# Combining Center Pivot Irrigation Applications of Chlorothalonil with a Moderately Resistant Cultivar for Control of Late Leaf Spot in Peanut

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**ABSTRACT**

Culbreath, A. K., and Brenneman, T. B. 1992. Combining center pivot irrigation applications of chlorothalonil with a moderately resistant cultivar for control of late leaf spot in peanut. Plant Dis. 76:29-32.

The efficacy of center pivot irrigation applications (chemigation) of chlorothalonil at recommended rates (1.25 kg a.i./ha) was less than with conventional, ground spray applications for control of late leaf spot (*Cercosporidium personatum*) in Florunner (susceptible) and Southern Runner (moderately resistant) peanut (*Arachis hypogaea*) cultivars in 1989 and 1990. Final leaf spot ratings in chemigated plots of Florunner were lower ($P \leq 0.05$) than those in untreated plots in both years and in 1989 were higher ($P \leq 0.05$) than ratings of unsprayed plots of Southern Runner. Leaf spot ratings were lower in unsprayed and chemigated treatments for Southern Runner than for Florunner, respectively, in both years. In 1989, yields of both chemigated and untreated Southern Runner were higher ($P \leq 0.05$) than those of untreated Florunner, whereas chemigation did not improve yield of Florunner. In 1989, plants of Florunner treated with chlorothalonil via a spray boom mounted on the center pivot (Pivot Agricultural Spray System [PASS]) had higher leaf spot ratings than plants receiving ground sprays of the same rate of fungicide application. Plants of Southern Runner receiving PASS-applied chlorothalonil had leaf spot ratings similar to those plants treated with ground sprays. Pod yields of plants of each cultivar treated with chlorothalonil via the PASS system were not different ($P \leq 0.05$) from those receiving ground sprays. No differences in yield among treatments or between cultivars occurred in 1990.

The use of chemigation (application of chemicals via sprinkler irrigation systems) of fungicides to control peanut (*Arachis hypogaea* L.) diseases such as early leaf spot (*Cercospora arachidicola* S. Hori) and late leaf spot (*Cercosporidium personatum* (Berk. & Curt.) Deighton) offers several advantages over fungicide application by conventional ground sprays. Reduction of tractor traffic in the field helps prevent soil compaction (13) and may suppress development of Rhizoctonia limb rot (6,7), a serious peanut disease problem caused by *Rhizoctonia solani* Kühn anastomosis group 4 (AG-4). With approximately 60% of the peanut acreage in Georgia under irrigation, the potential is great for more widespread application of this technology to peanut production.

The efficacy of chemigation for leaf spot control on peanut varies. Backman (1) reported higher yields from peanut plants treated with chlorothalonil via chemigation than from those treated with similar rates of chlorothalonil via ground sprays, although in 2 of 3 yr, disease incidence and percent defoliation were higher in chemigated plots. Brenneman et al (7) evaluated the efficacy of applications of chlorothalonil at 1.25 kg a.i./ha by standard chemigation and via a spray boom mounted on the center pivot system, Pivot Agricultural Spray System (PASS) (Garvey Irrigation Consultants, Lenox, GA), to Florunner, a cultivar susceptible to leaf spot. With a leaf spot epidemic in which the level of defoliation reached 70% in untreated plots, chlorothalonil applied by chemigation or PASS provided adequate leaf spot control, although plants in both treatments had more ($P = 0.05$) defoliation than those treated with ground sprays. Pod yields were lower from the ground-sprayed plants because of plant damage and soil compaction from tractor wheel traffic. In a year in which defoliation by leaf spot reached 95%, ground sprays of chlorothalonil resulted in better disease control than either chemigation or PASS applications. Differences in disease levels were reflected directly in pod yields (7). Such variability in results has contributed to the slow acceptance of chemigation technology in the southeastern United States. However, if this technology could be coupled with a cultivar resistant to leaf spot, the advantages of chemigation could be realized without compromising foliar disease control in years of severe epidemics.

A cultivar resistant to late leaf spot, Southern Runner, is available (12) and is grown on a small percentage of the peanut acreage in the Southeast. Southern Runner performs well in tests with reduced fungicide application regimes (11) or with fungicides less effective than chlorothalonil (4). The objective of this study was to determine potential benefits derived from the use of a resistant cultivar with center pivot applications of chlorothalonil compared with the use of a susceptible cultivar with those same treatments.

## MATERIALS AND METHODS

The study was conducted in 1989 and 1990 at the Coastal Plain Experiment

Accepted for publication 23 June 1991 (submitted for electronic processing).

Station, Bowen Farm, Tifton, GA, using one quadrant (0.15 ha) in each of two adjacent single-tower center pivot irrigation systems (pivots C and D). Soil in both quadrants was a Pelham loamy sand (loamy, siliceous, thermic, Arenic Paleaquults). Soybean (*Glycine max* (L.) Merr.) had been grown in 1988 and 1989 in the respective quadrants used in pivot C in 1989 and 1990. Cotton (*Gossypium hirsutum* L.) had been grown in 1988 and 1989 in the respective quadrants used in pivot D in 1989 and 1990. Quadrants used in 1990 were adjacent to quadrants under the same pivot area used in 1989. The soil was moldboard-plowed, disked, and bedded. The peanut cultivars, Florunner and Southern Runner, were planted (112 kg of seed per hectare) on 22 May 1989 and 1990 in single rows (0.91 m apart) with two rows per bed.

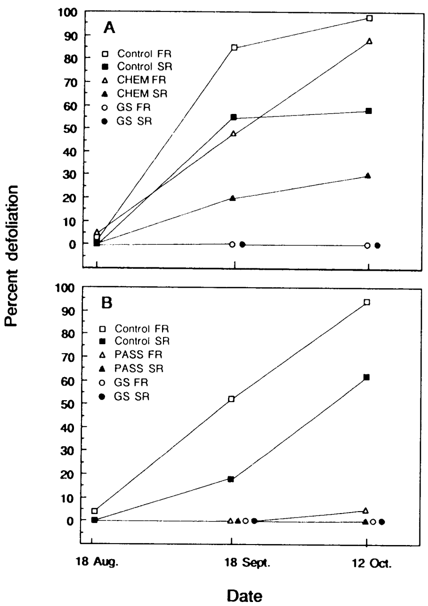


**Fig. 1.** Effects of chlorothalonil (1.25 kg a.i./ha) applied via **(A)** chemigation (CHEM), **(B)** an underslung boom (PASS), and ground sprays (GS) on defoliation caused by late leaf spot on Florunner (FR) and Southern Runner (SR) peanut cultivars, 1989.

Within each pivot area, a completely randomized, split-plot design with four replications was used. Whole-plot treatments under pivot C were 1) an untreated control, 2) chlorothalonil (Bravo 720, 1.25 kg a.i./ha) applied via ground spray, and 3) chlorothalonil (Bravo 720, 1.25 kg a.i./ha) applied directly through the irrigation pivot. Whole-plot treatments used under pivot D were similar to those used under pivot C except that chlorothalonil (1.25 kg a.i./ha) was applied via PASS (7) instead of directly through the irrigation pivot. Whole plots were two beds (four rows) 6.1 m long in 1989 and 7.6 m long in 1990. Subplots were one bed (two rows) planted to either Florunner or Southern Runner. Two chemigated or PASS-treated border rows of Florunner and 2.1-m fallow alleys separated the whole plots. No border beds were used between subplots.

Pivot-applied treatments were by standard chemigation procedures in one quadrant (pivot C) and by PASS in the other (pivot D) in both years. Standard chemigation applications were made through impact sprinklers using 76.5 kl of water per hectare. Chlorothalonil was applied via the PASS system in 25.5 kl of water per hectare. Chlorothalonil in ground sprays was applied, using a $CO_2$-pressurized backpack sprayer equipped with three D2-13 hollow cone nozzles per row, in 114.2 L of water per hectare at 345 kPa. Plots not receiving fungicide treatments via the pivot were covered with plastic sheets during these applications. Fungicide applications were made at 14-day intervals beginning 4 wk after planting. A total of seven applications were made in each year. Irrigation (102 kl/ha) was applied to all plots the evening before each treatment to minimize the effects of different water applications to the plots. Total rainfall on the plots was 5,113 kl/ha in 1989 and 2,558 kl/ha in 1990. Additional irrigation was applied as needed for crop maintenance. In addition, applications of 50.4 kl of water per hectare were made on 13, 18, 19, and 21 August 1990 to promote conditions conducive for leaf spot epidemics.

Leaf spot ratings were made for plants in each subplot on 19 August, 18 September, and 12 October in 1989, and on 9 September and 1 and 9 October in 1990. The Florida 1–10 scale (9) was used as an index of both the number of lesions on the leaves and the amount of defoliation. Digging dates were 13 and 25 October 1989 and 8 and 14 October 1990 for Florunner and Southern Runner, respectively. Yields were determined as pod weight at approximately 12% moisture (w/w). Data were analyzed using analysis of variance. A Waller-Duncan Bayesian *k*-ratio *t* test (18) was used to evaluate minimum significant differences among treatments. Fisher's least significant difference (LSD) (18) was calculated to evaluate cultivar effects within treatments in cases with significant treatment by cultivar interactions. Differences referred to in the remainder of this paper are significant ($P \leq 0.05$) unless otherwise stated.

## RESULTS

**1989 tests.** The incidence of late leaf spot was high in both quadrants, and severe defoliation was observed in Florunner (Fig. 1). In the standard chemigation study, fungicide treatment and cultivar effects were highly significant ($P \leq 0.01$) for final leaf spot rating and yield. Significant treatment by cultivar interactions were detected for both variables. Based on leaf spot ratings, application of chlorothalonil via standard chemigation was not as effective as ground sprays for control of late leaf spot in either cultivar (Table 1). Final leaf spot ratings of both cultivars treated with the fungicide via standard chemigation were lower than those of corresponding untreated plants. Florunner plants in chemigated plots were severely defoliated at harvest (Fig. 1). Severity of leaf spot was lower in Southern Runner than in Florunner in chemigated and untreated plots.

**Table 1.** Ratings for late leaf spot and pod yields for Florunner (FR) and Southern Runner (SR) peanut cultivars treated with seven applications of chlorothalonil (1.25 kg a.i./ha) via chemigation and ground sprays

| | Leaf spot rating[x] | | | | | | Yield (kg/ha) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | | | 1990 | | | 1989 | | | 1990 | | |
| Treatment | FR | SR | Treatment mean | FR | SR | Treatment mean | FR | SR | Treatment mean | FR | SR | Treatment mean |
| Unsprayed | 9.1 a[y] | 6.4 a | 7.8 | 6.8 a | 5.9 a | 6.3 | 813 b | 2,134 b | 1,474 | 2,629 | 2,254 | 2,441 a |
| Chemigation | 8.1 b | 5.5 b | 6.8 | 5.8 b | 5.2 b | 5.5 | 1,463 b | 1,880 b | 1,672 | 2,726 | 2,701 | 2,714 a |
| Ground spray | 3.1 c | 2.9 c | 3.0 | 1.3 c | 1.1 c | 1.2 | 3,365 a | 3,212 a | 3,289 | 2,514 | 2,531 | 2,522 a |
| Cultivar mean | 6.7 | 4.9 | | 4.6 | 4.1 | | 1,880 | 2,409 | | 2,623 | 2,495 | |
| LSD[z] ($P \leq 0.05$) | 0.6 | | | 0.4 | | | 783 | | | NS | | |

[x]Rated at harvest for Florunner and 10 days before harvest for Southern Runner using the Florida 1–10 scale where 1 = no disease and 10 = dead plants (9).

[y]Numbers within columns followed by the same letter are not different according to Waller-Duncan Bayesian *k*-ratio *t* test ($P \leq 0.05$).

[z]Within fungicide treatment comparison of cultivar effects, Fisher's protected LSD ($P \leq 0.05$); NS indicates that no fungicide or cultivar effects were significant in the analysis of variance.

Differences in leaf spot severity between the cultivars were reflected in yields. Yields of both cultivars chemigated with chlorothalonil were lower than those from plants treated with ground sprays (Table 1). Yields from chemigated plots of both cultivars were not different from those of untreated plants (Table 1). Yields of untreated and chemigated Southern Runner were greater than those of untreated Florunner.

Final leaf spot ratings and yields were different ($P \leq 0.01$) among treatments and between cultivars (Table 2) in the PASS portion of the study. Treatment by cultivar interactions were not detected for either variable. Application of chlorothalonil via PASS to Florunner resulted in leaf spot ratings higher than those of plants treated with ground sprays. Chlorothalonil applied via PASS to Southern Runner resulted in disease ratings similar to those of plots treated with ground sprays. Florunner treated via PASS had higher leaf spot ratings than Southern Runner. Little defoliation was observed in either cultivar in either PASS or ground spray applications (Fig. 1). Yields from either cultivar treated via PASS were similar to those from plants receiving ground sprays. No difference in yield between cultivars was detected for either of these treatments, and yields from both cultivars treated via PASS were higher than those from untreated plants. In untreated plots, yields of Southern Runner were higher than those of Florunner (Table 2).

**1990 tests.** Leaf spot epidemics in both quadrants were less severe and began later in 1990 than in 1989. However, because of frequent applications of small amounts of irrigation during the latter portion of the season, moderate leaf spot epidemics eventually developed. Defoliation in untreated and chemigated plots was much lower in 1990 than in 1989 (Figs. 1 and 2). In the 1990 chemigation study, treatment and cultivar main effects were detected for leaf spot ratings, but treatment by cultivar interactions were not significant. Leaf spot intensity was lower on plants of both cultivars treated with chemigation applications than on those plants that were not treated (Table 1). Chemigated plants of both cultivars, however, had higher leaf spot ratings than their respective ground-sprayed treatments. Leaf spot severity ratings in Southern Runner were lower than in Florunner in both unsprayed and chemigated plots. Leaf spot ratings in chemigated Florunner were not lower than those of untreated Southern Runner. Pod yields were low from plants in all plots, and differences in leaf spot severity were not reflected in yield for either treatment or cultivar effects.

In the PASS portion of the 1990 study, significant treatment, cultivar, and treatment by cultivar interactions on leaf spot ratings were detected. There were no significant treatment or cultivar effects on yield (Table 2). Untreated Southern Runner had leaf spot ratings that were lower than those of untreated Florunner. Leaf spot ratings of both cultivars treated via PASS were low and were not different from those of plants treated with ground sprays (Table 2).

## DISCUSSION

The use of Southern Runner can help suppress development of leaf spot epidemics and limit yield losses to leaf spot when used with full-season applications of chlorothalonil via standard chemigation or PASS. As previously reported (7), full-season applications of chlorothalonil via standard chemigation or PASS are less effective than ground sprays for leaf spot control in Florunner when environmental conditions are favorable for development of severe epidemics. In addition, during a severe epidemic as observed in 1989, the level of control provided by standard chemigation was not adequate to prevent yield reduction in comparison with ground sprays, even if combined with Southern Runner, a cultivar resistant to leaf spot. Our results indicate, however, that use of Southern Runner can minimize yield losses to leaf spot in comparison to losses incurred with Florunner.

In contrast to standard chemigation, the application of chlorothalonil via PASS should be a viable option for late leaf spot control with a susceptible cultivar such as Florunner. Although leaf spot ratings of Florunner treated via PASS were higher than those treated with ground sprays in 1989, no reduction in yield was observed. Risks of loss of yield to leaf spot should be even lower if PASS applications of chlorothalonil are used on Southern Runner.

Differences in deposition of chlorothalonil by chemigation in comparison with ground sprays (8) may account for differences in results with chemigation and ground spray treatments. Results of other studies on the efficacy of chlorothalonil applied by chemigation were more positive (1,14) in relation to ground spray applications than those reported by Brenneman and Sumner (7) or results from this study. The explanation for these differences in relative performance may be related to the environmental effects on disease incidence and severity. Also, different formulations of chlorothalonil, the type of nozzles used on the irrigation system, and the amount of water used as a carrier for the fungicide may affect leaf spot control, because these parameters influence efficacy of insecticides in various systems (20).

The lack of yield differences in 1990 in either pivot area may be attributable to extremely high temperatures encountered in southern Georgia. During the period from 15 May to 31 October 1990, maximum daily temperature was greater than 35 C on 46 days, compared with 12 days for that same period of time in 1989. These temperatures may have inhibited pollination and pod production in plants in all treatments, although moisture applied via irrigation was adequate to sustain vegetative growth. Also, although final defoliation was moderately heavy in untreated plants, the

**Table 2.** Ratings for late leaf spot and pod yields for Florunner (FR) and Southern Runner (SR) peanut cultivars treated with seven applications of chlorothalonil (1.25 kg a.i./ha) via a pivot-mounted boom (PASS) and ground spray application method

| | **Leaf spot rating**[x] | | | | | | **Yield (kg/ha)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1989** | | | **1990** | | | **1989** | | | **1990** | | |
| **Treatment** | **FR** | **SR** | **Treatment mean** | **FR** | **SR** | **Treatment mean** | **FR** | **SR** | **Treatment mean** | **FR** | **SR** | **Treatment mean** |
| Unsprayed | 8.6 a[y] | 6.6 a | 7.6 | 6.4 a | 4.9 a | 5.7 | 2,633 a | 3,537 a | 3,085 | 2,482 | 2,767 | 2,624 a |
| PASS | 3.8 b | 3.2 b | 3.5 | 1.3 b | 1.1 b | 1.2 | 4,675 b | 4,371 b | 4,523 | 2,441 | 2,579 | 2,510 a |
| Ground spray | 2.9 c | 2.8 b | 2.8 | 1.2 b | 1.1 b | 1.2 | 4,604 b | 4,137 b | 4,371 | 2,270 | 2,563 | 2,417 a |
| Cultivar mean | 5.1 | 4.2 | | 3.0 | 2.4 | | 3,971 | 4,015 | | 2,398 | 2,636 | |
| LSD[z] ($P \leq 0.05$) | 0.6 | | | 0.6 | | | 486 | | | NS | | |

[x]Rated at harvest for Florunner and 10 days before harvest for Southern Runner using the Florida 1–10 scale where 1 = no disease and 10 = dead plants (9).

[y]Numbers within columns followed by the same letter are not different according to Waller-Duncan Bayesian *k*-ratio *t* test ($P \leq 0.05$).

[z]Within fungicide treatment comparison of cultivar effects, Fisher's protected LSD ($P \leq 0.05$); NS indicates that no fungicide or cultivar effects were significant in the analysis of variance.

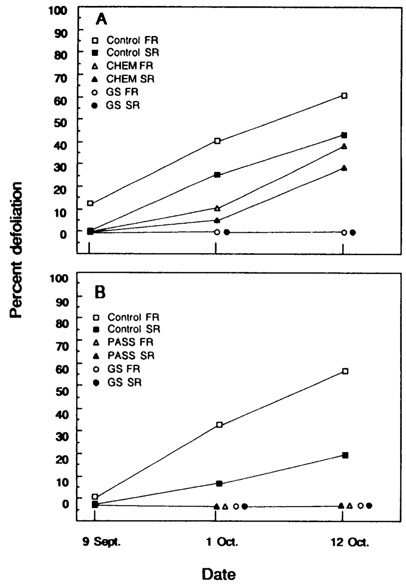


**Fig. 2.** Effects of chlorothalonil (1.25 kg a.i./ha) applied via **(A)** chemigation (CHEM), **(B)** an underslung boom (PASS), and ground sprays (GS) on defoliation caused by late spot on Florunner (FR) and Southern Runner (SR) peanut cultivars, 1990.

late occurrence of the leaf spot epidemic may have resulted in little pod loss. Low yields overall in 1990, coupled with late occurrence of the leaf spot epidemic, may have prevented yield reductions to leaf spot, although differences among treatment and cultivar effects on leaf spot severity were detected.

Consideration of the environmental effects for determining timing and number of fungicide applications could improve the efficiency of disease control programs using either pivot-applied fungicides or ground sprays. The combination of a weather-based leaf spot advisory (16) with pivot-applied fungicides could help eliminate unnecessary sprays, help ensure that applications are made at optimum times for disease control, and enhance other advantages of use of the pivot system for fungicide application.

Chlorothalonil applications by standard chemigation or PASS are less effective for leaf spot control than ground sprays under some conditions, but both methods offer several advantages over ground sprays (13). In particular, the reduction in tractor traffic that is allowed with PASS or chemigation treatments compared with ground sprays may result in less soil compaction (15) and less damage to peanut vines (17). Reduction of damage to the vines would reduce predisposition to Rhizoctonia limb rot (2). This disease is a problem primarily in irrigated fields (19). No tractor traffic was used for any fungicide application in our study; therefore, compaction and vine injury by tractor traffic were not factors. Incidence and severity of limb rot were very low, and treatment comparisons could not be made. Reduced predisposition to limb rot and soil compaction must be considered, however, in evaluating the commercial benefit of using chemigation or PASS with a cultivar resistant to leaf spot. The advantages afforded by chemigation or PASS also may aid in the integration of Southern Runner into multiple pest management programs. This cultivar is susceptible to limb rot (2) and has denser vegetative growth than Florunner when grown under irrigation (12), which provides excellent conditions for limb rot development, especially if vines are injured (2). The effects of tractor traffic and vine injury on limb rot in Southern Runner, however, have not been investigated.

The use of chemigation on Southern Runner can help minimize yield reduction in years with severe epidemics of late leaf spot. Combining Southern Runner with PASS applications of chlorothalonil can provide leaf spot control comparable to that achieved with ground sprays, even in extreme leaf spot epidemics. In addition, because Southern Runner appears to have a low to moderate level of resistance to *Sclerotium rolfsii* Sacc. (5) and tomato spotted wilt virus (3,10), this cultivar has great potential for use in programs for integrated management of multiple pathogens. Our results suggest that use of Southern Runner with pivot-applied chlorothalonil for leaf spot control could be useful in such programs.


## ACKNOWLEDGMENTS

This research was supported by state and Hatch funds allocated to the Georgia Agricultural Experiment Station. Additional funding was provided by the Georgia Agricultural Commodity Commission for Peanuts and Fermenta Plant Protection Company. Mike Heath, Steve Lahue, and Fannie J. Fowler provided technical and clerical assistance essential to the completion of this study.


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