Use of Azoxystrobin for Disease Control in Texas Peanut

W. J. Grichar*, B. A. Besler, and A. J. Jaks[1]

ABSTRACT

Field studies were conducted at 11 locations across south Texas from 1994 to 1997 to determine the activity of azoxystrobin against southern stem rot (*Sclerotium rolfsii* Sacc.), Rhizoctonia pod rot (*Rhizoctonia solani* Kuhn), early leaf spot (*Cercospora arachidicola* Hori) and late leaf spot [*Cercosporidium personatum* (Berk. & Curt.) Deighton]. Azoxystrobin at 0.22 to 0.45 kg/ha applied twice provided control of stem rot, Rhizoctonia pod rot, and leaf spot comparable to tebuconazole at 0.2 kg/ha applied four times. Peanut yield increases were evident with all fungicide treatments over the untreated check.

Key Words: *Arachis hypogaea,* foliar diseases, groundnut, pod rot, southern blight, yield.

Southern stem rot, caused by *Sclerotium rolfsii* Sacc., and Rhizoctonia pod rot, caused by *Rhizoctonia solani* Kuhn, are two of the most important soil-borne pathogens of peanut (*Arachis hypogaea* L.) in the Southwestern U.S. Reported annual peanut yield losses due to southern stem rot are 10% in the Southeastern U.S. and up to 5% in the Southwest (Melouk and Backman, 1995). In Texas and Oklahoma, damage from stem rot costs peanut producers approximately $15 million annually (Smith and Lee, 1986).

Rhizoctonia induced diseases are usually found as a complex of soil-borne diseases, and the severity of each and the individual contributions to disease-induced losses are difficult to determine (Melouk and Backman, 1995). Pod rot by *R. solani* occurs after direct penetration of the pod by the fungus. When the pathogen first invades peanut tissue, the pod displays brown to dark brown cankers on its surface. As the disease progresses, the developing seed can be colonized, killed, and then digested to the point that there are frequently dry mummies remaining within the blackened shell (Melouk and Backman, 1995).

Early (*Cercospora arachidicola* Hori) and late leaf spots [*Cercosporidium personatum* (Berk. & Curtis) Deighton] are two of the most important foliar diseases of peanut worldwide. Annual yield losses in Texas due to leaf spot diseases can vary from year to year due to temperature, rainfall patterns, humidity levels, and amount of primary inoculum. Generally, leaf spot diseases are more of a problem in south Texas where high humidities and leaf wetness are prevalent for longer time periods than in other areas of the state (author's pers. observ.).

In the Southeastern U.S., annual yield losses due to leaf spot average 5% even with the use of protectant fungicides, whereas peanut losses would likely approach 50 to 70% without fungicides (Chiteka *et al.*, 1988; Nutter and Shokes, 1995; Shokes and Culbreath, 1997). Peanut yield losses in the Southwest can approach these figures in years of heavy leaf spot pressure (author's pers. opinion). Peanut production in the U.S. depended mainly on routine applications of chlorothalonil from the early 1970s to the late 1990s due to its effectiveness against foliar diseases, either on a calendar or advisory schedule (Shokes *et al.*, 1983; Phipps and Powell, 1984; Nutter and Shokes, 1995; Bailey, 1999).

For over 20 yr, chlorothalonil has been used extensively to control both early and late leaf spot on peanut. Recently, the sterol-inhibiting fungicides propiconazole and tebuconazole were registered for use on peanuts in the U.S. These fungicides are active against both foliar and soil-borne diseases of peanut (Brenneman and Murphy, 1991; Brenneman *et al.*, 1991, 1994; Culbreath *et al.*, 1995; Grichar, 1995; Grichar and Jaks, 1995; Besler *et al.*, 1996).

Azoxystrobin {methyl(E)-2-[2-[6-(2-cyanaphenoxy) pyrimidin-4-yloxy]phenyl]-3-methoxyacrylate} is a fungicide cleared for use on peanut in June 1997. Azoxystrobin is based on naturally occurring fungicides called strobilurins, found in some wood-decaying mushrooms. It is a beta-methoxy acrylic acid derivative and was the first registered fungicide from this class of chemistry (Anon., 1996).

Azoxystrobin controls fungal pathogens by inhibiting electron transport at a unique site of action, which gives it a different mode of action than other registered fungicides (Anon., 1996). It works preventatively to stop infections from developing and systemically to stop many diseases during the early stages of their development. Field studies were initiated in 1994 to compare the activity of this fungicide with tebuconazole, which is widely used by peanut producers in Texas.

Materials and Methods

Studies were conducted in the south Texas peanut-growing region from 1994 to 1997 in fields with a history of disease problems. The locations were in the south Texas peanut-growing region, which included the Texas Agric. Exp. Sta. located near Yoakum in Lavaca Co.; Jimmy Seay Farm, near Pleasanton in Atascosa Co.; Charles Palmer Farm, near Verdi in Atascosa Co.; and Floyd Royal Farm near Jourdanton in Atascosa Co.; Butch Vaughan Farm near Pearsall in Frio Co.; and Schimank Farm near Giddings in Lee Co.

All studies except at the Butch Vaughan Farm near Pearsall and Charles Palmer Farm near Verdi were in fields which had been in continuous peanuts for at least the past 5 yr. The Vaughan Farm had been out of peanuts for the past 2 yr, while at the Palmer Farm peanuts were planted every other year in rotation with corn (*Zea mays* L.). Organic matter was < 1% at each location and peanuts were harvested when 135 to 145 d old. A schedule of events and other specifics about the various locations are described in Table 1.

[1]Res. Scient. and Res. Assoc. Texas Agric. Exp. Sta., Yoakum, TX 77995.
*Corresponding author (email: w-grichar@tamu.edu).

Table 1. Schedule of events and locations of studies conducted with azoxystrobin.

	Location					
	Yoakum	Pleasanton	Verdi	Pearsall	Jourdanton	Giddings
Event	1994-1997	1996, 1997	1994, 1996	1997	1996	1997
Seed rate (kg/ha)	112	100	90	90	100	90
Irrigation	Yes	Yes	Yes	Yes	Yes	Yes
Cultivars						
1994	GK-7	-	Florunner	-	-	-
1995	GK-7	-	-	-	-	-
1996	GK-7	AT-108	AT-108	-	GK-7	-
1997	GK-7	GK-7	-	AT-108	-	AT-108
Soil type	Tremona loamy fine sand	Webb fine sandy loam	Poth loamy fine sand	Duval very fine sand	Neuces loamy fine sand	Poth loamy fine sand
Soil-borne disease pressure:						
1994	Moderate	-	Heavy	-	-	-
1995	Heavy	-	-	-	-	-
1996	Heavy	Heavy	Heavy	-	Heavy	-
1997	Heavy	Heavy	-	Low	-	Low
Crop rotation	No	No	Yes	Yes	No	No

The experimental design was a randomized complete block with four replications. Plots consisted of four rows 7.6 m long spaced on 91-cm centers. Data were obtained from the middle two rows to minimize the effect of spray drift from adjacent plots. The treatments included azoxystrobin (Abound, Zeneca Ag Products, Wilmington, DE) at 0.22, 0.34, and 0.45 kg/ha applied at approximately 60 and 90 d after planting. Tebuconazole (Folicur 3.6F, Bayer Corp., Kansas City, MO) at 0.2 kg/ha applied four times on a 14-d schedule beginning 60 d after planting was used as a standard. An untreated check was included also at each site.

Typically in the Southwest, three applications of tebuconazole at 0.2 kg/ha are applied during the growing season while normally two applications of azoxystrobin are applied by growers (author's pers. observ.). Normally, initial fungicides for soil-borne disease control are applied beginning about 60 d after planting.

All off-station trials had natural populations of *S. rolfsii, R. solani, C. arachidicola,* and *C. personatum.* Disease pressure varied across locations. Leaf spot incidence was minimal at Verdi in 1994 and at Pearsall in 1997. Leaf spot pressure was low in 1996 at Pleasanton and Giddings in 1997 and moderate at Jourdanton and Verdi in 1996.

At the Yoakum location, stubble from the ryegrass (*Secale cereale* L.) cover crop was shredded and lightly incorporated into the soil. To increase the inoculum in the soil-borne test area at this location, *S. rolfsii* was cultured on autoclaved grains, air dried, screened over a 0.65-cm screen to break up large particles, and then applied uniformly over each row at the rate of 15 g/7.9 m of row approximately 1 mo after planting of peanuts. Isolates of *S. rolfsii* used were obtained from peanuts grown in the same area the previous year. Leaf spot was managed with chlorothalonil (Bravo 720, ISK Biosciences, Mentor, OH) at 1.26 kg/ha applied broadcast with a tractor-mounted spray unit. Leaf spot sprays began 42-45 d after planting and continued on a 14-d schedule until 2 wk prior to peanut harvest for a total of seven foliar sprays.

A separate site was maintained at Yoakum for foliar disease evaluations. Soil-borne disease pressure was light in this area. Plot size and configuration was similar to the soil-borne disease area. All fungicide sprays were applied to the two center rows of the four-row plots with a CO_2 pressurized backpack sprayer. The sprayer was equipped with a two-row boom using three D2-13 or D2-25 solid cone nozzles per row delivering 140 to 180 L/ha.

Leaf spot intensity ratings were made approximately 2 wk prior to digging of peanut. Ratings were made using the Florida 1-10 scale, where 1 = no leaf spot and 10 = plants completely defoliated and killed by leaf spot (Chiteka *et al.*, 1988).

Immediately after plants were inverted, incidence of southern stem rot and *Rhizoctonia* disease sites (loci) were determined in each two-row plot. One disease locus was defined as one or more disease plant(s) in up to 31 cm of linear row (Rodriguez-Kabana *et al.*, 1975). Plants were dried in windrows for 5-8 d and pods were harvested mechanically and weighed. Weight of pods was recorded after soil and foreign matter were removed from the plot samples. Disease loci and pod yield were subjected to an analysis of variance within years. Means were separated using Fisher's least significant difference test ($P \leq 0.05$) (Steel and Torrie, 1980). Due to variation in varieties and disease incidence from location to location data were not combined.

Results and Discussion

Southern Stem Rot Control. Disease loci counts after digging indicated that disease incidence varied from location to location (Table 2). Both azoxystrobin and tebuconazole reduced disease when compared with the untreated check at all locations. Azoxystrobin provided southern stem rot control comparable to tebuconazole at five locations, while at the Yoakum location in 1994, azoxystrobin applied twice provided better control than tebuconazole applied four times (Table 2). At the Verdi location in 1994, azoxystrobin at 0.22 kg/ha controlled southern stem rot as well as tebuconazole; however, azoxystrobin at 0.45 kg/ha did not provide as good control as tebuconazole. Other research has reported on the excellent activity of tebuconazole (Brenneman *et al.*, 1991, 1994; Grichar, 1995; Besler *et al.*, 1996).

Timing of a fungicide treatment can be critical for soil-borne disease control. Brenneman *et al.* (1994) reported the timing of tebuconazole sprays influenced the effectiveness against soil-borne pathogens, especially in some years where conditions were conducive to early season disease development. Overall, there was a strong negative correlation between the number of tebuconazole sprays and stem rot incidence (Brenneman *et al.*, 1994).

***Rhizoctonia* Pod Rot Control.** Azoxystrobin provided better *Rhizoctonia* pod rot control than tebuconazole at the Pleasanton location in 1996 (Table 3). The 0.45 kg/ha rate of azoxystrobin provided better *Rhizoctonia* control than the 0.22 kg/ha rate. Differences in Rhizoctonia pod rot control between tebuconazole and the three rates of azoxystrobin were not observed at the other locations. All fungicide treatments significantly reduced disease incidence over the untreated check except for the Giddings location where Rhizoctonia pod rot pressure was lowest. In North Carolina and Virginia, when tebuconazole was applied four times during the growing season, it provided 87% control of Rhizoctonia pod rot (Komm, 1996). Csinos and Rodgers (1996) noted that in Georgia tebuconazole application resulted in a nonsignificant trend in reduced pod rot.

Leaf Spot Control. Late leaf spot was the predominant foliar pathogen at Yoakum (70% of the total leaf spot) while early leaf spot was the predominant pathogen at Pleasanton, Jourdanton, and Verdi.

At Yoakum, chlorothalonil (Bravo 720®) was applied at 45, 75, 105, and 120 d after planting with the scheduled sprays of azoxystrobin or 45 and 120 d after planting with scheduled sprays of tebuconazole. At the other locations, none of the azoxystrobin or tebuconazole plots received chlorothalonil. Leaf spot incidence was highest at Yoakum (Table 4). All azoxystrobin rates provided leaf spot control comparable to tebuconazole. Concern over the four-block spray regime for tebuconazole has been expressed due to the possible development of fungicide resistance (Backman, 1992; Brenneman and Culbreath, 1994; Bowen *et al.*, 1997). Brenneman and Culbreath (1994) noted that plots which received four applications of tebuconazole (applications 3-6) had lower leaf spot ratings than cholorthalonil alone or other chlorothalonil + tebuconazole combinations.

Peanut Yield. Azoxystrobin at 0.34 and 0.45 kg/ha consistently increased peanut yields (up to 43%) over the untreated check when southern stem rot was the major soil-borne disease at Pearsall, Verdi or Yoakum (Table 5). However, azoxystrobin at 0.22 kg/ha failed to significantly improve peanut yields over the untreated check at four of seven locations. Although the disease evaluations indicate no significant differences between azoxystrobin treatments (Table 2), there were trends toward reduced southern stem rot control with the lower azoxystrobin rate. This may have accounted for the lack of yield response. Azoxystrobin at 0.45 kg/ha produced peanut yield comparable with tebuconazole at five locations and outyielded tebuconazole at two locations.

Peanut yields with azoxystrobin treatments in areas with high *R. solani* pressure in 1996 were improved by at least 6% when compared with the untreated check (Table 6). Azoxystrobin at 0.45 kg/ha improved yields by at least 4% over tebuconazole at Pleasanton in 1996 and 36% at the Giddings location in 1997.

Some of the yield changes observed at Giddings, Jourdanton, Pearsall, Pleasanton, and Verdi may have been due to an interaction of individual diseases. The interactions should have been more prevalent at Jourdanton and Verdi in 1996 because foliar disease pressure was moderate while at all other locations foliar disease incidence was low (author's pers. opinion) (Table 4).

These results indicate that azoxystrobin can provide soil-borne as well as foliar disease control. Using

Table 2. Control of southern stem rot with azoxystrobin and tebuconazole.

			Disease hits/15.2m row							
		Application	1994		1995	1996		1997	
Treatment	Rate	timing	Yoakum	Verdi	Yoakum	Yoakum	Verdi	Yoakum	Pearsall
	kg/ha	DAP[a]	no.						
Azoxystrobin	0.22	60,90	2.7	10.9	13.7	17.6	13.5	13.7	5.6
Azoxystrobin	0.34	60,90	2.9	-	11.2	14.4	9.8	8.6	4.4
Azoxystrobin	0.45	60,90	2.0	12.1	13.6	11.8	7.3	10.6	2.6
Tebuconazole	0.20	60,74 88,102	8.6	5.9	13.7	14.9	6.5	13.3	2.6
Untreated	-	-	11.1	24.9	19.5	25.5	19.7	23.8	8.9
LSD (0.05)			4.6	5.9	5.6	6.3	6.2	5.7	3.5

[a]DAP = days after planting.

Table 3. Control of Rhizoctonia pod rot with azoxystrobin and tebuconazole.

			Disease hits/15.2m			
		Application	1996		1997	
Treatment	Rate	timing	Pleasanton	Jourdanton	Pleasanton	Giddings
	kg/ha	DAP[a]	no.			
Azoxystrobin	0.22	60,90	19.1	4.5	12.1	-
Azoxystrobin	0.34	60,90	16.0	5.8	11.9	8.0
Azoxystrobin	0.45	60,90	11.9	4.8	12.1	9.3
Tebuconazole	0.20	60,74 88,102	26.2	6.0	12.7	7.0
Untreated	-	-	33.3	22.5	19.1	13.0
LSD (0.05)			6.5	7.3	3.5	6.2

[a]DAP = days after planting.

Table 4. Leaf spot ratings with azoxystrobin and tebuconazole in south Texas.

			Leaf spot rating[b]				
		Application	1996				1997
Treatment	Rate	timing	Pleasanton	Jourdanton	Verdi	Yoakum	Yoakum
	kg/ha	DAP[a]					
Azoxystrobin	0.2	60,90	3.1	3.8	3.9	4.1	-
Azoxystrobin	0.3	60,90	3.3	4.0	3.4	3.8	2.9
Azoxystrobin	0.4	60,90	2.9	3.5	3.6	3.6	-
Tebuconazole	0.2	60,74 88,102	3.0	3.8	3.1	3.8	3.8
Untreated	-	-	4.3	6.5	5.8	9.5	8.5
LSD (0.05)			0.5	0.8	0.7	0.5	0.5

[a]DAP = days after planting.
[b]Disease ratings based on the Florida 1-10 scale when 1 = no disease and 10 = dead plants.

Table 5. Peanut yields when azoxystrobin and tebuconazole were used to control southern stem rot.

			Peanut yield						
		Application	1994		1995	1996		1997	
Treatment	Rate	timing	Yoakum	Verdi	Yoakum	Yoakum	Verdi	Yoakum	Pearsall
	kg/ha	DAP[a]	kg/ha						
Azoxystrobin	0.22	60,90	4090	3280	1550	2120	5900	1510	4300
Azoxystrobin	0.34	60,90	3920	-	1850	2200	6470	1510	4500
Azoxystrobin	0.45	60,90	4400	3180	1810	2590	6140	1740	4780
Tebuconazole	0.20	60,74 88,102	3880	3040	1960	2060	6100	1620	4710
Untreated	-	-	3070	2300	1350	1170	5400	1250	4040
LSD (0.05)			770	830	400	470	640	340	690

[a]DAP = days after planting.

Table 6. Peanut yields when azoxystrobin and tebuconazole were used to control Rhizoctonia pod rot.

Treatment	Rate	Application timing	Yield 1996 Pleasanton	Yield 1996 Jourdanton	Yield 1997 Pleasanton	Yield 1997 Giddings
	kg/ha	DAP[a]	----------kg/ha ----------		---------- kg/ha ----------	
Azoxystrobin	0.22	60,90	4250	4790	3300	-
Azoxystrobin	0.34	60,90	4870	4940	2920	4310
Azoxystrobin	0.45	60,90	4260	4980	3090	3660
Tebuconazole	0.20	60,74 88,102	4090	4830	3400	2690
Untreated	-	-	3620	3390	2750	2930
LSD (0.05)			500	840	560	1460

[a]DAP = days after planting.

azoxystrobin alone for leaf spot control may not be appropriate if only a two spray program remains cleared for use during the growing season. Chlorothalonil will be needed in combination with azoxystrobin to provide season-long leaf spot control as well as provide resistance management. The price structure for both fungicides is such that four applications of tebuconazole costs about the same as two applications of azoxystrobin. However, a grower may have a reduction in application costs when applying azoxystrobin only two times compared with tebuconazole.

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