CONTROLLING SOUTHERN BLIGHT OF BICOLOR LESPEDEZA

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Use of methyl bromide and mycorrhizal inoculum to treat soil infested with **Sclerotium rolfsii** increases growth and vigor and reduces mortality of bicolor lespedeza seedlings.

Lespedeza bicolor Turcz. is widely planted throughout the United States for wildlife food and cover and for erosion control *(2, 8)*. The production of this shrub lespedeza in forest tree nurseries is often limited by southern blight caused by *Sclerotium rolfsii* Sacc. The fungus attacks seedlings from pre-emergence to more mature growth stages during the first year after seeding. Wefts of white mycelium and small, spherical sclerotia can often be seen with the unaided eye around the base of attacked plants (fig. 1).

The disease has become increasingly severe during the past 10 years in plantings at the Georgia Forestry Commission's Page Nursery near Reidsville. Losses have exceeded 50 percent of each year's crop for the past 5 years and have averaged about 80 percent of the last three annual crops.

Unsuccessful attempts to control the disease at the Page Nursery have included soil fumigation with methyl bromide formulations (Dowfume® MC-2, Nemaster®, and Dowfume MC-33) at rates up to 600 to 700 pounds per acre and fungicidal treatments with Demosan®, Captan®-Terracap®, and Benlate®. In contrast, studies on other crop plants have shown that methyl bromide *(4)* and Dasanit®-Terraclor® *(9)* control *S. rolfsii*.

Figure 1.—*Numerous sclerotia of* Sclerotium rolfsii *on stem of soybean seedlings. Sclerotia and stem are approximately natural size.*

In analyzing these failures, we considered that soil fumigation with methyl bromide may either have been done improperly or that it severely reduced populations of endomycorrhizal fungi that bicolor lespedeza may need to resist S. rolfsii. Endomycorrhizae have increased the resistance of some plants to certain soil-borne fungi: cotton and tobacco to *Thielaviopsis basicola (1, 7)* and tomato to *Fusarium oxysporium* f. sp. *lycopersici (3).*

This paper describes studies of the efficacy of methyl bromide fumigation and endomycorrhizae, as well as the fungicides Terraclor (PCNB: pentachloronitrobenzene) and Mocap®-Terraclor (0-ethyl S, S, dipropyl phosphorodithioate PCNB), for control of southern blight of bicolor lespedeza.

Materials and Methods

Field Test with *PCNB* and *Mocap-PCNB.*—In 1977, field plots were established at the Page, Davisboro, and Morgan Memorial Nurseries near Reidsville, Davisboro, and Byron, Georgia, respectively. Treatments used at each location were a check, PCNB (10 percent granular), and Mocap-PCNB (3 percent + 10 percent granular). The chemicals were broadcast onto the soil surface at the rate of 200 pounds per acre immediately after bicolor lespedeza was planted. Treatments were arranged in a randomized complete block with five replications; plots were either 4 by 100 feet (Davisboro and Morgan Memorial) or 4 by 50 feet (Page) with two 38-inch rows in each plot. Only the Morgan Memorial Nursery site was fumigated with methyl bromide before planting. Numbers of dead and living seedlings were recorded 2 weeks after seeding in ten 1-foot spots selected at random in each plot. Dead and dying seedlings were plated on potato-dextrose agar to verify the presence of S. rolfsii.

Greenhouse Test with *PCNB*.—A greenhouse test was conducted to determine the efficacy of high dosages of PCNB in controlling southern blight. Soil infested with *S. rolfsii* was obtained from the Page Nursery and placed in 6-inch plastic pots. Treatments used were a check, PCNB (Terraclor 75 percent wettable powder) at 196 pounds (active ingredient) per acre, PCNB at 272 pounds (active ingredient) per acre, and PCNB at 392 pounds (active ingredient) per acre. The fungicide was mixed into the top 2 inches of soil. Treatments were arranged as a randomized complete block with five replications. The pots were placed on inverted saucers, spaced to avoid cross-contamination from splashing. Numbers of dead and living seedlings and heights of living seedlings were recorded 11 weeks after planting. Again, dead and dying seedlings were plated on potato-dextrose agar.

Testing Methyl Bromide Fumigation and Endomycorrhizae.—A greenhouse test was conducted to determine the efficacy of methyl bromide soil fumigation with and without subsequent inoculation with mycorrhizal fungi in controlling southern blight. Infested soil from the Page Nursery was placed in 8-inch clay pots. Treatments used were fumigation, fumigation + *Glomus fasciculatus* inoculum, fumigation + *G. mosseae* inoculum, nonfumigated soil, *G. fasciculatus* in nonfumigated soil, and *G. mosseae* in nonfumigated soil.

The study was arranged in a randomized complete block with five replications. The potted soil was fumigated for 48 hours between two sheets of 4-mil plastic with methyl bromide (Dowfume MC-2) at the rate of 3 pounds per cubic yard. Inoculum of both species of *Glomus* was grown on root systems of *Sorghum vulgare* in greenhouse culture. One liter of inoculum of *G. fasciculatus* or *G. mosseae*—a mixture of sorghum roots, soil, and spores—was added to each of five fumigated and five nonfumigated pots; the check treatment involved a *Glomus*-free mixture of roots and soil mixed with soil. *A* concrete mixer thoroughly mixed the inoculum and soil. *Glomus*-free leachates prepared from each of the two cultures were added (100 ml/pot) reciprocally to all pots.

This procedure insured that microflora common to *G. mosseae* inoculum was present in pots inoculated with *G. fasciculatus* and vice versa and that microflora common to inocula of both species of *Glomus* was present in noninoculated check treatments.

The inoculum was assayed by a sieving-Baerman funnel-centrifugation technique. Microscopic counts were made separately of black spores and yellow-white spores because the older black spores may have been dead or nonfunctional.

Fifty bicolor lespedeza seeds were planted per pot after surface sterilization for 10 minutes in 30 percent hydrogen peroxide. Ten weeks later, counts were made of dead seedlings, root nodules (N-fixing) per 2 centimeters root section, and endomycorrhizal feeder roots. Fresh weights were recorded of roots and top of each live seedling. Mycorrhizal assays were made by examining two 2 centimeters root sections from each plant after they had been preserved, cleared, and stained *(5)*. The intensity of mycorrhizal infection was estimated as the percentage of each 2 centimeters section of feeder root containing fungus hyphae, vesicles, or arbuscules.

Results and Discussion

Field Test of Fungicides.—Although PCNB alone and a Mocap-PCNB mixture have controlled *S. rolfsii* on some ornamentals, vegetables, and peanuts *(4, 6, 9)*, they did not control the disease on bicolor lespedeza in this study (table 1). Severe phytotoxicity resulted from the use of both fungicides. The degree of this phytotoxicity is illustrated by the 55 percent reduction in average stand density in plots treated with PCNB and the 59-percent reduction in plots treated with Mocap-PCNB at the Morgan Nursery where no southern blight was detected. The Mocap-PCNB formulation was significantly more phytotoxic than the PCNB formulation at all three sites.

Greenhouse Test of Fungicides.—PCNB was also phytotoxic in the greenhouse test (table 2). Seedling mortality increased and the average height of surviving seedlings decreased as dosage of PCNB increased.

Mortality in check pots was due to *S. rolfsii*. Mortality in treated pots may have been caused by *S. rolfsii*, PCNB toxicity, or the interaction between them. The additional mortality in PCNB-treated pots was assumed to be due either directly or indirectly to PCNB toxicity.

Apparently, PCNB and Mocap-PCNB are too toxic for use as a control of southern blight of bicolor lespedeza. Because mortality decreases as seedlings mature, disease control is needed most during the first few weeks after planting. Accordingly, reduction of phytotoxicity through split-applications of PCNB or Mocap-PCNB does not appear promising.

Efficacy of Methyl Bromide Fumigation and Endomycorrhizae.—Soil populations of *S. rolfsii* were eradicated by fumigation with 3 pounds of methyl bromide per cubic yard of soil (table 3). Apparently, past fumigations at the Page Nursery have drastically reduced soil populations of endomycorrhizal fungi, but they have not eliminated *S. rolfsii*. Fumigation with high rates of methyl bromide (> 1 pound per 100 square feet and < 3 pounds per cubic yard) at optimum conditions is needed for culture of bicolor lespedeza at this nursery. The addition of either *G. mosseae* or *G. fasciculatus* inoculum to the Page Nursery site should increase growth and vigor of lespedeza seedlings, but it would not prevent mortality caused by *S. rolfsii*. However, addition of mycorrhizal inoculum to non-fumigated soil reduced mortality during the first 2 months after planting (table 3). The greater intensity of mycorrhizal infection and slight increase in plant size indicate that *G. mosseae* may be a better symbiont than *G. fasciculatus* on bicolor lespedeza. However, the number of spores added and the proportion of newer white or yellow spores to older black ones were unequal for

the two fungi: 940 (650 newer, 290 older) for *G. mosseae* and 1,025 (482 newer, 543 older) for *G. fasciculatus*. This disparity, rather than a possible superiority of *G. mosseae*, may account for the slightly different response to the two endomycorrhizal species.

Table 1.—*Stand density of Lespedeza bicolor and mortality caused by Sclerotium rolfsii in three forest nurseries 2 weeks after seeding and treatment with PCNB or Mocap-PCNB*[1]

	Number of seedlings/ft [2]								
	Live			Dead			Percent mortality		
Nursery	Check	PCNB	Mo-PCNB	Check	PCNB	Mo-PCNB	Check	PCNB	Mo-PCNB
Davisboro	73.8[a]	57.0[b]	42.0[c]	6.0[a]	0.6[b]	0.0[c]	8.1[a]	0.8[b]	0.0[c]
Page	4.8[a]	3.6[b]	0.6[c]	6.6[a]	2.4[b]	1.2[c]	57.0[a]	39.6[b]	62.5[a]
Morgan	87.0[a]	39.0[b]	36.0[c]	0.0[a]	0.0[a]	0.0[a]	0.0[a]	0.0[a]	0.0[a]
Average	55.2[a]	33.0[b]	26.4[c]	4.2[a]	1.2[b]	0.6[c]	7.7[a]	2.7[b]	1.5[a]

[1]In each row, each set of three means followed by a common letter does not differ significantly at P=0.05 according to Duncan's New Multiple Range Test.

Table 2.—*Height and mortality of Lespedeza bicolor 11 weeks after seeding in potted soil infested with Sclerotium rolfsii and treated with three dosages of PCNB*[1]

Treatment	Percent Mortality	Average seedling height
lb/acre	*percent*	*mm*
Check (0)	81.6[a]	138[d]
PCNB (196)	91.2[b]	121[c]
PCNB (272)	91.2[b]	91[b]
PCNB (392)	92.0[b]	66[a]

[1]In each column, means followed by a common letter do not differ significantly at P=0.05 according to Duncan's New Multiple Range Teat.

Table 3.—*Survival and growth of Lespedeza bicolor 10 weeks after seeding in soil infested with Sclerotium rolfsii and treated with methyl bromide and Glomus mosseae (GM) or G. fasciculatus (GF)* [1]

	Nonfumigated			Fumigated		
Seedling response	CK	GM	GF	CK	GM	GF
Mortality (percent)	91.2[a]	84.8[b]	84.8[b]	26.4[d]	23.2[d]	32.8[c]
Fresh weight (g)						
Roots	0.03[a]	0.10[ab]	0.11[ab]	0.17[b]	0.22[c]	0.20[c]
Tops	0.13[a]	0.42[b]	0.40[c]	0.31[b]	0.47[c]	0.45[c]
Total	0.16[a]	0.52[b]	0.51[b]	0.48[b]	0.69[c]	0.65[c]
Nodules/2-cm root (No.)	1.5[a]	3.2[b]	3.0[b]	1.2[a]	0.7[a]	1.3[a]
Roots mycorrhizal (percent)	0.0[a]	38.0[b]	49.5[b]	0.0[a]	56.0[b]	60.4[b]
Mycorrhizal intensity (percent)	0.0[a]	31.9[c]	17.3[b]	0.0[a]	33.5[c]	25.5[b]

[1]In each row, means followed by a common letter do not differ significantly at P=0.05 according to Duncan's New Multiple Range Test. Mortality in fumigated pots was not caused by S. rolfsii.

Literature Cited

1. Baltruschat, H., and F. Schonbeck.
   1972. Untersuchungen fiber den Einfluss der endotrophen mycorrhiza auf die Chlamydosporenbildung von Thielaviopsis basicola in Tabakwunzeln. Phytopathol. z. 74: 358-361.
2. Davison, V. E.
   1974. Lespedezas for quail and good land use. U.S. Dep. Agric., Leafl. 373, 8 p.
3. Dehne, H. W, and F. Schonbeck.
   1975. Untersuchugen fiber den Einfluss der endotropen Mycorrhiza auf die Fusarium-Welke der Tomate. Z. Pflanzenkr. Pflanzenschutz 82: 630-632.
4. Harrison, A. L.
   1961. Control of Sclerotium rolfsii with chemicals. Phytopathol. 51: 120-128.
5. Philips, J. M., and D. S. Hayman.
   1970. Improved procedures for clearing roots and staining parasites and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Br. Mycol. Soc. 55: 158-161.
6. Rodrigues-Kabana, R., P. A. Beckman, and Carol McLead.
   1975. A soil plate method for rapid screening of pesticides against Sclerotium rolfsii. USDA Plant Dis. Rep. 59: 439-442.
7. Schonbeck, F., and H. W. Dehne.
   1977. Damage to mycorrhizal and non-mycorrhizal cotton seedlings by Thielaviopsis basicola. USDA Plant Dis. Rep. 61 : 266-267.
8. Schopmeyer, C. S. (Coord.).
   1974. Seeds of woody plants in the United States. U.S. Dep. Agric., Handb. 450, 883 p.
9. Thompson, S. S.
   1974. PCNB and PCNB plus fensulfothion as related to Sclerotium rolfsii control and lesion nematode damage in peanuts. Proc. Am. Peanut Res. & Educ. Assoc. 6: 62 (Abstr.).