Effects of Tractor Traffic and Chlorothalonil Applied via Ground Sprays or Center Pivot Irrigation Systems on Peanut Diseases and Pod Yields

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ABSTRACT

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Chlorothalonil (Bravo 720) was applied at 1,255 g/ha seven times to peanut cultivar Florunner in 0.12, 17.8, or 1.7 kl of water per hectare via ground sprays, center pivot irrigation (chemigation), or pivot-mounted underslung boom, respectively. Chemigated plots either were or were not subjected to tractor traffic. Rhizoctonia limb rot (caused by *Rhizoctonia solani* anastomosis group 4) was generally not controlled by chlorothalonil and tended to be more severe with tractor traffic. Plants in untreated plots had final defoliation of 96 and 68% because of late leaf spot (caused by *Cercosporidium personatum*) in 1987 and 1988, respectively. Ground sprays gave the best leaf spot control in both years, followed by the underslung boom and chemigation applications. In 1987, yields were significantly lower in plots that received the underslung boom or chemigation treatments than in ground-sprayed plots. With less disease in 1988, pod yields were equal in chemigated and ground-sprayed plots and were significantly higher in plots treated by means of the underslung boom.

Peanut (*Arachis hypogaea* L.) is the most valuable agronomic crop in Georgia, but successful production requires intensive management. This is particularly true for diseases, some of which can be devastating. Two of the most serious diseases are late leaf spot, caused by *Cercosporidium personatum* (Berk. & Curt.) Deighton, and Rhizoctonia limb rot, caused by *Rhizoctonia solani* Kühn anastomosis group (AG) 4. Crop losses as a result of these two pathogens in Georgia in 1987 were estimated to be $16.2 and $17.2 million, respectively (16).

There are currently no satisfactory control measures for Rhizoctonia limb rot on peanut. Cultivars differ in susceptibility to the disease, and both irrigation and wounding favor disease development (2). Although the effects of wounding were demonstrated in greenhouse studies, tractor traffic in the field does significantly damage peanut stems, and data for 1 yr from previous chemigation studies indicate that tractor traffic does tend to increase the severity of Rhizoctonia limb rot (3). Tractor traffic has also been shown to increase the severity of Sclerotinia blight of peanut (caused by *Sclerotinia minor* Jagger), another disease that affects lower lateral peanut stems (11).

Although one runner-type cultivar (Southern Runner) with some resistance to late leaf spot has been released (5), growers in Georgia still rely almost entirely on fungicides such as chlorothalonil to control this disease. Over the years, numerous fungicide application methods have been evaluated. These methods range from ultralow-volume controlled droplet applicators (9) to injection in sprinkler irrigation systems (chemigation) applying in excess of 25 kl of water per hectare (8). Conventional tractor-mounted hydraulic sprayers are used most commonly and provide the most consistent control.

Chemigation with fungicides for peanut leaf spot has provided control ranging from excellent (1,8) to poor (13,15; T. Kucharek, *personal communication*). Similar variability has been found in other crops; differences in pesticides and/or formulations apparently explain some of the variation (17). Chemigation with chlorothalonil has been effective in controlling *R. solani* on cucumber (12) but has not been evaluated for its efficacy on Rhizoctonia limb rot of peanut. Moreover, most chemigation studies evaluating chlorothalonil used Bravo 500, a formulation that is no longer available to peanut growers. Analysis of residues from chemigation treatments indicates that less chlorothalonil is deposited on peanut foliage with Bravo 720 than with Bravo 500 (T. B. Brenneman, *unpublished*). The lower residues could result in reduced efficacy, but this has not been investigated.

A recently introduced pesticide delivery method uses a separate boom mounted beneath a center pivot irrigation system. Such a system has been used to apply chlorothalonil to control foliar diseases of potato (17), but the technology has not been evaluated for peanut disease control. An apparatus of this type, the Pivot Agrichemical Spray System (PASS) (Garvey Irrigation Consultants, Lenox, GA), is currently being marketed in Georgia for use on a variety of crops, including peanut.

We evaluated the new chlorothalonil formulation Bravo 720 for efficacy in controlling peanut leaf spot and limb rot when applied via ground sprays (tractor-mounted hydraulic sprayer), chemigation, and underslung boom (PASS). We also evaluated the effects of tractor traffic on disease development and yield in chemigated plots.

MATERIALS AND METHODS

The study was initiated in 1987 in a field of Pelham loamy sand (thermic Arenic Paleaquult) near Tifton, GA. It was contained in one quadrant (0.15 ha) of a single-tower center pivot irrigation system and was repeated in 1988 in an adjacent quadrant. In both tests, tobacco and onions had been planted the previous year and sweet corn and lettuce the year before that.

The soil was moldboard-plowed, disked, and bedded. Peanut cultivar Florunner was planted in single rows 0.91 m apart at 123 kg of seed per hectare in 1987 and 112 kg/ha in 1988. Planting date was 18 May in both years, and standard management recommendations of the Georgia Cooperative Extension Service were followed (7). The field received no tractor traffic after peanut vines closed the rows, except where specified as a prescribed treatment. Plots were single beds (7.6 × 1.8 m in 1987, 6.1 × 1.8 m in 1988), with two rows per bed. Two border rows and 2.1-m alleys were used between plots. A completely randomized design with four replications was used.

Treatments were as follows: 1) unsprayed, no tractor traffic (control treatment); 2) chemigation, no tractor traffic; 3) chemigation, with tractor traffic; 4) PASS application, no tractor traffic; and 5) ground spray. In all fungicide treatments, chlorothalonil was applied as Bravo 720 (1,255 g a.i./ha) on a 14-day schedule initiated in the fifth week after planting (seven applications). No leaf spot was evident either year when the first applications were made. All fungicide applied via chemigation or PASS was diluted 1:3.7 (fungicide:water). Chemigation treatments were applied in 17.8 kl of water per hectare via E53

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WhirlJet nozzles (Spraying Systems Co., Wheaton, IL), whereas the PASS system applied 1.7 kl of water per hectare. To minimize the effects of additional water on chemigated plots, the entire field received 127 kl of water per hectare the evening before each application. During chemigations, plots not being treated were covered with plastic sheets or elevated fiberglass shelters. A Ford 2910 tractor was used to travel each chemigated plot receiving treatment 3 as well as the ground-sprayed plots. Ground sprays were applied with a CO_2-pressurized backpack sprayer with three TeeJet D2-13 nozzles (Spraying Systems Co.) per row delivering 124.4 L of spray per hectare at 345 kPa.

Leaf spot was rated three times during each growing season on the Florida 1–10 scale (4), where 1 indicates no disease; this scale accounts for both lesion incidence and defoliation. Peanuts were dug on 28 September 1987 and 5 October 1988 and were harvested 5–7 days later. Rhizoctonia limb rot was rated immediately after digging by visually estimating the percentage of infected vines and leaves at each of six randomly selected areas (0.6 m) per plot. Yield data were based on weight of pods at 7–8% moisture (w/w), and crop values were determined from a single composite sample from all replicates in accordance with Federal-State Inspection Service methods (14). Data were analyzed by analysis of variance, and the significance of differences between means was evaluated with Duncan's multiple range test (SAS Institute Inc., Cary, NC).

Stems with apparent limb rot symptoms were collected at harvest, and the fungi on them were identified. Seven stems per replication were collected in each of two categories: stems with restricted, zonate lesions on the central portion of a lateral branch, with no apparent physical wound; and stems from row middles with necrotic stem terminals associated with tractor traffic in the plot. Stems in the first category were collected from treatments 1 and 3; stems in the second category were collected only from treatment 3, because treatment 1 did not receive tractor traffic. Immediately after collection, stems were surface-disinfested in 0.52% sodium hypochlorite for 1–2 min. Segments with lesions were plated on water agar and incubated at 22–24 C. All fungi present were subsequently transferred to potato-dextrose agar and identified.

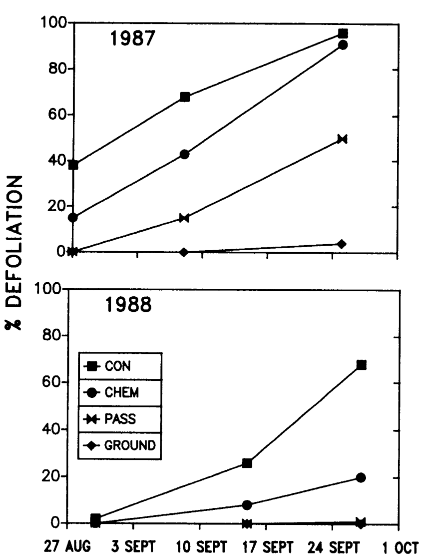

Fig. 1. Disease progress curves for late leaf spot of peanut (caused by *Cercosporidium personatum*) in plots treated with chlorothalonil (1,255 g a.i./ha, seven applications) applied by several methods. CON = control; CHEM = chemigation with center pivot; PASS = pivot-mounted, underslung boom; GROUND = ground spray.

RESULTS

Late leaf spot occurred in both years but was more severe in 1987 than in 1988 (Fig. 1). By harvest in 1987, plants in unsprayed plots were almost totally defoliated, and many were dead. In contrast, defoliation in unsprayed plots was only 68% in 1988. Leaf spot reduced yields in both years (Table 1).

Ground sprays were most effective in controlling peanut leaf spot, with defoliation at harvest not exceeding 4.5% (Fig. 1). Chemigation provided acceptable leaf spot control in 1988, but in the more severe epidemic in 1987, plots were 92% defoliated at harvest, which resulted in a mean yield reduction in excess of 1,300 kg/ha compared to ground-sprayed plots.

The leaf spot rating at harvest in 1987 was significantly higher in the chemigated plots with no traffic than in the chemigated plots with tractor traffic (Table 1). The reason for this is not known, and no significant differences were observed in 1988.

Chlorothalonil applied via PASS gave better leaf spot control than chemigation but less control than ground sprays. Defoliation was only 1% in 1988 but reached 50% in 1987, resulting in significant yield reductions (Table 1).

Rhizoctonia limb rot was present in both years but was also more severe in 1987; in some plots, more than 30% of vines and leaves were infected (Table 1). Overall, chlorothalonil did not reduce limb rot symptoms when compared to disease levels in untreated plots. Plots that received chlorothalonil with no tractor traffic (that is, the PASS and chemigation treatments without traffic) had the lowest numerical limb rot ratings in both years, although these differences were not always statistically significant.

Tractor traffic did not influence pod yield in chemigated plots in 1987, although the large yield reduction caused by leaf spot may have masked potential differences. With better leaf spot control in 1988, a significant ($P = 0.10$) yield reduction of 437 kg/ha was recorded in chemigated plots as a result of tractor traffic alone.

Very few plants in either test were observed to be infected with *Sclerotium rolfsii* Sacc., so this pathogen should not have been a confounding factor. The predominant fungus isolated from diseased stems (both stems with "classic" target-shaped lesions nearer the crown of the plant and stem tips mechanically crushed by tractor traffic) was *R. solani* AG 4 (Table 2). The binucleate, *Rhizoctonia*-like fungus CAG-3 was isolated from

Table 1. Disease ratings, pod yields, and crop values of peanuts treated with chlorothalonil[v] via several application methods

Treatment	Leaf spot rating[w,x]		Rhizoctonia limb rot[x,y] (%)		Yield[x] (kg/ha)		Value[z] ($/ha)	
	1987	1988	1987	1988	1987	1988	1987	1988
Unsprayed control	8.7 a	6.7 a	28.8 ab	5.0 ab	3,569 c	4,981 c	2,552	3,610
Chemigation, no traffic	8.4 a	4.8 b	20.2 b	4.3 ab	3,886 c	5,936 ab	2,934	4,111
Chemigation, tractor traffic	8.0 b	5.1 b	34.0 a	9.2 a	3,928 c	5,499 bc	2,927	3,942
PASS	6.0 c	3.2 c	21.7 b	3.0 b	4,602 b	6,210 a	3,305	4,273
Ground spray, tractor traffic	3.9 d	2.3 d	31.3 a	5.0 ab	5,261 a	5,448 bc	3,540	3,756

[v]Seven applications of Bravo 720 (1,255 g a.i./ha).
[w]Rated at harvest on the Florida 1–10 scale (4), where 1 = no disease and 10 = dead plants.
[x]Numbers in columns followed by the same letter do not differ significantly ($P = 0.05$) according to Duncan's multiple range test. Data for each year were analyzed separately.
[y]Based on mean ratings of six 0.6-m locations per plot, averaged over four plots. Rating is an estimate of the percentage of infected vines and leaves at each location.
[z]Value of crop for each treatment was determined from a single composite sample from all replicates in accordance with Federal-State Inspection Service methods (14).

Table 2. Fungi isolated from diseased stems of peanut cultivar Florunner in a 1988 chlorothalonil chemigation study

Fungus	Stems sampled and treatments[a]: Unwounded laterals, Unsprayed	Unwounded laterals, Chemigated, with traffic	Damaged terminals[b], Chemigated, with traffic
Rhizoctonia solani (AG 4)	9	15	12
Rhizoctonia binucleate[c] (CAG-3)	0	0	9
Rhizoctonia binucleate[c] (CAG-2)	4	0	2
Trichoderma spp.	9	4	0
Fusarium spp.	1	4	1
Fusarium oxysporum	3	1	0
Sterile white basidiomycete	0	1	0
Sclerotium rolfsii	2	1	3
Phoma spp.	1	2	0

[a]Data indicate the number of isolates recovered per species. Twenty-eight stems were collected (seven per replication) for each stem sample-treatment combination.
[b]Unsprayed plots were not evaluated since they did not receive tractor traffic and therefore did not have damaged stem terminals.
[c] *Rhizoctonia*-like fungus.

about 32% of the injured stem tips. This fungus was not found associated with any of the "classic" target-pattern lesions on uninjured stems and apparently is able to colonize only damaged tissues. The overall number and species of fungi found were similar in the unsprayed and chemigated plots, although fewer isolates of *Trichoderma* spp. and of the binucleate, *Rhizoctonia*-like fungus CAG-2 were found where chlorothalonil had been applied. Similar but less extensive isolations done in 1987 yielded levels of *R. solani* AG 4 similar to those found in 1988.

DISCUSSION

Chlorothalonil applied via chemigation or an underslung boom provided adequate control of leaf spot when the disease was not severe. With a severe epidemic, however, applications via these systems on a 14-day schedule would not be sufficient. This conclusion was observed previously with Bravo 500 (T. Kucharek, *personal communication*) and apparently holds for Bravo 720 as well. When environmental conditions are highly conducive to leaf spot development, growers should use other application methods or shorten the treatment interval to maintain adequate levels of chlorothalonil residue on foliage, particularly with chemigation treatments.

Past research on chemigation with chlorothalonil has demonstrated that plots treated in that manner may produce higher pod yields than those treated with ground sprays even though leaf spot control is inferior (1). Our 1988 results support this conclusion, but our 1987 study illustrates that too much defoliation can greatly reduce yield. Backman (1) speculated that higher yields with chemigation resulted from reduced damage from equipment or from chlorothalonil flooding the soil and affecting pod and root diseases. Although later research has shown that yield may or may not be reduced when chemigated plots are traveled by a tractor (3,8), such traffic certainly injures peanut stems. This injury was evident in our study and was associated with an increase in Rhizoctonia limb rot. Although increased disease levels were not sufficient to explain the entire yield differential, they were a contributing factor. Other factors, such as soil compaction, which is known to influence peanut fruiting patterns (10) and yields of other crops (17), apparently contributed to the detrimental effect of tractor traffic on pod yields.

Chemigation offers numerous advantages over ground sprays from a practical and economic standpoint (6), as does application with an underslung boom (17). Specifically, the underslung boom allows the flexibility of applying pesticides either in conjunction with an irrigation application or separately in a relatively low volume of water (1.7 kl/ha). Perhaps its biggest advantage, however, is its environmental safety. The unit is self-contained, with no direct connection to the water source, thus minimizing the possibility of direct chemical backflow contaminating the water supply.

When used judiciously, chemigation and the underslung boom should have a place in peanut foliar disease control programs in the southeastern United States. As discussed by Wyman et al (17), some pesticides are better suited to these types of application than others. Suitability depends largely on formulation, and as new fungicides and formulations become available, application via irrigation systems may become an even more attractive alternative.

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