Chemigation and Ground-Spray Applications of Cyproconazole for Control of Late Leaf Spot of Peanut

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ABSTRACT

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In field experiments conducted during 1990 and 1991, chemigation applications of the ergosterol biosynthesis inhibiting fungicide cyproconazole (0.112 kg a.i./ha) were equal to or better than ground-spray applications of cyproconazole or chlorothalonil (1.26 kg a.i./ha) for control of late leaf spot, caused by *Cercosporidium personatum*, on peanut (*Arachis hypogaea*) cultivars Florunner and Southern Runner. Late-season leaf spot epidemics and resulting defoliation were severe in nontreated plots in both years. All fungicide treatments provided similar levels of control in 1990. Leaf spot was less severe on plants treated with cyproconazole by chemigation than on those treated with chlorothalonil by ground sprays in 1991. Within cultivars, yields for all three fungicide treatments were similar and were higher than in nontreated plots in both years. Yield of Southern Runner was higher than that of Florunner for all treatments in 1990 and in nontreated plots in 1991.

Several ergosterol biosynthesis inhibiting (EBI) fungicides give good control of diseases caused by foliar and soilborne pathogens. Diseases of peanut (*Arachis hypogaea* L.) controlled by EBI fungicides include late leaf spot, caused by *Cercosporidium personatum* (Berk. & Curt.) Deighton, southern stem rot, caused by *Sclerotium rolfsii* Sacc., and Rhizoctonia limb rot, caused by *Rhizoctonia solani* Kühn anastomosis group 4 (2–4,9,10). The efficacy of any fungicide, however, may vary with application method and environmental conditions. For example, chlorothalonil applied in irrigation water (chemigation) has been reported to be less effective than ground sprays for leaf spot control in years with environmental conditions conducive for development of severe leaf spot epidemics (5,8).

Studies involving the application of EBI fungicides via center-pivot irrigation systems have been limited. Brenneman and Sumner (4) reported control of late leaf spot and Rhizoctonia limb rot by chemigation-applied tebuconazole, even in a year with environmental conditions conducive for development of severe leaf spot epidemics. Propiconazole applied via chemigation has been demonstrated to provide leaf spot control inferior to that of ground-applied propiconazole, although control of diseases caused by soilborne pathogens was superior to ground-spray applications (3).

Approximately 60% of the peanut acreage in Georgia is irrigated, and a large portion of the crop is under center-pivot systems. Center-pivot irrigation systems offer an economical and convenient means for application of foliar fungicides. Therefore, it is important that the efficacy of new fungicides applied via chemigation be compared to the efficacy of ground-spray applications of that material and chlorothalonil.

The experimental EBI fungicide cyproconazole has been shown to give good control of late leaf spot and southern stem rot of peanut applied by ground spray in tank-mix combinations with chlorothalonil (9,10). The effects of chemigation applications of this fungicide on leaf spot severity have not been determined. The objective of this study was to compare center-pivot irrigation applications of cyproconazole to ground-spray applications of cyproconazole and chlorothalonil for control of late leaf spot on the susceptible cultivar Florunner and the moderately resistant cultivar Southern Runner (11).

MATERIALS AND METHODS

Field experiments were conducted at the University of Georgia Coastal Plain Experiment Station, USDA-ARS Belflower Farm, Tifton, in 1990 and 1991. Two quadrants (0.15 ha) in each of two adjacent single-tower center-pivot irrigation systems were used for the experiment. Soil in areas occupied by both pivots consisted of Tifton loamy sand (fine-loamy, siliceous, thermic Plinthic Paleudults; pH = 6.1). Cotton (*Gossypium hirsutum* L.) had been grown in areas occupied by both pivots in the 3 yr preceding the 1990 experiment. All quadrants used in 1991 had been planted to peanut in 1990. The soil was moldboard plowed 20–25 cm deep, disked 8–13 cm deep, and bedded (0.9 m). Florunner and Southern Runner peanuts (112 kg/ha of seed) were planted on 17 May 1990 and 29 May 1991. Plots were treated with aldicarb (Temik 15G), 1.12 kg a.i./ha in-furrow at planting.

Split-plot experimental designs were used in both years. There were four replications, with one replication of each treatment in each of the two quadrants (0.15 ha) in both pivots. Whole-plot treatments consisted of: 1) nontreated control; 2) ground-spray applications of chlorothalonil (Bravo 720), 1.26 kg a.i./ha; 3) ground-spray applications of cyproconazole (Alto 100 SL), 0.112 kg a.i./ha; and 4) cyproconazole, 0.112 kg a.i./ha applied through the center-pivot irrigation system.

Whole plots were four beds (eight rows spaced at 0.9 m) 7.6 m long receiving no fungicides or fungicides applied by either ground spray or chemigation. Subplots were two beds (four rows) planted to either Florunner or Southern Runner. Two chemigated border rows of Florunner and 2.1-m fallow alleys separated the whole plots. No border rows were used between subplots. Plots not receiving fungicide treatments via the pivot were covered with plastic sheets during chemigation applications.

Ground-spray and chemigation applications of fungicide were made on 22 June, 6 July, 18 July, 1 August, 15 August, 12 September, and 27 September in 1990 and on 25 June, 9 July, 24 July, 6 August, 21 August, 3 September, and 16 September in 1991.

Pivot-applied treatments were by standard chemigation procedures in both years. Chemigation applications were made with Nelson R30-D4 sprinklers with nozzle inner diameter of 0.42–0.79 cm (Nelson Irrigation Corporation, Walla Walla, WA). Sprinklers were spaced 2.75 m apart along the boom and were suspended from the pivot on drop booms 2.4 m above the soil surface. Formulated cyproconazole applied through the pivot was diluted 1:3 (fungicide:SoyOil 937 [Coastal Chemical Co., Greenville, NC]) and injected into the pivot water supply via a Hydracone R1 diaphragm metering pump (Pulsefeeder, Rochester, NY) at 26.1 L/hr. Chemigation applications were made with the equivalent of 25.4 kl/ha of water. Ground sprays were

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applied by means of a CO_2-pressurized backpack sprayer equipped with three D2-13 hollow cone nozzles per row, in the equivalent of 114.2 L/ha of water at 345 kPa. Irrigation (102 kl/ha of water) was applied to all plots the evening before each treatment to minimize the effects of different water applications to the plots due to chemigation treatments. Additional irrigation was applied as needed for crop maintenance. In 1990, applications of 50.4 kl/ha of water were made on several occasions to promote conditions conducive for leaf spot epidemics. Plots received a total of 5,740 kl/ha of water as either rain or irrigation in 1990 and 6,490 kl/ha of water in 1991.

Leaf spot ratings and visual estimates of percent defoliation due to leaf spot were recorded four times in 1990 (1 September, 1 October, 8 October, and 18 October) and five times in 1991 (2 August, 16 August, 30 August, 16 September, and 10 October). The Florida 1–10 scale (7) was used as an index of both number of lesions on the leaves and amount of defoliation. Area under the disease progress curve (AUDPC) was calculated from percent defoliation estimates over time in days according to the formula described by Shaner and Finney (16). Digging and inverting dates were 18 October 1990 and 10 October 1991 for Florunner and 20 October 1990 and 21 October 1991 for Southern Runner. Immediately after the plants were inverted, the number of infection loci of *S. rolfsii* was determined for each subplot, where one locus represented 30.5 cm or less of linear row with one or more plants showing symptoms and/or signs of disease (15). Plots were harvested mechanically, and yield was determined for each plot as pod weight at approximately 12% moisture (w/w). Data were analyzed using analysis of variance. Fisher's protected least significant difference (17) values were calculated for evaluation of whole-plot and subplot treatment effects. Differences referred to in the test are significant at the $P = 0.05$ level unless otherwise stated.

RESULTS

Late-season leaf spot epidemics and resulting defoliation were severe in nontreated plots in both years. Treatment, cultivar, and treatment × cultivar effects were significant for final leaf spot severity and defoliation ratings and AUDPCs for defoliation in both years. Within cultivars, leaf spot ratings and AUDPCs were significantly higher for nontreated plots than for any of the fungicide treatments in both years (Table 1). There were no differences in final leaf spot severity and defoliation ratings or AUDPCs among fungicide treatments in 1990. Leaf spot ratings were lower in plots treated with cyproconazole by chemigation than in any other treatment on Florunner in 1991 (Table 1). The severity of leaf spot in nontreated plots was lower in Southern Runner than in Florunner in 1990. Severe defoliation was observed in nontreated plots of both cultivars, but little defoliation due to leaf spot occurred in plots of either genotype treated with cyproconazole by either application method in either year or with chlorothalonil in 1990 (Fig. 1). Defoliation due to leaf spot was observed on Florunner plants treated with chlorothalonil in 1991 (Table 1, Fig. 1). Incidence of stem rot was extremely low in all plots, and treatment comparisons were not significant in either year.

Treatment, cultivar, and treatment × cultivar effects on yield were significant in both years. Yield was higher in Southern Runner than in Florunner in all treatments in 1990. Within cultivars, yields of nontreated plots were lower than those of any fungicide treatment, and yields of plots receiving fungicides were similar in both years (Table 1). In 1990, yield of nontreated Southern Runner was not significantly different ($P > 0.05$) from yield of Florunner treated with either fungicide. In 1991, yield of Southern Runner was higher than that of Florunner only in nontreated plots.

DISCUSSION

Chemigation applications of cyproconazole were as effective for control of late leaf spot as ground sprays of cyproconazole applied at the same rate or ground sprays of chlorothalonil at recommended rates. Results were consistent across 2 yr in which leaf spot epidemics were severe. Similar leaf spot control for chemigation with an oil diluent and ground-spray applications of tebuconazole, another EBI fungicide, has been reported (4). Chemigation applications of chlorothalonil have been inconsistent for leaf spot control (1,5,8) and have been reported to be inferior to ground-spray applications in years with environmental conditions favorable for severe leaf spot epidemics (5,8).

In 1991, frequent rains during the first half of the growing season provided conditions very conducive for leaf spot development. Ground-spray applications of chlorothalonil were not as effective for preventing defoliation due to leaf spot as either treatment of cyproconazole. Better control of leaf spot with chemigation applications of cyproconazole than with ground-spray applications

Table 1. Effect of cyproconazole applied via center-pivot irrigation (chemigation) or ground sprays on severity of late leaf spot, area under the disease progress curve for defoliation (AUDPC), and pod yields in Florunner and Southern Runner peanut cultivars

		Leaf spot[a]			AUDPC[c]			Yield (kg/ha)		
Treatment	Rate (kg/ha)	Florunner	Southern Runner	LSD[b]	Florunner	Southern Runner	LSD[b]	Florunner	Southern Runner	LSD[b]
1990										
Nontreated	...	8.8	7.2	1.2	2,890	1,731	687	2,200	4,742	1,046
Ground spray										
Chlorothalonil	1.26	1.2	1.2	NS	8	3	NS	4,909	6,524	1,208
Cyproconazole	0.112	1.2	1.4	NS	4	0	NS	4,924	6,768	847
Chemigation										
Cyproconazole	0.112	1.2	1.2	NS	2	0	NS	5,063	6,748	826
LSD ($P \leq 0.05$)[d]		0.7	0.3		168	60		802	760	
1991										
Nontreated	...	10.0	8.9	NS	3,000	2,609	NS	1,551	3,370	399
Ground spray										
Chlorothalonil	1.26	3.4	3.1	NS	243	116	NS	4,874	4,932	NS
Cyproconazole	0.112	2.5	2.2	NS	93	138	NS	4,238	4,509	NS
Chemigation										
Cyproconazole	0.112	1.2	1.3	NS	58	58	NS	4,908	4,921	NS
LSD ($P \leq 0.05$)[d]		1.2	1.6		114	218		723	708	

[a]Rated on the Florida 1–10 scale (7), where 1 = no leaf spot and 10 = completely defoliated and killed by leaf spot.
[b]For comparision of cultivars within treatments ($P < 0.05$). NS = not significant.
[c]Calculated from four evaluations in 1990 and five evaluations in 1991.
[d]For comparison of treatments within cultivars.

may be due to better coverage of peanut foliage. Additionally, absorption of cyproconazole by the plant may have prevented the frequent rains from removing the fungicide from treated leaves.

It is not known why superior control of leaf spot was obtained by chemigation with cyproconazole. Deposition of the protectant fungicide chlorothalonil on peanut foliage has been reported to be less when it was applied via chemigation than by ground sprays (6). However, cyproconazole may be absorbed rapidly by the foliage or salvaged from the soil by root uptake. Root uptake of diniconazole, another triazole-type EBI, has been demonstrated in peanut (13). The systemic nature of the compound would have been an advantage in a year like 1991 with frequent heavy rainfall. Not only would it be less likely to wash off, but it may have been redistributed to the new foliage under the ideal conditions for rapid growth (14).

Application of SoyOil with cyproconazole via chemigation also may have enhanced control compared to cyproconazole applied by ground sprays. This effect was observed in previous chemigation studies with tebuconazole where an oil diluent increased the level of foliar disease control (4). The authors of that study speculated that the improvement may have been due to reduced dispersion in the irrigation water, increased affinity for the plant surface, or improved penetration of the lipid layer of foliage. Although the effects of an oil diluent on efficacy of chemigation applications of cyproconazole were not tested in our experiment, chemigation applications of cyproconazole with oil were superior to ground-spray applications on Florunner in 1991. Tebuconazole applied via chemigation with an oil diluent was superior to chemigation applications with a water diluent in 1 yr of a 2-yr study. The difference in efficacy between the two cyproconazole treatments in our experiment was small in 1991 and nonexistent in 1990, however, and no significant defoliation or yield loss due to leaf spot occurred with either treatment.

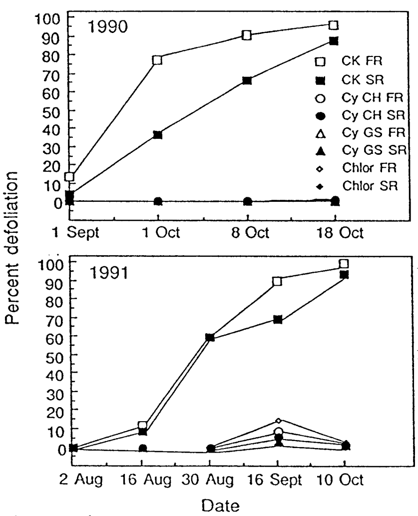

Fig. 1. Disease progress curves (defoliation) for late leaf spot, caused by *Cercosporidium personatum*, in peanut cultivars Florunner (FR) and Southern Runner (SR) receiving no fungicides (CK), cyproconazole (CY) by chemigation (CH) or ground sprays (GS), or chlorothalonil (Chlor) by ground sprays.

Higher yields from plants treated with cyproconazole than from plants treated with chlorothalonil alone have been reported (10) and have been attributed to control of diseases caused by soilborne fungal pathogens. Similar yields for plots treated with cyproconazole and chlorothalonil in our experiment, in which incidence and severity of southern stem rot and Rhizoctonia limb rot were extremely low, support that conclusion. Because of the low incidence of soilborne diseases, it was not possible to determine the efficacy of chemigation-applied cyproconazole on these diseases.

Use of full-season applications of cyproconazole in this test should not be interpreted as an intended-use pattern for this material. Resistance to EBI fungicides in populations of *C. personatum* has not been documented but must be considered a potential problem. Applications of tank-mix combinations of cyproconazole and chlorothalonil have been examined as measures for management of resistance (9,10). The efficacy of tank mixes for preventing resistance in *C. personatum* has not been determined, however. Tank mixes of cyproconazole and chlorothalonil have been more effective for control of leaf spot than chlorothalonil alone (10). Better control with the mixture than with chlorothalonil alone may provide additional incentive for growers to use this resistance management strategy. Chemigation applications of a mixture of these two fungicides have not been examined but may be an improved means by which to control late leaf spot, utilize the production and economic advantages of chemigation (12), and prevent or slow development of populations of *C. personatum* with reduced sensitivity to EBI fungicides.

Culbreath and Brenneman (8) reported less yield loss to leaf spot in Southern Runner than in Florunner in chemigated plots treated with chlorothalonil in a year with severe leaf spot epidemics. In these tests, excellent control of leaf spot with cyproconazole by either application method was achieved on both cultivars. Therefore, the resistance of Southern Runner to *C. personatum* (11) was not needed to prevent yield losses to leaf spot in plots receiving chemigation applications of cyproconazole. On the basis of our results, use of cyproconazole potentially can allow the utilization of the benefits of chemigation without sacrificing efficacy of leaf spot control.

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