4.1
P > t[e]	ns	ns	ns	**	ns	ns	**	**	ns	ns	***	***	ns	**
	Southern stem rot incidence (%)[c]													
Standard	11.8	8.9	2.0	21.4	3.0	7.8	36.0	2.0	17.3	7.3	16.4	11.9	20.3	12.8
Reduced	10.6	8.4	4.3	26.5	2.3	5.0	25.8	2.0	13.0	8.8	20.0	13.5	17.8	14.0
P > t	ns	ns	ns	ns	ns	*	*	ns	ns	ns	ns	ns	ns	ns
	Pod yield (kg/ha)													
Standard	3644	4100	7130	6552	6657	6751	6472	6595	6511	5785	6999	5560	3956	4866
Reduced	4099	4193	7220	6285	6550	6909	6259	6393	6396	5591	6100	5433	4201	4778
P > t	***	ns	ns	ns	ns	ns	ns	ns	ns	ns	***	ns	**	ns
	Net returns ($/ha)[d]													
Standard	1202	1329	2566	2331	2504	2368	2277	2348	2084	1923	2432	1284	1084	1360
Reduced	1432	1449	2665	2198	2472	2561	2270	2521	2173	1985	2240	1531	1311	1432
P > t	*	*	ns	ns	ns	*	ns	*	ns	ns	***	*	***	**

[a]Defines counties where the studies were located. Two trials (A and B) were conducted in Dougherty County in 2003, Lanier County in 2003, 2004 and 2005, and Berrien County in 2005. Fungicide programs are defined in Table 2.

[b]Final leaf spot intensity was assessed prior to peanut inversion using the Florida 1–10 scale developed by Chiketa *et al*. 1988.

[c]Final stem rot incidence was assessed immediately following peanut inversion, based on the percentage of 30.5-cm row segments showing signs or symptoms of *S. rolfsii* infection (Rodriguez-Kabana *et al*. 1975).

[d]Net returns are defined as the difference between variable costs and the estimated crop value.

[e]Probability of a greater t-value for each comparison. Probabilities of less than 0.10, 0.05 and 0.01 are indicated by *, **, and ***, respectively; ns denotes a probability greater than 0.10.

but limb rot was present at low levels in four of the trials. No differences in limb rot control were observed between standard and reduced programs where that disease was evaluated, therefore, only leaf spot and southern stem rot data are presented.

Dougherty County Trial. Leaf spot intensity was generally low and no differences in leaf spot intensity were observed among fungicide programs (Table 3). Southern stem rot incidence was moderate, and control was similar for both programs in either test (Table 3). There was no difference in pod yield or quality between standard or reduced programs in trial B; however, differences ($P \leq 0.01$) in yield were observed among the the two programs yields, where yields were 455 kg/ha higher for the reduced program in trial A (Table 3). Net returns were $120 to $230/ha higher for the reduced programs in trial B and A, respectively (Table 3).

Lanier County Trials. Leaf spot risk was estimated to be low in 2003 and 2005, but moderate in 2004 when the trial was conducted in a field utilizing a 3-year rotation. Likewise, southern stem rot risk levels varied and were deemed low, moderate and low for 2003, 2004, and 2005, respectively (Table 1). Differences ($P \leq 0.05$) in leaf spot control between the two fungicide programs were observed in 2004 for trial 1 where higher levels of leaf spot developed in the standard program compared to the reduced program (Table 3).

In trial 2, the incidence of southern stem rot was higher for the standard program than for the reduced program in 2003 and 2004 (Table 3). No other differences in southern stem rot were observed. Yields were similar between the standard and reduced programs in all years for trials 1 and 2. No differences in net returns between the standard and reduced program were observed for trial 1 during any year of the study; however, the net returns for the reduced program were 7–8% higher for the reduced program in 2003 and 2005 for trial 2 (Table 3).

Macon County Trials. No differences in leaf spot or southern stem rot were observed between the standard and reduced program in either year (Table 3). Leaf spot pressure was generally low throughout the duration of the study; and southern stem rot was the predominant disease both years comparisions were made. Yields were similar for the two programs averaging 6453 and 5688 kg/ha in 2004 and 2005, respectively (Table 3). Revenues were not different among the programs averaging $2128 and $1954/ha for the respective years (Table 3).

Tift County Trials. Leaf spot pressure was high in 2004 and moderate in 2005. Intensity of leaf spot was lower ($P \leq 0.01$) in the standard input fungicide programs than the reduced program in both years (Table 3). Southern stem rot was moderate in both years, and incidence was similar for the two programs (Table 3). Yield for the standard program was 899 kg/ha higher ($P \leq 0.01$) than in the reduced program in 2004, but was similar for the two programs in 2005 (Table 3). The reduced program resulted in net returns that were $192/ha lower ($P \leq 0.01$) than the standard fungicide program in 2004; however, $247/ha higher net returns ($P < 0.05$) were achieved for the reduced program compared to the standard program following changes to the fungicides that comprised the two programs.

Berrien County Trials. Leaf spot ratings were similar for the two programs at the Berrien 1 trial; however, there was an increase ($P < 0.05$) in leaf spot intensity in the reduced program at the Berrien 2 trial (Table 3). No differences in southern stem rot control were observed between the two programs at either location. Pod yields varied by location averaging 4078 and 4822 kg/ha for trial 1 and 2, respectively. No differences were observed between the two programs in trial 2. However, yields for the reduced program were 245 kg/ha greater ($P < 0.05$) than the standard program in trial 1. The reduced program had $227/ha and $72/ha higher net returns than the standard program in both trial 1 ($P < 0.01$) and trial 2 ($P < 0.05$), respectively.

Discussion

Results of this research validate the University of Georgia Fungal Disease Risk Index (Kemerait *et al.* 2004), and indicate that reduced fungicide programs can be used in an integrated system for management of fungal diseases of peanut. Leaf spot and southern stem rot intensity varied by location and year, which may have been attributed to the cropping histories and different cultural practices implemented in each field, which agrees with risk levels predicted by the index. Variations in disease pressure also are caused by the highly variable environmental conditions of the region. Above average rainfall amounts likely accounted for increased levels of disease, especially leaf spot in 2004. Over the duration of the research trials, total rainfall was 25, 35 and 15% above the ten-year average for 2003, 2004 and 2005, respectively (Hoogenboom *et al.* 2003). Differences in the level of leaf spot control between standard and reduced programs varied by location and warranted an examination of the products that comprised each program. Tebuconazole was used in each instance where differences were observed in leaf spot control between standard and reduced programs. Lower leaf spot ratings for the reduced program at trial 1 in Lanier Co. in 2004 can be attributed to the use of pyraclostrobin in the reduced program.

Tebuconazole has been highly efficacious against leaf spot in the past (Brenneman and Culbreath, 1994); however, results from trials conducted in recent years have raised concerns about the development of fungicide resistance to sterol demethylation inhibiting (DMI) fungicides (Culbreath *et al.* 2005). Recent studies have indicated that reductions in efficacy of tebuconazole may be a result of reduced sensitivity within *C. arachidicola* and *C. personatum* populations (Culbreath *et al.* 2005). Current resistance management recommendations include the use a non-DMI fungicide prior to and after applications of a DMI (Brenneman and Culbreath, 1994); furthermore, chlorothalonil should be included with tebuconazole for management of leaf spot where resistance has developed. Since reduced fungicide input programs provide fewer opportunities to incorporate compounds with different modes of action, this approach must be monitored closely to avoid development of fungicide resistance.

Sclerotium rolfsii was present at all locations included in these studies to some degree. Disease incidence was generally highest in fields that had been planted to peanut within the past four years, reinforcing the importance of crop rotation and field history. Sclerotia of *S. rolfsii* can remain viable in the soil for up to 3 years, and the fungus is capable of infecting more than 500 species of plants (Punja, 1985). Results from the cultivar studies corroborate previous findings that some cultivars have improved levels of resistance to southern stem rot (Brenneman *et al.* 2005). Although southern stem rot intensity was generally higher in the late-maturing cultivars, assessments within the season indicate that, with the exception of Tifrunner, the late-maturing cultivars have levels of resistance equal to or better than that of earliy-maturing cultivars such as Georgia Green (data not presented). However, because they are later maturing, the duration of southern stem rot epidemics resulted in higher levels of disease. Components of fungicide programs and application timing may need to be modified if producers wish to use integrated systems that include reduced fungicide programs and late-maturing cultivars.

These studies support results of previous reports indicating that fungicide inputs to manage peanut diseases can be reduced without compromising yields (Cantonwine *et al.* 2006; Monfort *et al.* 2004; Woodward *et al.* 2008; Woodward *et al.* 2009). Cantonwine *et al.* (2006) evaluated the economic benefits of various integrated disease management systems and found that the standard production system consisting of Georgia Green, conventional tillage, and a 7-spray chlorothalonil program did not maximize net returns. No differences were observed among the four, five or seven-spray programs of chlorothalonil evaluated in their study indicating that by using an integrated system, as many as three applications could be excluded from the standard leaf spot management program. However, those studies focused exclusively on foliar diseases and did not consider soilborne diseases, which can be responsible for significant yield reductions. In addition, the cost of fungicides used to manage soilborne diseases is substantially greater than that of fungicides used solely for leaf spot control.

Although yields varied by location, reductions in yield and net returns for the reduced fungicide program occurred only in the 2004 Tift Co. trial. Overall, yields of the reduced programs were not significantly different from those of the standard programs, and net returns typically favored reduced programs. These results indicate that integrated disease management systems can be used to manage peanut diseases without jeopardizing yield or net returns. Other considerations that must be made when utilizing reduced input programs are the efficacy of fungicides that make up the program and inherient risk of using reduced programs in fields with a history of moderate or high disease pressure.

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