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Control of Southern Stem Rot and Rhizoctonia Limb Rot of Peanut with Flutolanil

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ABSTRACT

Flutolanil (SN 84364) was evaluated in vitro against *Sclerotium rolfsii* and *Rhizoctonia solani* AG-4. ED50 values were < *0.01* and < *0.1* μg/mL for *S. rolfsii* and *R. solani*, respectively, while Pentachloronitrobenzene (PCNB) had ED50 values of < *0.1* and < *1.0* μg/mL, respectively. Concentrations of flutolanil at 0.1 μg/mL greatly reduced sclerotia and sclerotia initial development of *S. rolfsii*. Field evaluations were conducted near Tifton, GA, during 1983-86 for control of southern stem rot (*S. rolfsii*) and Rhizoctonia limb rot (*R. solani* AG 4) on peanut (*Arachis hypogaea* L.). Flutolanil 50 WP applied as a banded (40 cm) foliar spray at rates of 1.12 - 5.6 kg ai/ha at pegging (about 60 days post seeding) significantly ($P = 0.05$) decreased both disease loci numbers caused by *S. rolfsii* and percentage of vines infected with *R. solani*. Yields were increased significantly ($P = 0.05$) in all treatments over the four years of trials. Flutolanil 7 G was significantly ($P = 0.05$) less effective in controlling southern stem rot and increasing yield than the 50 WP formulation.

Key Words: White Mold, ground nuts, Rhizoctonia.

Annual losses from *Sclerotium rolfsii* Sacc. and *Rhizoctonia solani* Kühn on peanut (*Arachis hypogaea* L.) in Georgia total about 12.5 percent. *Sclerotium rolfsii* causes southern stem rot of peanut, but can damage underground portions of the plant under certain environmental conditions (4, 7, 9). *Rhizoctonia solani* anastomosis group AG-4 causes disease on peanut from seeding through harvest. However, the greatest losses from this organism in Georgia occur at or near maturity on lower limbs and leaves causing Rhizoctonia limb rot. Decaying pegs account for the greatest loss in yield. Soilborne diseases are the most difficult to control. Only 50-70% of disease incited by *S. rolfsii* can be controlled by incorporating all cultural practices and currently available fungicides (4, 5, 6, 8, 9).

The objective of this research was to evaluate the efficacy of flutolanil (ISO proposed) [3'-isopropoxy-2-(trichloromethyl) benzanilide] against soilborne peanut pathogens under field disease conditions. This compound is being developed by Nor-AM as SN 84364. The target diseases in this study were southern stem rot, incited by *S. rolfsii*, and Rhizoctonia limb rot, incited by *R. solani* AG-4.

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Materials and Methods

Laboratory Trials

Isolates of *S. rolfsii* and *R. solani* AG-4 obtained from peanut in Georgia were used in this study. Moistened ryegrass seed was autoclaved in 250 mL flasks at 121 C for 20 min for two consecutive days. Flasks were inoculated with 4 mm plugs of *S. rolfsii* from 1-wk-old potato-dextrose agar (PDA) plates and incubated for 1 wk in an unlighted incubator at 27 C. *R. solani* AG-4 cultured on PDA was used as an inoculum source. Flutolanil 50 WP and Pentachloronitrobenzene (PCNB) 10G were tested at concentrations of 10.0, 1.0, 0.1, and 0.01 μg ai/mL in water agar. The water agar was amended with the test materials after being cooled to 45 C. The amended agar was mixed with a stirring bar, 10 cm petri plates were poured and allowed to gel. PCNB 10G was ground with a mortar and pestle before being added to the agar. Rye seed were inoculated two weeks before the test and incubated in the dark at 27 C. Ten petri plates for each concentration of each treatment were inoculated with *S. rolfsii* by placing a single, infested seed in the center of each plate. For evaluation of *R. solani*, a 5-mm plug of *R. solani* on PDA was inverted, placed onto the test plates. Control plates were inoculated unamended water agar petri plates. The petri plates were placed in plastic bags to maintain high relative humidity and incubated at 27 C in the dark. Mean radial growth average of two locations on each plate for ten plates was determined after 72 hr. Sclerotia and sclerotia initial numbers were counted after three weeks. Data were subjected to analysis of variance. The trial was repeated using other isolates of the pathogens. Only the data from one trial is presented although isolates responded similarly.

Field Trials

The research area was located near Tifton, Ga., on a Tifton loamy sand (fine-loamy, siliceous, thermic Plinthic Paleudult, pH 5.7). Each plot consisted of two rows, 7.6 M long with rows 0.9 M apart. Treatments were replicated four times in a randomized complete block design. Plots were seeded (112 kg/ha), dug and inverted on May 10 and October 4 in 1983, May 11 and September 24 in 1984, May 1 and September 26 in 1985, and May 5 and October 3 in 1986, respectively. Florunner peanut was used throughout.

Cultural practices, fertilization, weed, leafspot and insect control were consistent with Cooperative Extension Service recommendations for all years (10). Plots were irrigated with overhead sprinklers as required. Treatments were applied by preweighing samples for each plot and applying granules with a salt-shaker-like container or wettable powder with a CO_2 activated knapsack sprayer using 935 L/ha in 1983, 467 L/ha in 1985 and 234 L/ha of spray volume in 1986, and all three volumes in 1984 as indicated in Table 2. Application timing was as is indicated in the tables.

Evaluation of *Sclerotium rolfsii* in 1983-4 and 1986 was made both during the growing season and at digging and inverting, but only at

digging in 1985. Numbers of disease loci caused by *S. rolfsii* were estimated during the growing season and enumerated for each plot at digging and inverting by the method of Rodriguez-Kabana *et al.* (7). *Rhizoctonia* limb rot incited by *R. solani* was estimated as a percentage of vines infected in each plot. Yield was calculated after peanuts were dug, combined, dried and weighed.

Data were analyzed by analysis of variance and separations of means aided by Duncan's multiple range test.

Results

Laboratory trials

All concentrations of flutolanil and PCNB greater than 0.1 μg/mL decreased radial growth of *S. rolfsii* (C.V. = 47.2) over the control (Fig. 1). The ED50 for flutolanil was lower than 0.01 μg/mL while the ED50 for PCNB was about 0.1 μg/mL.

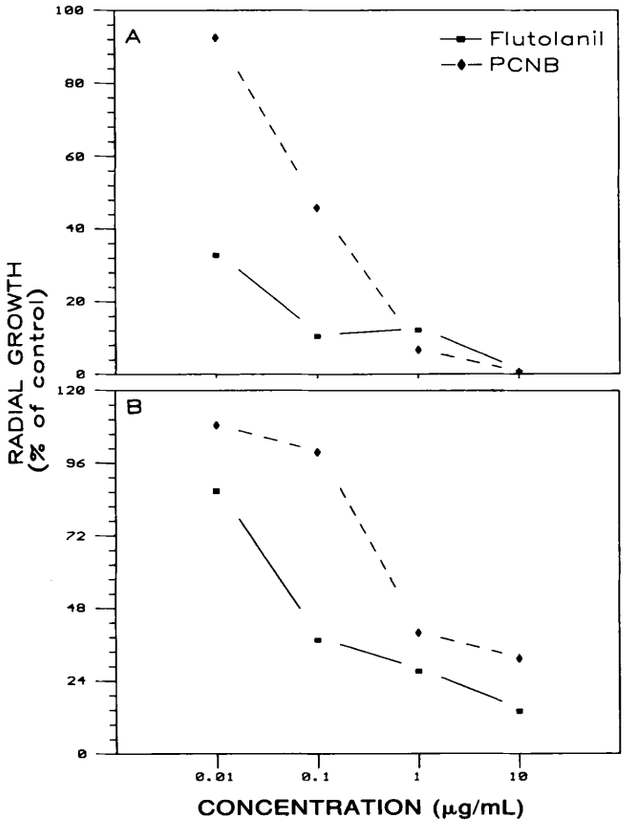

Figure 1. Radial growth of (A) *Sclerotium rolfsii* and (B) *Rhizoctonia solani* as a percent of the untreated control as affected by concentrations of flutolanil and PCNB in water agar.

All concentrations of flutolanil and PCNB at 1.0 and 10.0 μg/mL reduced radial growth (C.V. = 10.5) of *R. solani* AG4. The ED50 value for flutolanil was about 0.1 μg/mL and approximately 1.0 μg/mL for PCNB.

Concentrations of flutolanil at ≧ 0.1 μ/mL and PCNB at 1.0 and 10.0 μg/mL reduced sclerotia formation of *S. rolfsii* (C.V. = 54.3) compared with the control (Fig. 2). Numbers of sclerotia initials were decreased (C.V. = 102.4) by all concentrations of flutolanil and PCNB compared with the control.

Disease incidence and severity were lowest in 1983, but increased to high levels in 1985 and 1986 (Tables 1-4) with continuous cropping of peanuts. In 1983, plots treated with flutolanil or PCNB- fensulfothion had significantly fewer disease loci on September 9 than the untreated control (Table 1). However, at digging and inverting only peanuts treated with flutolanil had significantly fewer disease loci than the untreated control. Both treatments increased pod yield, but peanuts treated with flutolanil had significantly higher pod yield than plots treated with PCNB-fensulfothion.

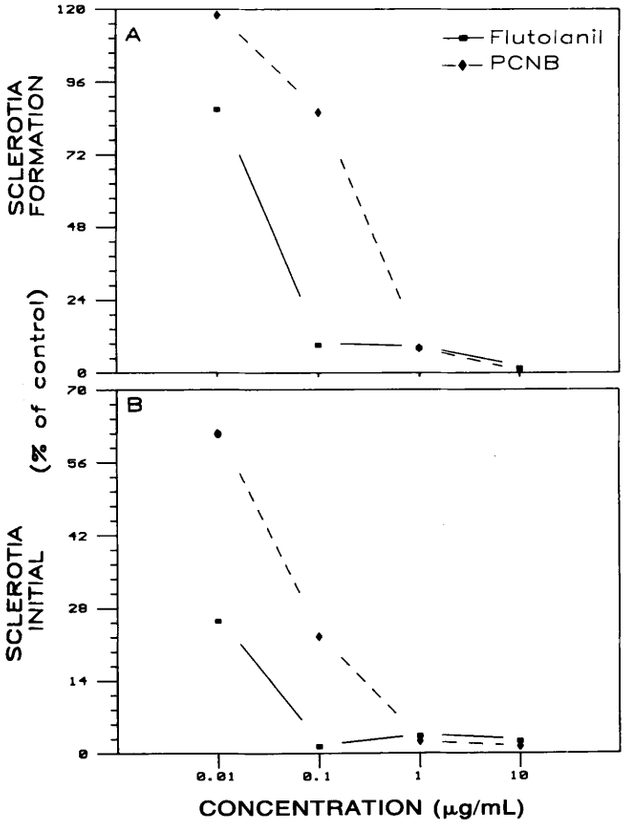

Figure 2. Formation of *S. rolfsii* (A) sclerotia and (B) sclerotia initials as a percent of the untreated control as affected by concentrations of flutolanil and PCNB in water agar.

In 1984, peanuts treated with flutolanil at any rate, or PCNB had fewer disease loci at each of two dates and higher yields than the untreated control (Table 2). The spray volume used for application of flutolanil or the rate of material applied at pegging (from 5.6 to 1.4 kg ai/ha) did not significantly alter control of disease or yield

Table 1. Evaluation of flutolanil for control of *Sclerotium rolfsii*, 1983.

Treatment	Rate[1] (kg ai/ha)	Disease loci (No./15.2M row)[2] 119 DAP	147 DAP	Yield (kg/ha)
Flutolanil 50 WP	2.8	3.0 [b]	5.8 [b]	6077 [a]
PCNB-fensulfothion 10-3G	11.2 - 3.36	5.3 [b]	11.5 [a]	5183 [b]
Untreated Control	----	11.0 [a]	14.5 [a]	4252 [c]

[1] Applications were made 58 day after planting (DAP).

[2] Each disease locus was an infection site from one plant up to 30 cm of row.

[3] Means in columns followed by the same letter are not significantly different according to Duncan's multiple range test, P = 0.05.

response. Some treatments of flutolanil resulted in significantly less Rhizoctonia limb rot damage than the untreated control. Peanuts receiving split applications of flutolanil at the higher rates, or those receiving the higher spray volumes tended to have less Rhizoctonia limb rot.

Table 2. Evaluation of flutolanil for control of *Sclerotium rolfsii* and Rhizoctonia limb rot of peanut, 1984.

Treatment	Rate (kg ai/ha)	Application[1]	Disease loci[2] (No./15.2M row) 108 DAP	135 DAP	Rhizoctonia[3] Rating %	Yield (kg/ha)
Flutolanil 50 WP	2.8 + 2.8	Peg + (A)	0.3 c	1.3 c	12.5 d	6172 a
Flutolanil 50 WP	2.8	Peg (B)	0.3 c	2.8 c	12.5 d	6115 a
Flutolanil 50 WP	1.4 + 1.4	Peg + (A)	0.3 c	0.8 c	15.0 cd	6106 a
Flutolanil 50 WP	2.8	Peg (C)	1.8 c	1.5 c	37.5 bcd	6083 a
Flutolanil 50 WP	2.8	Peg (A)	1.3 c	3.3 c	50.0 ab	6017 a
Flutolanil 50 WP	1.4	Peg (A)	1.5 c	2.5 c	42.5 abc	6009 a
Flutolanil 50 WP	5.6	Peg (A)	0.0 c	0.8 c	12.5 d	5976 a
Flutolanil 50 WP	0.7 + 0.7	Peg + (A)	2.8 c	3.0 c	32.5 bcd	5863 a
PCNB 10G	11.2	Peg	6.3 b	8.0 b	57.5 ab	5236 b
Untreated Control	---	---	10.8 a	17.0 a	70.0 a	4577 c

[1] Applications were made at pegging (Peg), 62 days after planting (DAP) or at Peg + 62 + 83 DAP as a split application. Amounts of water used were: A = 234 L spray/ha; B = 467 L spray/ha; and C = 935 L spray/ha.

[2] Each disease locus was an infection of one plant up to 30 cm of row.

[3] Rhizoctonia rating was determined by estimating percent of vines and leaves infected in each plot at digging and inverting.

[4] Means in columns followed by the same letter are not significantly different according to Duncan's multiple range test, P = 0.05.

In 1985, all treatments reduced numbers of disease loci and increased pod yield over the untreated control. Plots treated with flutolanil 50 WP at 2.24 and 1.12 kg ai/ha had fewer disease loci and higher yields than any other treatment except for PCNB and chlorpyrifos. (Table 3). Flutolanil 50 WP at 1.12 kg/ha significantly reduced numbers of disease loci and increased yields over flutolanil 7 G at 1.12 kg ai/ha.

However, only peanuts treated with flutolanil 50 WP at 2.24 or 1.12 kg ai/ha reduced Rhizoctonia limb rot rating.

In 1986, flutolanil applied at rates of 1.12 kg/ ai/ha or more at first flower or later decreased numbers of disease loci on 117 days after planting and at digging (Table 4). Most flutolanil treatments reduced Rhizoctonia limb rot. All flutolanil treatments increased yields over both the untreated control and the PCNB-ethoprop treatment. Peanuts treated with flutolanil at 2.24 kg ai/ha applied at pegging or at first disease, and at 3.36 kg ai/ha applied at first flower had the lowest levels of disease and highest yields.

Table 3. Evaluation of flutolanil for control of *Sclerotium rolfsii* and Rhizoctonia limb rot of peanuts, 1985.

Treatment	Rate[1] (kg ai/ha)	Disease loci[2] (No./15.2M row)	Rhizoctonia[3] Rating %	Yield (kg/ha)
Flutolanil 50 WP	2.24	3.5 d	8.8 c	6456 a
Flutolanil 50 WP	1.12	6.0 cd	11.0 bc	6241 a
PCNB 10G + Chlorpyrifos 15G	10.0 + 2.24	8.8 bc	11.5 abc	5954 ab
Chlorpyrifos 15G	1.12	12.3 b	15.5 a	5485 b
Chlorpyrifos 15G	2.24	11.0 bc	13.0 ab	5437 b
Flutolanil 7G	1.12	13.3 b	15.0 ab	5393 b
Flutolanil 7G + Chlorpyrifos 15G	1.12 + 1.12	11.3 bc	13.5 ab	5296 b
Untreated Control	---	24.0 a	15.5 a	4365 c

[1] Applications were made on 7-3-85, 63 days after seeding.

[2] Each disease locus was an infection of one plant to 30 cm of row, determined after after inverting.

[3] Rhizoctonia limb rot rating was determined by estimating the percent of vines and leaves infected in five locations in each plot, after inverting.

[4] Means in columns followed by the same letter are not significantly different according to Duncan's multiple range test, P = 0.05.

Discussion

Four years of field evaluation of flutolanil on peanut has demonstrated a level of disease control that has not been demonstrated by currently available fungicides for control of soilborne diseases caused by basidiomycetes. In addition to flutolanil's high activity against *S. rolfsii* in the field, the fungicide also demonstrated a significant level of activity against Rhizoctonia limb rot. Currently available fungicides provide very little control of Rhizoctonia limb rot of peanut and consequently this disease has become a greater and greater problem to peanut producers in Georgia.

The significantly less activity of the 7 G formulation over the 50 WP formulation is unexplained. However, poor release of the fungicide from granules or lability would be the most logical explanations.

Flutolanil applied at pegging or first appearance of disease controlled disease and increased yield over the same rate of fungicide applied at planting. (Table 4). This suggests that residual activity for these two diseases is important and time of application could effect efficacy and rate of fungicide used.

Activity of foliar fungicides on soilborne diseases has been noted (3) and foliar application may prove to be the simplest for growers to use. Application equipment for granules is expensive, specialized and usually unattainable during the narrow application window required for control of soilborne diseases of peanut. However, all growers have sprayers that are used for applications of other chemicals. This philosophy represents a shift in the dogma that granules are required for control of soilborne diseases under the peanut canopy. Although the fungicide is being sprayed on the foliage, apparently it is still reaching the soil and is active on the target organisms.

Flutolanil is systemic with curative and protective properties (1, 2). There is no published information on its mode of action on *S. rolfsii* or *R. solani*. However, flutolanil has especially high activity against mycelial growth and infection cushion formation (2) and the fungicide is absorbed by roots and translocated acropetally in rice (1, 2). It is not known whether flutolanil has systemic activity in peanut or its action by simply protecting vines, pegs and foliage at the soil level. Flutolanil represents new fungicide chemistry that has demonstrated high potential in control of southern stem rot and Rhizoctonia limb rot under high natural infestations of both *S. rolfsii* and *R. solani*.

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Table 4. Evaluation of flutolanil and PCNB-Ethoprop for control of *Sclerotium rolfsii* and Rhizoctonia limb rot, 1986.

Treatment	Rate (kg ai/ha)	Application[1]	Disease loci[2] No./15.2M row) 112 DAP	151 DAP	Rhizoctonia[3] rating %	Yield (kg/ha)
Flutolanil 50 WP	2.24	Peg	0.5 f	5.5 d	45.9 de	5800 a
Flutolanil 50 WP	2.24	1st disease	1.0 ef	7.5 d	38.4 e	5630 a
Flutolanil 50 WP	3.36	Flower	3.5 def	10.8 cd	52.5 cd	5470 a
Flutolanil 50 WP	1.12	Peg	5.8 cde	13.8 bc	51.9 cd	5036 ab
Flutolanil 50 WP	1.68	1st flower	7.8 bcd	14.8 bc	53.8 bcd	4935 ab
Flutolanil 50 WP	1.12	Plant	8.8 bc	17.8 ab	52.7 cd	4237 b
Flutolanil 50 WP	2.24	Plant	11.3 b	18.0 ab	65.2 a	4169 b
Flutolanil 50 WP	0.56	Peg	8.5 bcd	19.5 ab	60.2 abc	4135 b
PCNB-ethoprop 10-3G	11.20 - 3.36	Peg	16.5 a	23.5 a	63.5 ab	3201 c
Untreated Control	--	--	12.3 ab	23.8a	68.3a	3031 c

[1] Application dates were at planting (Plant) (5-5-86), at first flower (1st Flower) 45 days after planting (DAP), at pegging (Peg) 56 DAP, or first disease (1st disease).

[2] Numbers of disease loci were determined by measurement. Each locus was one dead plant up to 30 cm of linear row with dead plants.

[3] Rhizoctonia limb rot rating is based on a mean of six locations in each plot, averaged over four plots. Rhizoctonia rating was determined by estimating percent of vines and leaves infected at each location within plots at digging.

[4] Means in columns followed by the same letter are not significantly different according to Duncan's multiple range test, $P = 0.05$.

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