Targeting Fungicides for Control of Southern Stem Rot on Peanut

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ABSTRACT

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The application of either PCNB 10G, PCNB-chlorpyrifos 10-2G, ethoprop-PCNB 3-10G, or PCNB 10G + ethoprop 10G in narrow bands (10 or 15 cm) centered over the row at half the recommended rate per hectare in many treatments resulted in significant increases in yield and disease control over the untreated control and was not significantly different from the recommended rate of the material applied in wider bands (30 or 41 cm). Narrow band width applications of the foliar-applied flutolanil 50WP and diniconazole 25WP tended to give increased yields and better control of diseases than wider band width applications. These data indicate that fungicide applications targeted to the site of initial infection of *Sclerotium rolfsii* on peanut will allow reduced rates of fungicides to be used with no loss in disease control. Rhizoctonia limb rot control will require different strategies.

Additional keywords: *Rhizoctonia solani* AG-4, white mold

Although foliar diseases of peanut (*Arachis hypogaea* L.) are potentially devastating, they can be managed well in Georgia with available fungicides (8,12). Soilborne diseases pose a greater threat to the peanut industry (6,10–12). The two most important soilborne diseases of peanut are *Sclerotium rolfsii* Sacc. and *Rhizoctonia solani* Kühn. *S. rolfsii* causes southern stem rot of peanut and under certain environmental conditions can cause infections on underground portions of the plant, notably the pods. *R. solani* anastomosis group (AG)-4, the incitant of Rhizoctonia limb rot, can infect almost all portions of the peanut plant. However, the greatest losses from this organism in Georgia have been at or near maturity on lower vines, leaves, and pegs. Injured or decayed pegs account for the greatest loss in yield. Only 50–70% of disease incited by *S. rolfsii* can be controlled by incorporating all cultural practices and currently available fungicides (8,11,12). Registered chemicals for the control of Rhizoctonia limb rot are not available at this time. Experimental fungicides such as diniconazole (6,9) and flutolanil (4) are being evaluated for control of these soilborne diseases. However, registration of these materials may be years away. Currently recommended materials are not as active as the experimentals and are steadily increasing in price.

Observations by researchers (1–3,7) have confirmed that *S. rolfsii* initially infects the main stems of peanut plants and its other hosts. These observations have led to the speculation that the application of granular fungicides for management of *S. rolfsii* may best be accomplished by directing the fungicides to the site of initial infection. At the recommended band width of 30–40 cm for PCNB, the granular is being diluted and spread under the entire canopy. In contrast, *R. solani*, the incitant of Rhizoctonia limb rot, initially infects the limbs away from the main stems and the pegs. These represent two distinctly different soilborne disease targets in the peanut canopy.

The objective of this research was to investigate application techniques and chemical placement of currently available experimental fungicides (fungicides to improve efficacy and/or reduce rates of fungicide used on soilborne diseases of peanut).

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Table 1. Effect of application of PCNB and chlorpyrifos in different band widths, alone and in combination, on control of *Sclerotium rolfsii* and Rhizoctonia limb blight of peanut in 1984

Treatment	Rate[v] (kg a.i./ha)	Application band with[w] (cm)	Disease loci[x] (no./15 m of row)	Rhizoctonia rating[y] (%)	Yield (kg/ha)
PCNB-chlorpyrifos 10-2G	11.2–2.8	41	2.8 b[z]	75 a	5,692 a
PCNB-chlorpyrifos 10-2G	5.6–1.4	10	3.5 ab	83 a	5,570 ab
PCNB-chlorpyrifos 10-2G	2.8–0.7	10	2.8 b	75 a	5,587 ab
PCNB 10G	11.2	41	5.3 ab	73 a	5,106 cd
PCNB 10G	5.6	41	6.5 ab	75 a	5,188 bcd
PCNB 10G	5.6	10	4.8 ab	73 a	5,432 abc
PCNB 10G	2.8	10	7.3 ab	78 a	5,081 cd
Chlorpyrifos 15G	2.8	10	4.5 ab	80 a	4,968 d
Untreated control	···	···	8.3 a	68 a	4,838 d

[v] Materials were applied 61 days after seeding.
[w] In some instances, application widths on the soil listed as 10 cm varied from 10 to 15 cm.
[x] Number of 30-cm sections of row with one or more diseased plants. Loci counts were made when peanuts were inverted 136 days after seeding on 24 September 1984.
[y] Rhizoctonia limb rot rating is a mean of four replications based on a subjective severity scale of 0–100%, where 0 = no damage to vines and 100 = 100% of vines infected. The rating was made after the peanuts were inverted.
[z] Means in columns followed by the same letter are not significantly different according to Waller-Duncan's multiple range test ($P = 0.05$).

Table 2. Evaluation of fungicides applied at different band widths and rates for the control of *Sclerotium rolfsii* and Rhizoctonia limb rot in 1986 at location one

Treatment	Rate (kg a.i./ha)	Application band width[w] (cm)	Disease loci[x] (no./15 m of row)	Rhizoctonia rating[y] (%)	Yield (kg/ha)
Flutolanil 50WP	2.24	41	12.3 de[z]	24.6 cde	3,220 bcd
Flutolanil 50WP	2.24	20	8.3 e	22.7 cde	3,819 a
Flutolanil 50WP	2.24	10	7.5 e	23.7 cde	3,563 ab
Flutolanil 50WP	1.12	41	14.3 d	15.8 de	3,220 cdef
Flutolanil 50WP	1.12	20	14.0 d	22.7 cde	2,958 defg
Flutolanil 50WP	1.12	10	8.5 e	11.7 e	3,294 bcd
Diniconazole 25WP	0.28	41	8.3 e	16.5 de	3,535 ab
Diniconazole 25WP	0.28	20	11.5 de	17.7 de	3,161 bcde
Diniconazole 25WP	0.28	10	8.3 e	14.4 e	3,574 ab
Ethoprop-PCNB 3-10G	3.36–11.2	41	15.3 cd	28.8 bcd	2,747 efg
Ethoprop-PCNB 3-10G	3.36–11.2	20	15.0 cd	23.3 cde	2,694 fg
Ethoprop-PCNB 3-10G	3.36–11.2	10	13.5 d	19.2 de	3,485 abc
Ethoprop-PCNB 3-10G	1.68–5.6	41	24.3 b	38.1 b	2,606 fg
Ethoprop-PCNB 3-10G	1.68–5.6	20	19.8 bc	33.1 bc	2,585 g
Ethoprop-PCNB 3-10G	1.68–5.6	10	20.3 b	25.0 bcde	2,743 efg
Untreated control	···	···	32.5 a	65.6 a	1,130 h

[w] Applications were made 78 days after seeding on 1 July 1986. Widths were measured at the soil surface.
[x] Number of 30-cm sections of row with one or more diseased plants. Loci counts were made when peanuts were inverted 150 days after seeding on 11 September 1986.
[y] Rhizoctonia limb rot rating is based on a mean of six locations in each plot, averaged over four plots. Rating was determined by estimating the percentage of vines and leaves infected at each location within a plot at digging.
[z] Means in columns followed by the same letter are not significantly different according to Waller-Duncan's multiple range test ($P = 0.05$).

MATERIALS AND METHODS

Research disease nurseries were located near Tifton, GA, on a Tifton loamy sand (fine loamy, siliceous, thermic Plinthic Paleudult, pH approximately 5.7). Each treatment consisted of two rows, 7.6 m long and 0.9 m apart, replicated four times. Treatments were arranged in a randomized complete block design. The cultivar, Florunner, was seeded (112 kg/ha), then was dug and inverted on 11 May and 24 September in 1984, 1 May and 3 October in 1986, and 7 May and 17 September in 1987, respectively.

Cultural practices, fertilization, and weed, leaf spot, and insect control were consistent with Cooperative Extension Service recommendations for all years (8). Plots were irrigated with overhead sprinklers as required to maintain good soil moisture and encourage disease development. Treatments were applied by preweighing samples for each plot and applying granules with a salt-shaker-like container or a bicycle-wheel granular applicator. Aqueous sprays were applied with a CO_2-pressurized knapsack sprayer using 234 and 187 L/ha of spray in 1986 and 1987, respectively. The products evaluated, application timing, and band width information are in the tables.

Evaluation of *S. rolfsii* was made at digging and inverting. Numbers of disease loci caused by *S. rolfsii* were enumerated for each plot by the method of Rodriguez-Kabana et al (10). Rhizoctonia limb rot incited by *R. solani* was estimated by using a scale of 0–100% of peanut limbs infected in 1984 and 1986. Very little Rhizoctonia limb rot occurred in 1987 and thus no ratings were made. Yield was calculated after peanuts were dug, field dried, combined, redried to approximately 12%, and weighed.

Data were analyzed by analysis of variance and separations of means aided by the Waller-Duncan multiple range test and orthogonal contrasts comparison method.

RESULTS

In 1984, disease from *S. rolfsii* was relatively low, but Rhizoctonia limb rot was very severe (Table 1). Fungicide-insecticide combinations of pentachloronitrobenzene- (PCNB) chlorpyrifos 10-2G tended to have the lowest numbers of disease loci from *S. rolfsii* when compared with the control. However, only the 11.2–2.8 kg a.i./ha rate applied in a 41-cm band and the 2.8–0.7 kg a.i./ha rate applied in a 10-cm band had significantly fewer disease loci than the control. Rhizoctonia limb rot was uniformly high in all the plots and was not reduced by any of the treatments. Peanut plots treated with any of the PCNB-chlorpyrifos combination treatments, or PCNB 10G alone at 5.6 kg a.i./ha applied in a 10-cm band, had significantly higher yields than the control.

The orthogonal comparison method of analysis was used to compare numbers of disease loci, Rhizoctonia limb rot rating, and yield for PCNB-chlorpyrifos 10-2G at the rate of 11.2–2.8 kg a.i./ha applied in a 41-cm band and PCNB-chlorpyrifos 10-2G at the rate of 5.6–1.4 kg a.i./ha applied in a 10-cm band (Table 1). No significant differences were noted between the two treatments for those parameters at $P = 0.05$. Similarly, the numbers of disease loci, Rhizoctonia

limb rot rating, and yield were compared for PCNB 10G at the rate of 11.2 kg a.i./ha applied in a 41-cm band and PCNB 10G at the rate of 5.6 kg a.i./ha applied in a 10-cm band. No significant differences were detected between treatments for any of the measured parameters.

In 1986, disease caused by *S. rolfsii* and *R. solani* was more severe in location one (Table 2) than in location two (Table 3). All treatments decreased numbers of disease loci caused by *S. rolfsii* and the percentage of vines infected with *R. solani* and increased yield over the untreated control (Table 2). Peanuts treated with diniconazole 25WP at 0.28 kg a.i./ha applied in a 10-, 20-, or 41-cm band were not significantly different in disease control and yield, although peanut plots treated with the narrowest band width (10 cm) tended to have less disease and higher yield.

Peanut plots treated with flutolanil 50WP at the rate of 2.24 kg a.i./ha and applied in a band width of 10, 20, or 41 cm were not significantly different in disease control. However, yield was significantly higher in the plots where flutolanil 50WP was applied in a 20-cm band when compared with a 41-cm band. Peanut plots treated with 1.12 kg a.i./ha of flutolanil applied in a 10-, 20-, or 41-cm band were not significantly different in Rhizoctonia limb rot ratings or yield. However, disease loci were lower in plots treated with flutolanil in a 10-cm band rather than a 20- or 41-cm band. Employing the orthogonal contrast method of analysis, flutolanil 50WP at 2.24 kg a.i./ha applied in a 41-cm band and flutolanil 50WP at 1.12 kg a.i./ha applied in a 20-cm band were not significantly ($P = 0.05$) different for numbers of disease loci, Rhizoctonia limb rot rating, or yield. Similarly, flutolanil 50WP at 2.24 kg a.i./ha applied in a 20-cm band and flutolanil 50WP at 1.12 kg a.i./ha applied in a 10-cm band were not significantly different in disease or yield.

Peanut plots treated with ethoprop-PCNB 3-10G at 3.36–11.20 kg a.i./ha in a 10-, 20-, or 41-cm band width did not differ significantly in disease control. However, yield of peanut plots treated with the combination at the 10-cm band width were significantly higher than those treated at the same rate but applied in a 20- or 41-cm band width. No significant differences occurred among peanut plots treated with ethoprop-PCNB 3-10G at 1.68–5.6 kg a.i./ha, regardless of the band width application used. Employing the orthogonal contrast method of comparison, ethoprop-PCNB 3-10G at 3.36–11.2 kg a.i./ha applied in a 41-cm band and the same material at half that rate applied in a 20-cm band were not significantly different for Rhizoctonia limb rot rating or yield. However, they were different in numbers of disease loci. Similarly, ethoprop-PCNB 3-10G at 3.36–11.2 kg a.i./ha applied in a 20-cm band was compared with the same material at half that rate applied in a 10-cm band. No significant differences between treatments occurred for disease or yield.

At location two in 1986 (Table 3), disease levels were not as high as at location one (Table 1). Ethoprop-PCNB 3-10G at the rate of 3.36–11.2 kg a.i./ha applied in a 41-cm band and ethoprop-PCNB 3-10G at the rate of 1.68–5.6 kg a.i./ha applied in 20-cm band treatments were compared using the orthogonal contrast method of comparison. No significant difference occurred between treatments for numbers of disease loci, Rhizoctonia limb rot rating, or yield. Similarly, PCNB 10G applied at 11.2 or 5.6 kg a.i./ha in a 41-cm band were compared. No significant differences occurred between the two treatments for numbers of disease loci or yield. However, the lower rate had a significantly higher Rhizoctonia limb rot rating than the higher rate.

In 1987, PCNB 10G plus chlorpyrifos 15G at the rate of 11.2 + 2.24 kg a.i./ha applied in a 30-cm band was compared with the same materials at half that rate and half the band width using the orthogonal contrast comparison method (Table 4). No significant differences occurred between treatments for numbers of disease loci or yield. No significant differences in disease or yield were detected between plots treated with PCNB 10G + ethoprop 10G at the rate of 11.2 + 3.36 applied in a 30-cm band and plots treated with PCNB 10G + ethoprop 10G at half that rate applied in a 15-cm band. Similarly, no differences were detected in disease or yield between plots treated with PCNB 10G at the rate of 11.2 kg a.i./ha applied in a 30-cm band and PCNB 10G at the rate of 5.6 kg a.i./ha applied in a 15-cm band. No

Table 3. Evaluation of fungicides and insecticides applied at different band widths and rates for the control of *Sclerotium rolfsii* and Rhizoctonia limb rot in 1986 at location two

Treatment	Rate (kg a.i./ha)	Application band width[w] (cm)	Disease loci[x] (no./15 m of row)	Rhizoctonia rating[y] (%)	Yield (kg/ha)
Ethoprop-PCNB 3-10G	3.36–11.2	41	7.3	45.2	4,117
Ethoprop-PCNB 3-10G	1.68–5.6	20	10.5	58.2	3,988
PCNB 10G	11.2	41	12.8	37.7*[z]	3,978
PCNB 10G	5.6	41	12.5	54.2*	3,708
Untreated control	...	...	18.8	55.6	2,521

[w] Applications were made at pegging, 64 days after seeding. Widths were measured at the soil surface.
[x] Number of 30-cm sections of row with one or more diseased plants. Loci counts were made when peanuts were inverted 154 days after seeding on 3 October 1986.
[y] Rhizoctonia limb rot rating was based on a mean of six locations in each plot, averaged over four plots. Rating was determined by estimating the percentage of vines and leaves infected at each location within a plot at digging.
[z] Means followed by an asterisk are significantly different from each other ($P = 0.05$) using the orthogonal contrasts method of comparison.

Table 4. Evaluation of fungicide-insecticide combinations, band widths, and timing for control of *Sclerotium rolfsii* on peanut in 1987[w]

Treatment	Rate (kg a.i./ha)	Application band width[x] (cm)	Disease loci[y] (no./15 m of row)	Yield (kg/ha)
PCNB 10G + chlorpyrifos 15G	11.2 + 2.24	30	10.0[z]	4,015
PCNB 10G + chlorpyrifos 15G	5.6 + 2.24	15	11.3	4,087
PCNB 10G + ethoprop 10G	11.2 + 3.36	30	9.0	4,063
PCNB 10G + ethoprop 10G	5.6 + 1.68	15	8.3	4,062
PCNB 10G	11.2	30	12.3	4,054
PCNB 10G	5.6	15	12.0	3,836
Chlorpyrifos 15G	2.24	30	16.3	3,576
Ethoprop 10G	3.36	30	16.8	3,325
Untreated control	...	...	16.0	3,537

[w] Cultivar Florunner peanuts were planted 7 May 1987, dug 17 September 1987, and harvested 23 September 1987.
[x] Replications were made 60 days after seeding on 8 July 1987. Widths were measured at the soil surface.
[y] Number of 30-cm sections of row with one or more diseased plants. Loci counts were made when peanuts were inverted 133 days after seeding.
[z] Means, arranged in pairs, were not significantly different using the orthogonal contrasts method of comparison ($P = 0.05$) for any of the parameters measured.

differences were detected in disease or yield for plots treated with chlorpyrifos 15G or ethoprop 10G.

DISCUSSION

As already noted in other publications, new fungicides such as diniconazole (6,9) and flutolanil (4) have activity against both *S. rolfsii* and *R. solani* AG-4, organisms that cause soilborne disease. Published work indicates that they are superior to currently available fungicides such as PCNB and carboxin (4–6). However, these new fungicides may not be available for several years.

PCNB has been the standard fungicide for peanut soilborne disease control for many years. Thompson (11) has demonstrated that combinations of PCNB with an insecticide such as ethoprop or fensulfothion control soilborne diseases better than PCNB alone. The combination materials have been recommended as the products of choice in Georgia (8,12). The cost of these products has steadily risen since the mid-1970s, and these products have become cost-prohibitive for many growers in the southeastern United States.

Research described in this manuscript indicates that a reduced-application band width of granular fungicides with a concomitant reduction in the rate of the product will give similar control of disease caused by *S. rolfsii* and a comparable yield as with the application of a wider band width at the recommended rate. This also tended to be the case for the new fungicides, such as diniconazole and flutolanil.

Because PCNB does not have much activity on AG-4 in peanut (6), this reduction of band width has little influence on the incidence of Rhizoctonia limb rot. Initial incidence of *S. rolfsii* on peanut occurs on the crown (1,2,5) and not on running vines. The application of chemicals in a narrow band at the crown of the plant where the disease initiates eliminates the application of chemicals to areas under the canopy where the disease is not active, notably the interrow spaces. The application of foliar-applied fungicides, such as diniconazole and flutolanil, in a narrow band would probably limit activity on Rhizoctonia limb rot. Rhizoctonia limb rot occurs later in the growing season in Georgia, in late August and September during wet weather. In contrast, *S. rolfsii* is active during hot, humid, and wet conditions from the time the peanut canopy shades the ground to harvest.

These two serious soilborne diseases of peanut are separate targets that may necessitate two separate application timings and methods. Narrow-band application at the time the canopy completely shades the soil, typically 60–70 days after seeding, may be the best application time for control of *S. rolfsii*. Rhizoctonia limb rot occurs 3–6 wk later if wet conditions occur under a heavy canopy. Spray applications for control of this disease would require a full-canopy spray to protect the vines. Studies are under way to predict and control Rhizoctonia limb rot with the new chemistry fungicides that are being developed for commercial use.

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