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Activity of Tolclofos - Methyl (Rizolex) on *Sclerotium rolfsii* and *Rhizoctonia solani* in Peanut[1]

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ABSTRACT

Tolclofos-methyl was compared to PCNB *in vitro* to determine its relative activity against four isolates of *Sclerotium rolfsii* Sacc. and two isolates of *Rhizoctonia solani* Kuehn. Concentrations of 0.001, 0.01, 0.1, 1.0 and 10 μg/mL of each of the fungicides were used to evaluate their effects on radial growth on both *S. rolfsii* and *R. solani* and their effects on sclerotia formation and sclerotial germination of *S. rolfsii*. Little difference in efficacy between the fungicides occurred for *S. rolfsii*. However, tolclofos-methyl reduced radial growth of *R. solani* more than PCNB at concentrations of 0.1 and 1.0 μg/mL. In field tests in 1982 and 1984 tolclofos-methyl at 5.6 kg ai/ha or less was as effective or superior to PCNB or PCNB-fensulfothion in reducing incidence of southern stem rot and increasing yield. In 1984, tolclofos-methyl at 8.4 kg ai/ha reduced Rhizotonia limb rot damage over the control, but PCNB at 11.2 kg ai/ha did not.

Key Words: White mold; Rhizoctonia limb rot.

Sclerotium rolfsii Sacc., the causal agent of southern stem rot of peanut, and *Rhizoctonia solani* Kuehn the causal agent of Rhizoctonia limb rot caused in excess of $50 million loss in Georgia in 1984 (6). Recommended methods of management of southern stem rot include rotation with a grass crop, deep turning of land to bury crop litter, avoidance of close cultivation to prevent vine damage and covering with soil, and the use of chemicals. In Georgia, PCNB (Pentachloronitrobenzene) alone or in combination with an insecticide such as fensulfothion, ethoprop or chlorpyrifos is recommended for application at pegging time (5). However, even with the use of all these methods only 50-60% control of the disease can be expected. Csinos *et al.* (1) in their evaluation of fungicides found that PCNB with an insecticide, the best treatments evaluated, only controlled the disease 22-68% depending on the year. Thompson (4) also indicated only 52-63% control of southern stem rot with the combination material depending on the year the test was conducted. The recommended rates of the combination material is 112 kg of the formulated material/ha. This high quantity of material is costly to handle and to apply. Many growers have found the return on investment too poor to continue the use of the fungicide. Chemical control of southern stem rot would again become popular if percent control could be increased or cost/ha reduced. Rhizoctonia limb rot is managed primarily by reducing excessive vine growth and judicial watering late in the season.

Recently a new fungicide, tolclofos-methyl [0.0-di-

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methyl 0-(2,6-dichloro-4-methyl-phenyl) Phosphorothioate] (Rizolex) has been evaluated for activity on *Sclerotium rolfsii* and *Rhizoctonia solani* in the laboratory and on southern stem rot and Rhizoctonia limb rot on peanut in the field. These evaluations are reported here.

Materials and Methods

Laboratory Tests. Four isolates of *S. rolfsii,* isolated from dying peanut in Georgia and two isolates of *Rhizoctonia solani* AG-4 isolated from peanut stems were used in this study. Sixty grams of ryegrass seed moistened with 100 mL of deionized water were autoclaved in 250 mL flasks at 121 C for 15 min on two consecutive days. Inoculum was prepared by placing two 4-mm diameter plugs of *S. rolfsii* from 1-wk-old potato-dextrose agar (PDA) petri plate cultures into the flasks containing rye seed and incubating for 1 wk in an unlighted incubator at 27 C. Sclerotia of *S. rolfsii* were produced on PDA and air-dried before use. Fungicides evaluated were tolclofos-methyl and PCNB each at 0.001, 0.01, 0.1, 1.0, and 10.0 g/mL. Water agar was amended with specific concentrations of the fungicides after being cooled to 45 C and thoroughly mixed, dispensed into 10-cm petri plates and allowed to gel. Granular materials were ground with a mortar and pestle before being added to agar. Ten replications for each fungicide concentration for each isolate was used. Plates were inoculated with *S. rolfsii* by placing a single, infested rye seed in the center of each plate. Radial growth was recorded after 72 hr incubation at 27 C in the dark. Plates were inoculated with *R. solani* by placing an inverted 5 mm diameter plug from a 1 wk PDA culture in the center of each plate. Plates for each treatment were placed in plastic bags and incubated at 27 C in an unlighted incubator. Radial growth was recorded after 72 hrs of incubation. Inhibition of sclerotial germination was tested by placing 10 sclerotia on each of 10 plates per treatment for each of the *S. rolfsii* isolates. Petri plates were placed in plastic bags and incubated as previously described for 72 hrs, after which percent germination was recorded. Plates used to determine radial growth were then placed on the laboratory benches at ambient light and temperature. After 3 wks the numbers of sclerotia formed on each plate were recorded. All data reported is for the mean of four isolates of *S. rolfsii* with ten petri plates of each treatment for each isolate, except radial growth was the mean of three isolates. Two isolates of *R. solani* with ten petri plates (replications) for each treatment for each isolate was used to determine radial growth.

Data were subjected to analysis of variance, and means compared by use of Orthoganal contrasts.

Field Tests. The test area was a Tifton loamy sand infested with *Sclerotium rolfsii* and in continuous peanut cultivation since 1981. In 1982 and 1983 infested soil containing sclerotia of S. rolfsii, from a diseased lupin field, was used to further infest the test area. Soil containing approximately 50 sclerotia per plot was distributed over each plot when peanuts were 30 days old. Experimental design was a randomized complete block with four replications. Each plot was two rows, 7.6 m long and 0.7 m apart. Tests to evaluate tolclofos-methyl were conducted in 1982 and 1984.

In 1982 treatments of tolclofos-methyl 5G were: 2.8 kg ai/ha, 3.7 kg ai/ha and 5.6 kg ai/ha applied 53 days post seeding (at pegging); 1.4 kg ai/ha, 1.8 kg ai/ha, and 2.8 kg ai/ha applied once 53 days post seeding (at pegging) and again three weeds later (74 days post seeding). PCNB-fensulfothion 10-3G was applied at 11.2-3.36 kg ai/ha at pegging time (53 days post seeding) and the control plots were not treated with fungicide.

In 1984 tolclofos-methyl treatments were: 1.4 kg ai/ha, 2.8 kg ai/ha, 5.6 kg ai/ha, and 8.4 kg ai/ha applied at pegging time (60 days post seeding). The standard was PCNB 10G applied at 11.2 kg ai/ha at pegging time (60 days post seeding) and the control plots were not treated with fungicide: Tolclofos-methyl (Rizolex) was supplied by Sumitomo Chemical Co., Osaka, Japan, in 1982 and by Velsicol Chemical Corp., Chicago, Ill. in 1984. PCNB-fensulfothion 10-3G was supplied by Olin Corp., Little Rock, Ark., in 1982 and PCNB 10G was supplied by UniRoyal Chemical, Raleigh, N. C., in 1984. Granules were preweighed for each plot and applied in a 40 cm band over the row with salt shaker-like containers. Recommended fertilizer, nematicide, herbicides, insecticides and leaf spot fungicide were used to control other pests (8). Water was applied by overhead irrigation as required to enhance *S. rolfsii* disease progression.

Numbers of disease loci per plot were counted twice during the season, 90 and 131 days (at inverting) post seeding in 1982 and 108 and 136 days (at inverting) post seeding in 1984. A disease locus consisted of a 1-30 cm section of row infected with *S. rolfsii* as described by Rodriquez-Kabana et al. (3) In 1984, severe infection of *Rhizoctonia solani* occurred on vines. Plots were rated after they were inverted on a scale of 0-10 as a measure of percent of vines infected, where 0 = 0% infection and 10 = 100% of vines infected. Plots were inverted 131 and 136 days post seeding in 1982 and 1984, respectively. After plots were harvested, peanuts were dried, weighed and yields determined. Data were anaylzed by analysis of variance and Duncan's multiple-range test.

Results

Laboratory Tests

Radial growth of *S. rolfsii* was inhibited at concentrations of 0.1 μg/mL by both PCNB and tolclofos-methyl (Fig. 1-A). Radial growth was reduced more by PCNB than tolclofos-methyl at a concentration of 0.1 μg/mL ($P = 0.05$), but was inhibited more by tolclofos-methyl than PCNB at a concentration of 1.0 μg/mL. Sclerotia formation on petri plates was inhibited 40% or more at concentrations ≥ 0.1 μg/mL by both materials (Fig. 1-B). No differences ($P = 0.05$) between materials occurred in suppression of sclerotial formation. Germination of air dried sclerotia produced on PDA was inhibited 70% or greater by both PCNB and tolclofos-methyl at concentrations of 1.0 and 10.0 μg/mL (Fig. 1-C). No differences ($P = 0.05$) between the fungicides was observed in reduction of germination of sclerotia.

Radial growth of *R. solani* was inhibited by concentrations of tolclofos-methyl ≥ 0.1 μg/mL and by concentrations of PCNB ≥ 1.0 μg/mL (Fig. 2). Tolclofos-methyl at concentrations of 0.1 and 1.0 μg/mL reduced radial growth more ($P = 0.05$) than PCNB at those same concentrations.

Field Tests

In 1982, plots treated with any of the tolclofos-methyl treatments and the plots treated with PCNB-Fensulfothion had fewer disease loci than the untreated control 90 days after seeding (Table 1). However only plots treated with 5.6 kg ai/ha of tolclofos-methyl had fewer disease loci than the untreated control at digging, 131 days post seeding. All plots except those treated with tolclofos-methyl at 2.8 kg ai/ha applied at pegging had a lower disease index than the untreated control plots. Yield was higher in all treated plots than the control plots. Plots treated with tolclofos-methyl at 5.6 kg ai/ha at pegging had higher yields than plots treated with tolclofos-methyl at 1.4 kg ai/ha at pegging and 1.4 kg ai/ha 3 wks after pegging application.

In 1984, plots treated with 2.8, 5.6 and 8.4 kg ai/ha of tolclofos-methyl had fewer disease loci than the standard (PCNB 10G at 11.2 kg ai/ha) or the untreated control both 108 and 136 days post seeding (Table 2). Plots treated with tolclofos-methyl at 1.4 kg ai/ha was not different in disease loci from the control. Only plots treated with tolclofos-methyl at 8.4 kg ai/ha had a lower limb rot rating than the control. Plots treated with tolclofos-methyl at 2.8 and 8.4 kg ai/ha were higher in yield than the control plots.

Discussion

Tolclofos-methyl and PCNB both reduced radial

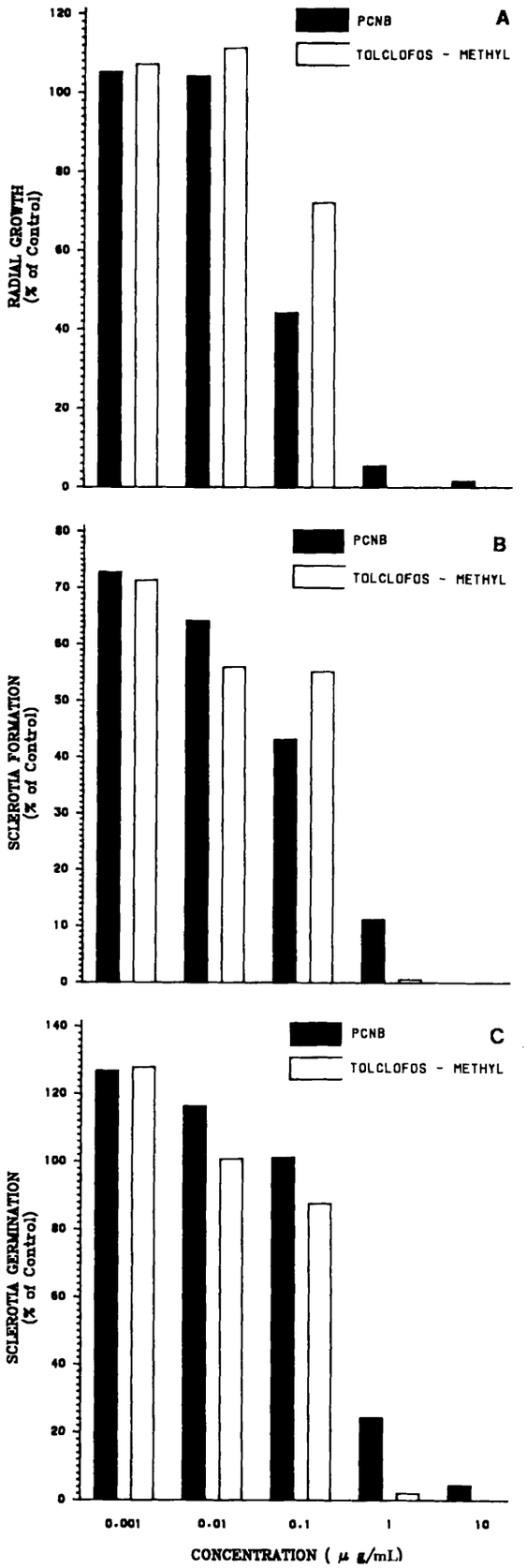

Fig. 1. Activity of PCNB and tolclofos-methyl on *Sclerotium rolfsii*. Effect on (A) radial growth, (B) sclerotium formation, and (C) sclerotial germination.

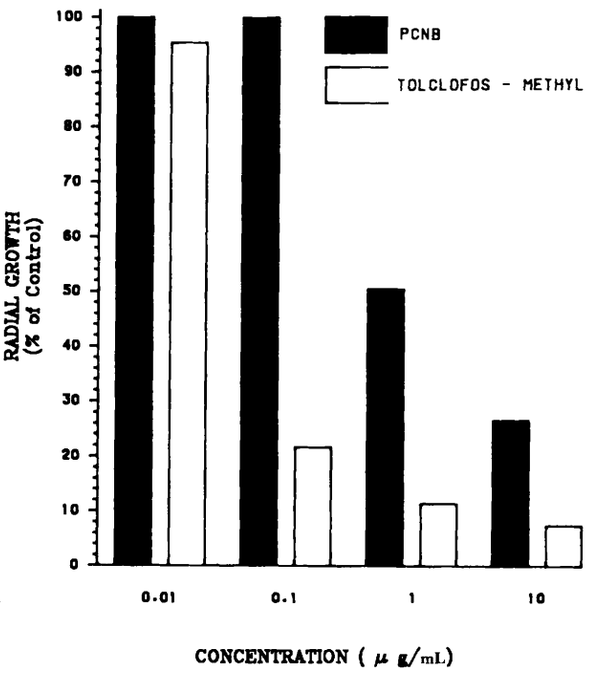

Fig. 2. Activity of tolclofos-methyl and PCNB on reducing radial growth of *R. solani*.

Table 1. Disease control of *Sclerotium rolfsii* by tolclofos-methyl and yield of peanut, 1982.

Treatment and formulation	Rate (kg ai/ha)	Application[1] Time	Disease Loci (No/30.5 m row) 90 days	131 days	Disease Index[3]	Yield (kg/ha)
Tolclofos-methyl 5G	5.6	Peg	0.0[c][2]	3.6[b]	7.2[c]	6189[a]
PCNB-fensulfothion 10-3G	11.2 - 3.4	Peg	7.0[b]	11.0[a]	10.0[c]	5999[ab]
Tolclofos-methyl 5G	2.8 + 2.8	Peg + 3 wks	3.6[bc]	9.0[a]	7.9[c]	5996[ab]
Tolclofos-methyl 5G	3.7	Peg	4.0[bc]	11.6[a]	9.3[c]	5872[ab]
Tolclofos-methyl 5G	1.8 + 1.8	Peg + 3 wks	4.6[b]	10.6[a]	10.4[bc]	5677[ab]
Tolclofos-methyl 5G	2.8	Peg	6.6[b]	8.6[ab]	20.0[ab]	5667[ab]
Tolclofos-methyl 5G	1.4 + 1.4	Peg + 3 wks	6.6[b]	12.0[a]	14.3[bc]	5616[b]
Control	-	-	14.6[a]	13.6[a]	27.9[a]	5044[c]

[1] Peg is at pegging, 53 days post seeding; Peg + 3 wks is a split application of chemical once 53 days post seeding and again on 74 days post seeding.

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

[3] Disease index was determined as the product of the number of disease loci counted at inverting for each plot and a subjective disease severity factor ranging from 0.1 to 1.0; where 0.1 is least severe and 1.0 is very severe.

growth, sclerotia formation and sclerotia germination of *S. rolfsii* equally well in laboratory tests with only a few differences at the higher concentrations. However, in both years of field evaluation, tolclofos-methyl at one-half the rate or less was equal to or superior to PCNB or PCNB-fensulfothion in its ability to reduce disease and increase yield. Tolclofos-methyl is an organo-phosphate, has curative and slightly systemic action, and has high fungitoxicity to *Rhizoctonia solani* (2) and *S. rolfsii*. The mode of action is not fully understood (2). However, the fungicide is metabolically specific and Van Bruggen and Arneson (7) have demonstrated resistance of *R. solani*

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

Treatment & formulation	Rate (kg ai/ha)	Disease Loci (No/30.5 m row) 108 days	136 days	Limb Rot[3] Rating	Yield (kg/ha)
Tolclofos-methyl 5G	2.8	$4.6^{c/2}$	7.0^{b}	1.5^{ab}	6188^{a}
Tolclofos-methyl 5G	8.4	2.6^{c}	2.0^{b}	0.3^{b}	5968^{ab}
Tolclofos-methyl 5G	5.6	2.0^{c}	3.6^{b}	2.3^{ab}	5887^{abc}
Tolclofos-methyl 5G	1.4	9.0^{bc}	14.6^{ab}	3.0^{ab}	5432^{abc}
PCNB 10G	11.2	20.6^{a}	24.0^{a}	3.8^{ab}	5293^{bc}
Control	--	16.0^{ab}	26.0^{a}	4.8^{a}	5115^{c}

/1 Applications made 60 days post seeding.

/2 Means in columns followed by the same letter are not significantly different according to Duncan's multiple-range test, P = 0.05.

/3 Limb rot rating for Rhizoctonia solani damage was made on a subjective 0-10 scale, where 0 = no damage, and 10 = 100% of vines damaged.

to tolclofos-methyl in the laboratory.

Both southern stem rot caused by *S. rolfsii* and Rhizoctonia limb rot caused by *R. solani* are major disease problems of peanut in the southeast (6). Tolclofos-methyl has demonstrated activity against both organisms in the laboratory and the field in sufficiently low concentrations to be potentially useful for control of these disease problems.

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