Tests with Soil Treatments and Crown Sprays to Control Rhizoctonia Crown and Root Rot of Sugarbeet[1]

C. L. SCHNEIDER and H. S. POTTER[2]

Received for publication October 26, 1973

The fungus *Rhizoctonia solani* Kühn incites severe crown and root rot of sugarbeet, which usually results in the premature death of the plant. Sugarbeet plantings under attack by the fungus characteristically show a progressive reduction in stand from early summer until harvest. Infected plants that survive are usually severely damaged by rot.

The only control measures presently recommended to growers are modified cultural practices, including special crop rotations. Although these measures are undoubtedly helpful, the disease has continued to damage the crop appreciably in most of the sugarbeet growing areas of North America. In response to the concern over continued losses caused by this disease, additional control measures have been sought, including the use of chemicals.

In previous studies, Afanasiev and Morris (2)[3] found that chemical soil treatments bis(dimethylthiocarbamoyl)disulfide (thiram), sodium borate, and 2, 3-dichloro-1, 4-naphthoquinone (dichlone) had little effect in controlling seedling blight and root rot of older beets. Later, Afanasiev and Baldridge (1) reported that broadcast application of pentachloronitrobenzene (PCNB) at 50-100 lb active ingredient/acre (a.i./acre) appreciably controlled those diseases. Potter found substantial suppression of Rhizoctonia infection with in-furrow applications of urea formaldehyde at 3-6 gallons (gal)/acre. He also observed that the treatments, particularly at the high rate, reduced the sugar content of beets (unpublished report).

In 1968, we initiated a program of testing chemicals and methods of application to control Rhizoctonia crown and root rot. The tests were conducted under relatively severe disease exposure in field plots artificially infested with virulent isolates of *R. solani*. The published results of the 1968-70 tests (6, 7, 8) are summarized as follows: a) Six

---

[1]Cooperative investigations of the Agricultural Research Service, USDA, and the Michigan Agricultural Experiment Station, East Lansing, Michigan. Journal article #6374. The following report includes the current status of research on pest control. It does not contain recommendations for use of pesticides nor does it imply that the uses discussed have been registered.

[2]Plant Pathologist, Agricultural Research Service, USDA and Plant Pathologist, Michigan State University, East Lansing, Michigan, respectively.

[3]Numbers in parentheses refer to literature cited.

fungicidal seed treatments and 18 pre-plant soil treatments provided no control; b) PCNB pre-plant soil treatment (4 lb a.i./acre) provided moderate control; c) Among eight fungicides applied at various rates to the soil before planting and sprayed in the crowns later, the following reduced incidence and severity of the disease: methyl-1-(butylcarbamoyl)-2-benzimidizole carbamate (benomyl); PCNB; 5, 6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide (carboxin); and dimethyl 4, 4'-*o*-phenylenebis (3-thioallophanate) (thiophanate-methyl).

In 1971 field experiments described in this report, we continued our studies on the efficacy of soil and crown applications of selected fungicides. We also tested the effect of soil fumigation and ammoniacal nitrogen fertilizer amended with a nitrogen stabilizer on the development of the disease.

Materials and Methods

Field plot technique

In three experiments, we tested separately the following different soil treatments: a) dichloropropene and chloropicrin fumigant; b) ammonium nitrogen fertilizer amended with nitrogen stabilizer; and c) PCNB fungicide. In a fourth experiment, we tested six fungicides applied as crown sprays. These four adjacent experiments were located in a field of Conover loam in Ingham County, Michigan. The commercial sugarbeet variety US H20 was planted in each experiment. After mid-June, plants were thinned, where necessary, to provide one plant/9 in. of row.

The part of the field comprising the three soil treatment experiments had been occupied the previous year by sugarbeet plots with a high incidence of crown and root rot after inoculation with *R. solani.* The residual inoculum from the diseased preceding crop was deemed adequate for initiating infection in our soil treatment plots. The part of the field comprising the crown spray experiment had been occupied by a small grain crop in the previous year; so to insure adequate exposure to the pathogen, we artificially infested the plots with *R. solani.* The fungus had previously been grown in flasks of sorghum grain medium (9). After the inoculum had been dried and lightly ground to separate the kernels, it was applied at the rate of approximately 3 ml/ft of row on 9 June with a hand-operated seeder approximately 3 in. on each side of a row and about ½ in. deep. Two weeks later, two of the four randomized blocks of the experiment received an additional application of inoculum at the rate of 6 ml/ft of row.

Soil fumigation test

In a previous test, dichloropropene (85%) + chloropicrin (15%) soil fumigant controlled Rhizoctonia infection of potato (H. S. Potter,

unpublished data). We accordingly tested a commercial liquid formulation in the present experiment. After the soil had been plowed and disked, the fumigant was applied at 15.3 and 30.1 gal/acre with a tractor-mounted, constant-gravity flow injector equipped with 4 shanks 10 in. deep on 12-in. centers. Immediately after application, the soil was worked with a spring-tooth harrow. Each 9.37 × 130.3 ft plot was planted with 4 rows, spaced 28 in. apart, 30 days after application of the fumigant.

Nitrogen fertilizer and stabilizer test

Nitrogen stabilizers such as 2-chloro-6-(trichloromethyl)pyridine (CTP) prevent the rapid conversion of ammonium nitrogen to nitrate nitrogen that usually occurs in the soil. According to Huber et al. (4), the specific form of nitrogen can affect severity of certain soilborne diseases. Instances are cited in which ammonium nitrogen increased the severity of disease caused by *R. solani*. Papavizas (5) reported decreased survivability of *R. solani* in soil treated with ammonium nitrogen and CTP.

In our study, we tested the effect of an ammonium sulfate fertilizer amended with CTP. The 8-32-16 fertilizer was sidedressed at planting, 2 in. to the side of the row and at approximately the same depth as the seed. The application rate of 1250 lb/acre provided 100 lb of nitrogen/acre, which had been recommended on the basis of soil analysis. CTP previously blended with the fertilizer without CTP, in which, presumably, the ammonium nitrogen was readily converted to the nitrate form. Each plot comprised 4 rows, 19 ft long.

Fungicide soil treatment test

In a previous test (8), PCNB, applied in a 10-in. band along the drill row immediately before planting at 4 lb a.i./acre, reduced the loss in stand from 80% to 65%. In the present experiment, we tested the efficacy of increased dosages of PCNB (8 and 10 lb a.i./acre). An aqueous suspension of the fungicide was applied at 100 gal/acre in a 10-in. band along the drill row. The treated soil was then worked with a rotary hoe to about a depth of 1.5 in. just before planting. Plots of each treatment comprised two rows, each 19 ft long.

Crown spray test

We tested the following fungicides, applied in the crowns: thiophanate methyl; manganous ethylenebis[dithiocarbamate] (maneb); benomyl; PCNB; chlorothalonil; and triphenyltin hydroxide (TPTH). Aqueous suspensions of the fungicides were applied at 65 gal/acre with a hand-operated pressure sprayer. The spray was directed into the crowns and at the bases of the plants while the operator moved down the row at a constant pace.

The first spray was applied on 30 June. Each fungicide was applied three times thereafter at 2-week intervals. Benomyl and PCNB were also applied once thereafter at 2-week intervals and twice at 3-week intervals. The dosages used, in the case of benomyl, maneb, and TPTH, represent the maximum that their registrations permit on sugarbeet. Dosages of the other fungicides, not presently registered for use on sugarbeet, were based on the manufacturers' recommendations. The efficacy of a spreader-regulator spray adjuvant (polyoxyethylene polypropoxypropanol + akyl 2-ethoxyethanol) with benomyl was also tested.

Results and Discussion

Table 1 shows the average numbers of plants/plot in the three soil treatment tests on 3 June (emergence), 22 June (after thinning), and 14 October (harvest). In each test there was a decline in stands, attributable to Rhizoctonia infection. The average stands of the control plots in these three tests declined approximately 39% from mid-June until harvest.

In the soil fumigation and nitrogen-stabilizer tests, there were no significant differences in stands between treated and non-treated controls after the 22 June count. The reason for the significantly higher stand of the .25 lb CTP treatment in the 3 June seedling count was not determined, but was probably not associated with Rhizoctonia control because in subsequent counts the stand difference was no longer apparent. We obtained no evidence that the soil fumigation and nitrogen fertilizer treatments affected incidence and severity of root rot. However, the effect of these treatments under alternative conditions, for example, when applied in the spring instead of the fall, has yet to be determined.

In the fungicide soil treatment test, the 3 June seedling stands of both of the PCNB treatments were significantly lower than those of the untreated control. Evidently the PCNB treatments adversely affected germination or emergence of seedlings. By 22 June, however, the differences in stand between the treated and non-treated plots were no longer apparent, and by harvest time both of the PCNB treatments resulted in stands significantly greater than those of the control.

Root rot incidence and severity associated with the treatments in the fungicide soil treatment test were determined and expressed as numerical ratings (Table 1). The harvest stand counts and root rot ratings show that the PCNB soil treatments significantly reduced Rhizoctonia infection. The 8 lb/acre rate of PCNB was as effective as the 16-lb rate in controlling the disease and provided more control than did a 4-lb rate in a previous test (8).

The effects of the various crown spray treatments on stands and on root rot ratings are shown in Table 2. In the untreated control plots,

Table 1.—Effect of various soil treatments of stand and root rot severity of sugarbeet in field plots infested with *Rhizoctonia solani*.

Experiment No. & type of treatment	Chemical and rate (a.i./acre)	Stand/19 ft of row on indicated date			Root rot rating[a b]
		3 Jun	22 Jun	14 Oct	
1. Fumigant	Dichloropropene (85%) + chlorpicrin (15%), 15.3 gal	78.2	14.1	5.9	--
	Dichloropropene (85%) + chlorpicrin (15%), 30.1 gal	72.8	16.2	8.4	--
	Untreated control	83.8	14.8	8.0	--
	LSD (.05)	n.s.	n.s.	n.s.	--
2. Ammonium nitrogen + nitrogen stabilizer	8-32-16 Fertilizer, 100 lb + CTP, .25 lb	92.7	13.9	8.4	--
	8-32-16 Fertilizer, 100 lb + CTP, .5 lb	76.1	13.3	8.6	--
	8-32-16 Fertilizer, 100 lb control	83.1	14.5	10.3	--
	LSD (.05)	9.0	n.s.	n.s.	--
3. Fungicide	PCNB (2 lb EC), 8 lb	61.8	16.1	12.3	1.8
	PCNB (2 lb EC), 16 lb	58.6	15.3	12.0	1.8
	Untreated control	77.3	12.3	7.8	2.6
	LSD (.05)	14.9	3.2	3.4	0.6

[a]Results in Exp. 1 are based on three replicated plots each comprising 260.6 ft of row; in Exp. 2, six replicated plots each comprising 38 ft of row; and in Exp. 3, four replicated plots each comprising 38 ft of row.
[b]Rating based on a severity index from 0 (no symptoms) to 4 (dead).

the average stand declined almost 50% from mid-June until harvest. Commencing with the 20 July count, there were significant differences in stand between some treatments and control.

Benomyl did not control the disease as it did in two previous tests at considerably higher dosages. The spreader-regulator apparently did not enhance the effectiveness of benomyl. Thiophanate-methyl and maneb also failed to control the disease.

Chlorothalonil, PCNB, and TPTH applications resulted in significantly higher stands and lower root rot ratings than those of the untreated control. Among these treatments, no significant differences were noted. The results with TPTH support previous observations by Finkner et al. (3) concerning reduction of Rhizoctonia damage in field plots sprayed with organo-tin fungicides for control of Cercospora leaf spot disease.

The results show that two sprays of PCNB were as effective as four. But in this regard we must emphasize that there was a noticeable decline in disease activity from early August until harvest. This contrasted markedly with observations in similar tests made during the preceding 3 years when disease activity continued unabated until harvest, with the average stand loss in the untreated control plots almost 90%. The below-average temperatures that prevailed during the latter part of the summer of 1971 may well have reduced the disease activity of Rhizoctonia, which appears to be favored by high temperatures. Under more normal temperatures, two sprays may not have been as effective as four.

The results obtained in the crown spray test indicate the possibility of reducing Rhizoctonia root rot incidence and severity with certain fungicides applied as soil treatments (PCNB) or as crown sprays (chlorothalonil, PCNB, triphenyltin hydroxide). Further testing to determine minimum effective dosages and application frequencies and to seek other materials with control capabilities certainly appears to be warranted on the basis of these tests.

Summary

In field plots infested with *Rhizoctonia solani*, pre-plant applications of PCNB (8 and 16 lb a.i./acre) and crown spray applications of chlorothalonil (1.5 lb), PCNB (2 and 4 lb), and TPTH (.3 lb) significantly reduced incidence and severity of root rot. Two crown applications of PCNB were as effective as four. No control was obtained by soil fumigation with dichloropropene + chloropicrin; by sidedressing of ammoniacal nitrogen fertilizer amended with a nitrogen stabilizer; and by crown applications of benomyl (.25 lb), maneb (1.6 lb), and thiophanate-methyl (1.7 lb). A significant reduction in seedling emergence was associated with 8 and 16 lb/acre of soil applications of PCNB.

Table 2.—Effect of various fungicidal crown sprays on stands and root rot severity of sugarbeet in plots infested with *Rhizoctonia solani*.

Treatment			Stand/19 ft of row on indicated date[a]		% loss in stand 22 June – 15 Oct[a]	Root rot rating[a b]
Fungicide	Dosage lb a.i./acre	No. applications	22 Jun	15 Oct		
Benomyl (50W)	.25	2	22.8	11.8	48.2	2.1
Benomyl (50W) + adjuvant[c]	.25	2	21.3	9.5	55.3	2.5
Benomyl (50W)	.25	3	23.8	13.5	43.3	1.8
Benomyl (50W)	.25	4	19.0	8.5	55.3	2.0
Chlorothalonil (75W)	1.5	4	18.8	16.5	12.2	0.7
Maneb (75W)	1.6	4	20.5	10.8	46.3	2.1
PCNB (2 lb EC)	2.0	2	22.0	16.0	27.3	1.2
PCNB (2 lb EC)	2.0	3	19.3	15.3	20.7	1.1
PCNB (2 lb EC)	2.0	4	21.5	17.0	20.9	1.1
PCNB (2 lb EC)	4.0	3	24.3	16.8	30.9	1.3
Thiophanate methyl (70W)	.7	4	19.5	11.3	42.1	2.0
TPTH (47.5W)	.3	4	20.5	16.0	21.9	1.1
Control			19.0	9.8	48.4	2.2
LSD (.05)			n.s.	5.5		1.0

[a]Results expressed as means of 4 plots, each comprising one row, 19 ft long.
[b]Ratings based on a numerical index ranging from 0 (no symptoms) to 4 (dead).
[c]A spreader-regulator (polyoxyethylene polypropoxypropanol + akyl 2-ethoxyethanol).

Acknowledgments

We gratefully acknowledge the technical assistance provided in certain phases of this investigation by J. W. Chesebro, Agricultural Department, Dow Chemical Co., Midland, Michigan.

Literature Cited

(1) AFANASIEV, M. M. and D. E. BALDRIDGE. 1968. Selection for resistance and chemical control of Rhizoctonia root rot disease of sugarbeets. J. Am. Soc. Sugar Beet Technol. 15:150-158.

(2) AFANASIEV, M. M. and H. E. MORRIS. 1952. Resistance and soil treatments for control of Rhizoctonia of sugarbeet. Proc. Am. Soc. Sugar Beet Technol. 7:562-567.

(3) FINKNER, R. E., D. E. FARUS, and L. CALPOUZOS. 1966. Evaluation of fungicides for the control of Cercospora leaf spot of sugarbeet. J. Am. Soc. Sugar Beet Technol. 14:232-237.

(4) HUBER, D. M., R. D. WATSUN, and G. W. STEINER. 1965. Crop residues, nitrogen and plant disease. Soil Sci. 100:302-308.

(5) PAPAVIZAS, G. C. 1969. Survival of root-infecting fungi in soil XI: Survival of *Rhizoctonia solani* as affected by inoculum concentration and various soil amendments. Phytopathol. Z. 64:101-111.

(6) SCHNEIDER, C. L. and H. S. POTTER. 1968. In Fungicide and Nematacide Tests 24:77. Amer. Phytopathol. Soc.

(7) SCHNEIDER, C. L. and H. S. POTTER. 1969. In Fungicide and Nematacide Tests 25:98-99. Amer. Phytopathol. Soc.

(8) SCHNEIDER, C. L. and H. S. POTTER. 1970. In Fungicide and Nematacide Tests 26:102-103. Amer. Phytopath. Soc.

(9) WHITEHEAD, M. D. 1957. Sorghum grain, a medium suitable for the increase of inoculum for studies of soilborne and certain other fungi. Phytopathology 47:450.