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Effects of Peanut Row Pattern, Cultivar, and Fungicides on Control of Southern Stem Rot, Early Leaf Spot, and Rust

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ABSTRACT

Field trials were conducted in Texas during 2001 at Pearsall and 2002 at Yoakum to determine cultivar responses to certain foliar and soilborne diseases in single row (91 cm) vs. twin-row (rows spaced 18 cm on 91-cm centers) patterns and sprayed four times with tebuconazole at 0.23 kg ai/ha or twice with azoxystrobin at 0.34 kg ai/ha. Azoxystrobin and tebuconazole controlled southern stem rot similarly. Tebuconazole controlled rust more effectively than azoxystrobin. In 2002, early leaf spot severity was high and disease control was less than desirable with both fungicides, but still better than the nontreated plots. Both fungicides reduced early leaf spot severity in the single and twin-row patterns when compared to nontreated plots. Early leaf spot severity in the nontreated plots was greater in the twin-row pattern compared to the single row pattern. Tamrun 96 yielded better than any of the other cultivars in the study and showed less southern stem rot than all other cultivars when averaged across fungicide treatments and row spacing. Tebuconazole and azoxystrobin increased yield compared to nontreated control. No significant differences in yield occurred between fungicide treatments. The twin-row pattern showed a yield increase compared to the single row pattern when averaged across cultivar and fungicide treatments.

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Foliar and soilborne diseases can severely affect yield and quality of peanut. Backman and Crawford (1984) found that yield losses in Alabama from early leaf spot ranged from 10 to 15% but exceeded 50% in growing seasons where conditions were conducive to disease development. Early leaf spot (*Cercospora arachidicola* Hori.) has caused 50 to 70% pod yield loss in the absence of fungicides (Shokes and Culbreath, 1997). In Georgia and Florida, yield reductions exceeded 1100 kg/ha when early leaf spot was not controlled (Jacobi and Backman, 1991). Early leaf spot can attack healthy peanut plants and reduces tissue development (Nutter and Shokes, 1995). Grichar *et al.* (2000) reported that early leaf spot is more prevalent in south Texas due to high humidities and longevity of leaf moisture. Under ideal environmental conditions, disease symptoms occur within 10 to 14 d after inoculation and develop throughout the growing season. The pathogen thrives when temperatures are between 24 and 28 C and relative humidity exceeds 90% for 2 d or more (Smith and Littrell, 1980). Early leaf spot and late leaf spot caused by *Cercosporidium personatum* (Berk. and M. A. Curtis) Deighton have potential to develop in south Texas where these environmental conditions prevail.

Control of early leaf spot includes the use of fungicides and cultural practices. Until recently, south Texas growers relied on the use of chlorothalonil for control of early leaf spot. Chlorothalonil does not control soilborne pathogens, resulting in the need for additional fungicides to control southern stem rot (caused by *Sclerotium rolfsii* Sacc.). Most growers in south Texas initiate fungicide applications 45 to 60 d after planting (DAP) to control both foliar and soilborne diseases and apply no more than two to five applications throughout the growing season, depending on temperature and relative humidity. Therefore, only one to two applications of a chlorothalonil product may be used. A 2- to 3-yr crop rotation without peanut has proven to suppress leaf spot (Nutter and Shokes, 1995).

Much like early leaf spot, rust (caused by *Puccinia arachidis* Speg.) can be devastating to peanut production. Subrahmanyan *et al.* (1989) reported pod yield reductions as high as 50 to 60% under severe rust pressure. Rust epidemics develop faster than leaf spot and may cause pod maturation 2 to 3 wk early, resulting in smaller seed and pod loss at digging (Nutter and Shokes, 1995). In south Texas, rust is prevalent due to tropical spore deposition (Van Arsdel and Harrison, 1972). Control of rust can be achieved through the use of chlorothalonil, although a spray schedule of every 7 to 10 d may be needed.

Southern stem rot is a soilborne disease that south Texas growers have to manage every growing season. Southern stem rot is greatly influenced by moisture (Boyle, 1961). Therefore, in irrigated fields with short rotations between peanut crops, southern stem rot incidence can increase significantly within a season. Yield reductions of up to 10% have been reported as a result of southern stem rot in the Southeast and up to 5% in Southwest peanut regions (Melouk and Backman, 1995). Smith and Lee (1986) reported that southern stem rot damage costs growers in Texas and Oklahoma approximately $15 million annually. Because this disease can significantly reduce peanut yields, growers include fungicide and cultural control measures in their management practice.

The development of peanut fungicides over the last 5 to 10 yr has given growers additional options in controlling early leaf spot, rust, and southern stem rot. In Georgia, tebuconazole controlled southern stem rot when applied multiple times as a foliar spray (Brenneman *et al.*, 1991). Hagan *et al.* (1991) concluded that tebuconazole reduced southern stem rot and enhanced yields as compared to the untreated check. Besler *et al.* (2001) found that tebuconazole reduced southern stem rot on several peanut cultivars when applied as few as two times. Also, when applied on 14-, 21-, and 28-d schedules, tebuconazole reduced leaf spot severity and increased yield compared with an untreated check. Jaks *et al.* (1998) reported significant rust control with tebuconazole when used in an advisory schedule program.

Azoxystrobin controls leaf spot and southern stem rot similar to tebuconazole (Grichar *et al.*, 2000). Lunsford *et al.* (1998) found that azoxystrobin reduced early leaf spot defoliation when applied at the rate of 0.17 kg/ha and was comparable to chlorothalonil.

Little research documents the effects of a twin-row planting pattern on the development of foliar and soilborne diseases in conjunction with fungicides. Growers in south Texas have been slow to adopt twin-rows because of concerns that a quicker canopy closure may increase the risk of damage by soil and foliar diseases from favorable microclimate conditions. Harrison (1970) found no apparent differences in soilborne disease development with a twin- and narrow-row pattern when compared to the single row pattern. Sconyers *et al.* (2002) concluded that southern stem rot disease incidence was greater in 10-cm twin-rows than a wider single row pattern. They also found that southern stem rot disease incidence was higher along linear rows in a 10-cm twin-row pattern than in a 30-cm twin-row or single row pattern.

The objective of this study was to evaluate the response of four runner-type cultivars to disease development (southern stem rot, early leaf spot, and rust), pod yield, and quality when sprayed with azoxystrobin and tebuconazole and planted in single and twin-row planting patterns. To exclusively determine season-long disease control with these two fungicides, chlorothalonil was not applied to test areas. However, alternate use of fungicides with different modes of action should be used commercially to minimize risk of disease tolerance to azoxystrobin or tebuconazole.

Material and Methods

Field studies were conducted in Texas during 2001 near Pearsall and 2002 at the Texas Agric. Exp. Sta. near Yoakum. Soil at the Pearsall location was a Duval very fine sand (fine-loamy, mixed, hyperthermic Aridic Haplustalfs) with less than 1% organic matter. Soil at Yoakum was a Straber loamy sand (fine mixed thermic Aquic

Table 1. Source of variation and associated statistical significance [Pr > F (0.05)] for southern stem rot, rust, early leaf spot, and yield.

		Southern stem rot	Rust	Early leaf spot	Yield
Source	df	2001-2002	2001	2002	2001-2002
Year	1	NS[d]	–	–	0.0001
Year × Fng[a]	2	NS	–	–	NS
Year × RP[b]	1	NS	–	–	NS
Year × Cult[c] × RP × Fng	16	NS	–	–	NS
Replication	2	NS	NS	0.0039	0.0001
RP	1	NS	NS	NS	0.0002
Fng	3	0.0001	0.0001	0.0001	0.0001
Fng × RP	2	NS	NS	0.0184	NS
Cult	3	0.0001	0.0001	0.0012	0.0001
Cult × RP	3	NS	NS	NS	NS
Cult × Fng	6	NS	NS	NS	NS
Cult × RP × Fng	6	NS	NS	NS	NS
Means square error		30.61	0.25	0.12	265247
C.V. (%)		43.34	11.82	9.25	14.29

[a]Fungicide treatments (Fng) included a nontreated control, azoxystrobin at 0.34 kg/ha, and tebuconazole at 0.23 kg/ha.
[b]Row Patterns (RP) included single row (two rows spaced 91 cm apart) and twin-row (18 cm apart on two 91-cm beds).
[c]Cultivars (Cult) include AT 1-1, Flavor Runner 458, Georgia Green, and Tamrun 96.
[d]NS = Not significant.

Palenstalfs) with less than 1% organic matter. The test site in Pearsall was in a 2-yr crop rotation with corn and grain sorghum while the Yoakum site was in continuous peanut for more than 5 yr. Both sites had a known history of leaf spot and southern stem rot disease incidence. The runner-type cultivars AT 1-1, Flavor Runner 458, Georgia Green, and Tamrun 96 were planted on 30 May 2001 and 3 Jun 2002. Seed of each cultivar was planted with a Monosem precision vacuum planter (Monosem ATI, Inc., Lenoxa, KS). Number of seeds per meter on a bed were held constant for both the single and twin-row patterns to achieve approximately 87 and 120,000 plants/ha, respectively. The experimental design was a split-split plot arrangement with three replications. Whole plots consisted of cultivars, fungicide treatments represented the split-plot, and row patterns represented split-split plots. Plot size was two rows × 7.6 m long.

Azoxystrobin (Syngenta, Greensboro, NC) at 0.34 kg/ha was applied 62 and 90 DAP in 2001 and 59 and 87 DAP in 2002. Tebuconazole (Bayer Crop Sciences, Research Triangle Park, NC) at 0.23 kg/ha was applied 62, 76, 90, and 105 DAP in 2001 and 59, 73, 87, and 102 DAP in 2002. Fungicides were applied with a CO_2-pressurized backpack sprayer with D3-13 hollowcone nozzles delivering 187 L/ha. Rust only developed in 2001 at Pearsall and was evaluated using the Intl. Crops Res. Inst. for the Semi-Arid Tropics (ICRISAT) scale of 1 to 9 (where 1 = no disease and 9 = plants severely affected) and 50 to 100% of the leaves are withering (Subrahmanyan *et al.*, 1982). One rating was taken late season on 9 Oct. Early leaf spot occurred only in 2002 at Yoakum and was evaluated using the Florida scale of 1 to10 (where 1 = no leaf spot and 10 = plants completely defoliated and killed by leaf spot) was used to assess leaf spot severity (Chiteka *et al.*, 1988). Early leaf spot was rated on 9 Aug., 1 Oct., and 15 Oct. However, only the final rating is reported. Southern stem rot developed both years at each location. Southern stem rot was assessed immediately after inversion on 19 Oct. in 2001. In 2002, due to high early leaf spot severity, southern stem rot was assessed above ground on Oct. 1. A disease locus was defined as ≤ 30 cm of consecutive southern stem rot damage of plants in a plot bed (Rodriquez-Kabana *et al.*, 1975). Identification of southern stem rot was determined by dead or wilted branches with visible mycelial growth and the presence of sclerotia.

Peanuts were dug on 19 Oct. 2001 and 15 Oct. 2002, allowed to field dry 5 to 7 d, and then harvested using a power-take-off driven combine. Plot weights were taken after all foreign matter was removed. Analysis of variance (ANOVA) was performed on southern stem rot disease incidence and peanut yield to test the effect of year, row pattern, fungicide treatments and all possible interactions. All main effects and possible interactions were analyzed for rust and early leaf spot for the year when these diseases occurred. Mean separation was then calculated using Fisher's Protected LSD test (P ≤ 0.05).

Table 2. Cultivar, fungicide, and row pattern effects on southern stem rot, rust, early leaf spot, and yield.

	Disease rating			
	Southern stem rot[a]	Rust[b]	Early leaf spot[c]	Yield
	2001-2002	2001	2002	2001-2002
Treatment	loci/7.6 m	1-9 scale	1-10 scale	kg/ha
Cultivar				
AT 1-1	7.8	5.5	8.2	3595
Flavor Runner 458	7.2	4.9	7.9	3639
Georgia Green	6.6	5.0	7.3	4258
Tamrun 96	3.7	5.3	8.0	4657
LSD[d] (P = 0.05)	1.3	0.3	0.3	240
Fungicide				
Nontreated control	9.9	7.8	9.3	3041
Azoxystrobin (2 appl.)	4.7	4.4	6.5	4502
Tebuconazole (4 appl.)	4.3	3.3	7.8	4570
LSD (P = 0.05)	1.1	0.3	0.3	208
Row pattern				
Single row	6.5	5.3	7.8	3455
Twin row	6.1	5.1	7.9	3774
LSD (P = 0.05)	NS[e]	NS	NS	170

[a]Loci/7.6 m where a disease locus was defined as ≤ 30 cm of consecutive southern stem rot damage of plants in a bed.
[b]ICRISAT scale where 1 = no disease and 9 = plants severely affected, 50 to 100% leaves withering.
[c]Florida scale where 1 = no leaf spot and 10 = plants completely defoliated and killed by leaf spot.
[d]LSD = least significant difference. Differences between means that are greater than the LSD within a column are significantly different.
[e]NS = Not significant.

Results and Discussion

Data for southern stem rot and yield were combined over years due to lack of year × treatment interaction (Table 1). A significant cultivar and fungicide treatment effect occurred for southern stem rot, while a significant cultivar, fungicide treatment, and row pattern effect occurred for yield. In 2001, a significant fungicide treatment and cultivar effect resulted for rust (Table 1). Significant fungicide treatment, cultivar, and fungicide treatment × row pattern effects occurred for early leaf spot.

Southern Stem Rot. Southern stem rot incidence was lower when azoxystrobin and tebuconazole were applied regardless of row pattern or cultivar compared with the nontreated control (Table 2). Besler *et al.* (1996) found that tebuconazole reduced southern stem rot incidence by 53%. No difference in southern stem rot control was noted between azoxystrobin and tebuconazole. These results also agree with Grichar *et al.* (2000) who concluded that azoxystrobin was comparable with tebuconazole for control of southern stem rot. The cultivar Tamrun 96 had lower southern stem rot disease incidence than all other cultivars when averaged across fungicide treatments and row pattern (Table 2). Besler *et al.* (1997) concluded that Tamrun 96 was low in southern stem rot disease incidence over a 3-yr period when compared to other cultivars. While AT 1-1 had the highest southern stem rot disease incidence, the reactions of Flavor Runner 458 and Georgia Green were intermediate.

Rust. Azoxystrobin and tebuconazole reduced rust when compared to the nontreated control (Table 2). Tebuconazole controlled rust more effectively than azoxystrobin. Because rust was more evident later in the season, improved control could be attributed to the late-season application of tebuconazole. Most cultivars had similar rust pressure when averaged across fungicide treatments and row pattern. Flavor Runner 458 had less rust than AT 1–1 and Tamrun 96 but not Georgia Green (Table 2).

Early Leaf Spot. Early leaf spot severity was extremely high in 2002 when fungicides were not applied (Table 2). This resulted in some plants being completely defoliated. Although azoxystrobin and tebuconazole reduced early leaf spot incidence when compared with the nontreated control, early leaf spot was still considered high in those treatments (Table 2). Heavy rainfall mid- to late-season coupled with favorable temperatures and humidity caused severe early leaf spot pressure, which overwhelmed plots that received fungicide

Table 3. Treatment by row pattern effect on early leaf spot control at Yoakum in 2002 when averaged across cultivars.

		Early leaf spot[a]	
	Rate	Single row	Twin-row
Treatment	kg/ha	--- 1-10 scale ---	
No spray	–	9.0	9.5
Azoxystrobin (2 appl.)	0.34	7.9	7.7
Tebuconazole (4 appl.)	0.23	6.6	6.4
LSD[b] (P = 0.05)		0.4	0.4

[a]Florida scale where 1 = no leaf spot and 10 = plants completely defoliated and killed by leaf spot.
[b]LSD = least significant difference. Differences between means that are greater than the LSD within and between columns are significantly different.

applications. When averaged across cultivars and row pattern, azoxystrobin and tebuconazole reduced leaf spot compared to the nontreated control. Grichar *et al*. (2000) reported that azoxystrobin applied at rates that ranged from 0.22 to 0.45 kg/ha controlled early leaf spot comparably to tebuconazole.

Each cultivar displayed a high level of early leaf spot incidence (Table 2). However, when averaged across fungicide treatments and row pattern, Georgia Green had less early leaf spot than all other cultivars. Georgia Green was reported to have intermediate leaf spot tolerance between Southern Runner and Florunner (Branch and Culbreath, 1995). There was a significant fungicide treatment × row pattern with more early leaf spot in the nontreated control plots where cultivars were planted in a twin-row configuration (Table 3). Azoxystrobin and tebuconazole lowered early leaf spot severity in both row pattterns when compared to the nontreated control. Tebuconazole lowered early leaf spot severity compared to azoxystrobin in both the single and twin-row pattern.

Pod Yield. When averaged across row patterns and cultivar, pod yields were higher when azoxystrobin and tebuconazole were applied when compared with the nontreated peanut (Table 2). However, no difference in yield was noted when comparing peanut treated with azoxystrobin and tebuconazole. Tamrun 96, when averaged across fungicide treatments and row pattern, yielded more than the other cultivars (Table 2). Georgia Green was higher in yield than AT 1–1 or Flavor Runner 458. Moderate southern stem rot disease incidence both years, high rust in 2001, and high early leaf spot severity in 2002, respectively, contributed to lower yields with cultivars AT 1–1 and Flavor Runner 458. However, due to excessive late-season rainfall in 2002, these two cultivars were not inverted at the optimum time, which may have contributed to lower yields.

Row pattern effects on yield revealed that the twin-row pattern was significantly higher in yield then the single row pattern (Table 2). Baldwin *et al.* (1998) found that when averaged across four runner cultivars and locations in Georgia, twin rows significantly increased yield by 381 kg/ha in the absence of disease. Another study conducted in Georgia in 1997 and 1998 found 716 kg/ha and 375 kg/ha increases in yield, respectively, in twin-rows compared to the single row pattern (McGriff *et al*., 1999). In the aforementioned studies, plants/m on a bed was held constant for both row patterns.

This study revealed that azoxystrobin and tebuconazole effectively controlled both southern stem rot and rust but was not as effective for control of early leaf spot. Azoxystrobin and tebuconazole were applied two and four times, respectively, throughout the growing season. Because leaf spot severity was high, additional fungicide applications would be required for better control. This study also revealed that Tamrun 96 was lower in southern stem rot incidence than AT 1–1, Flavor Runner 458, and Georgia Green. Therefore, growers who have fields with a history of southern stem rot may benefit by planting this cultivar. Peanuts planted in a twin-row pattern had higher yields than peanuts planted in a single row pattern when averaged across cultivar and fungicides. Based on these findings, there may be an advantage to planting twin-rows to increase yield.

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