Tests with Fungicides to Control Rhizoctonia Crown Rot of Sugarbeet[1] [2]

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Crown rot disease, incited by the soil-borne fungus, *Rhizoctonia solani* Kuehn, appreciably reduces stands of sugarbeet (*Beta vulgaris*) each year. Control measures presently recommended to growers consist mainly of cultural methods, such as crop rotation. Other means of control to complement cultural control methods, including the use of fungicides, have been investigated (1, 2, 6)[4]. We have reported on the results of screening tests with a large number of fungicides to control crown rot (4, 5, 6). In these tests the following fungicides, applied as crown sprays, significantly reduced crown rot incidence: 5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide, carboxin; methyl 1-(butylcarbamoyl)-2-benzimidizolecarbamate, benomyl; triphenyltin hydroxide, TPTH; pentachloronitrobenzene, PCNB; dimethyl [1,2-phenylene)bis (iminocarbonothioyl)] = bis[carbamate], thiophanate methyl; and tetrachloroisophthalonitrile, chlorothalonil.

In 1972, 1973, and 1974 we conducted additional field tests with most of the above fungicides at rates lower than had previously been used. We also tested additional fungicides, and investigated the use of foam with fungicide sprays. The results of these tests are presented here.

Materials and Methods

Screening Tests

In 1972, 1973 and 1974 we tested 10 fungicides, at varied rates, for effectiveness as crown sprays in plots artificially infested with a crown and root rotting isolate of *R. solani.* Some of the treatments were included in each of the three tests and others were included in one.

The fungicides evaluated were: bis (bimethylthiocarbamoyl) disulfide, thiram; 1,4-dichloro-2,5-dimethoxybenzene, chloroneb; carboxin; benomyl; 2,2,-methylenebis [3,4,6-trichlorophenol], hexachlorophene; PCNB; chlorothalonil; TPTH; and carboxin + thiram.

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[2]This report includes the current status of research on pest control. It does not contain recommendations for use of pesticides nor does it imply that uses discussed have been registered.

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[4]Numbers in parentheses refer to literature cited.

The tests were located on the Botany Farm at the Michigan Agricultural Experiment Station, East Lansing. The preceeding crop in each year had been maize. The plots of commercial sugarbeet variety U.S. H20 were arranged in randomized blocks. Plot length in 1972 and 1973 was 6.1 m and in 1974 was 5.0 m.

The plots were infested with dry whole sorghum grain inoculum of *R. solani* after seedling emergence. The inoculum was drilled 12 mm deep and at a distance of 7 cm on each side of a plant row. In 1972, 1973, and 1974, respectively, plots were infested 33, 26 and 40 days after planting and at rates totaling 23.6, 30.5 and 11.5 cc/m of row. The Rhizoctonia isolate used was the same as that used previously (4, 5, 6).

We applied the fungicide treatments in 561.2 l water/ha (60 gal/acre) with a hand-operated, CO_2-activated sprayer equipped with a single nozzle. The spray was directed into the crowns and at the bases of the plants as the operator walked along the row. The spray application dates were 6 July, 22 July and 16 August in 1972; 5 July, 17 July, and 3 August in 1973; and 11 July, 29 July, and 23 August in 1974. The application rate of each treatment, expressed as active ingredient/acre, is indicated in the Results section and in the appropriate table.

Stand counts were made at time of inoculation. Disease incidence, expressed as the number of plants with crown rot symptoms divided by the number of plants inoculated, was determined at harvest.

Test of fungicides with foam

When a spray containing foam is directed into the lower foliage of a sugarbeet plant, the resultant foam deposit slowly slides down blades and petioles and collects at the base of the plant where, presumably, crown rot infection commonly occurs. Accordingly we conducted a test with four fungicides to determine the effect of foam additive on their efficacy. The fungicide treatments included benomyl, carboxin, chlorothalonil, and TPTH. The foaming agent was a commercially available amphoteric surfactant containing the partial sodium salt of N-lauryl ß-iminodipropionic acid.

The experiment was located in the same field as the 1974 screening test with the same variety and the same plot inoculation techniques. There were four main plots of each fungicide treatment arranged in four randomized blocks. Each main plot comprised two rows, 10.1 m long. One row in each main plot was sprayed with fungicide + foam, whereas the adjoining plot was sprayed with the same fungicide alone.

Treatments were applied with experimental equipment developed at the ARS Agricultural Engineering Laboratory, OARDC, Wooster, Ohio. The sprayer, mounted on the 3-point hitch at the rear of a tractor, applied the foam and the nonfoam treatments at 280.6 l water/ha (30 gal/acre) from the same tank containing water, fungicide and foaming agent. A nozzle positioned directly over each of the paired plots directed a spray downward in a band 20 cm wide. The foaming agent was applied at 2.1

l/ha (0.225 gal/acre) with a foam generator that mixed the fungicide-foaming agent solution with air. The foam was discharged downward from a special nozzle in a conical pattern of small globs with an expansion ratio of about 15 to 1. Spray application dates were 9 and 17 July. Disease incidence was determined on 24 October.

Results

Screening tests

In each test, the first symptoms of crown rot appeared within 14-19 days after application of inoculum. Incipient symptoms appeared throughout the growing season. Plants that had died from crown rot were readily identified at harvest by their persistent withered foliage.

The general level of disease incidence varied considerably from year-to-year. Disease incidence in control plots in 1972, 1973, and 1974 was 19.7, 89.8, and 23.3 percent respectively. These wide variations may be associated with differences in soil moisture that prevailed shortly after inoculum application. In 1972 and 1974, drought-like conditions prevailed at that time; in 1973, soil moisture appeared to be normal and presumably more favorable for initiation of infection. Differences in disease incidence level among the three tests may also be associated with differences in the quantity of inoculum applied each year.

In each screening test, there were treatments that reduced crown rot incidence significantly below that of the control (Table 1), including: benomyl (420 g/ha), carboxin (3.36 kg), chlorothalonil (1.68 kg), TPTH (332.8 g) and PCNB (2.24 kg), as well as carboxin + thiram (840.6 g + 840.6 g). Chloroneb, hexachlorophene, and thiram did not significantly reduce disease incidence. There was no evidence of phytotoxicity associated with any of the treatments.

Test of fungicides with foam

Three of the four entries — carboxin (2.24 kg/ha), chlorothalonil (1.68 kg), and TPTH (332.8 g), significantly reduced crown rot, whereas benomyl (282.2 g) did not (Table 2). In comparison to the control, carboxin with foam significantly reduced crown rot, whereas carboxin alone did not. Foam additive had no significant effect on efficacy of the other fungicides. In the analysis of variance, F values for foam and foam x fungicide interaction were not statistically significant.

Discussion

The results of our tests confirm previous findings on the ability of topical applications of benomyl, chlorothalonil, carboxin, fentin chloride, and PCNB to reduce crown rot. The results with TPTH also confirm observations by Finkner *et al.* (3) on the reduction of crown rot in plots sprayed with organo-tin fungicides to control Cercospora leaf spot.

It should be emphasized that TPTH significantly reduced crown rot

Table 1.—Efficacy of various fungicidal crown sprays in reduction of Rhizoctonia crown rot of sugarbeet.

Fungicide and a.i. rate/ha and (acre).	Crown rot incidence (%)		
	1972[1]	1973[2]	1974[3]
Benomyl 50W, 280.2 g (4 oz)	18.8 b[4]	87.1 bc	45.0 b
Benomyl 50W, 420.3 g (6 oz)	14.4 ab	–	16.5 a
Benomyl 50W, 560.4 g (8 oz)	—	83.0 bc	—
Carboxin 75W, 1.68 kg (1.5 lb)	11.4 ab	82.6 bc	-
Carboxin 75W, 2.24 kg (2.0 lb)	—	—	28.2 ab
Carboxin 75W, 3.36 kg (3.0 lb)	—	75.3 ab	—
Carboxin + thiram 75W, 840.6 g + 840.6 g (12 oz + 12 oz)	3.4 a	—	—
Chloroneb 60W, 2.24 kg (2.0 lb)	11.8 ab	—	—
Chlorothalonil 75W, 1.68 kg (1.5 lb)	3.6 a	—	42.3 b
Chlorothalonil 6F, 1.68 kg (1.5 lb)	—	76.1 abc	—
Chlorothalonil 75W, 2.58 kg (2.3 lb)	—	—	30.7 ab
TPTH 47.5 W, 332.8 g (4.75 oz)	14.8 ab	84.1 bc	11.7 a
Hexachlorophene 20 EC, 146.2 ml (2 oz)	12.8 ab	—	—
PCNB 2 lb EC, 2.24 kg (2 lb)	—	64.6 a	—
Thiram 75W, 1.68 kg (1.5 lb)	13.2 ab	—	—
Control	23.6 b	89.8 c	37.7 b

[1]Means of 5 plots, each 6.1 m long.
[2]Means of 8 plots, each 6.1 m long.
[3]Means of 6 plots, each 5.0 m long.
[4]Entries in the same year followed by the same letter do not differ significantly at the 5% level.

Table 2.—Efficacy of four fungicidal crown sprays, with and without foam, in reduction of Rhizoctonia crown rot of sugarbeet.

Fungicide and a.i. rate/ha and (acre)	Crown rot incidence (%)		
	With foam[1]	Without foam[1]	Fungicide treatment mean
Benomyl 50W, 280.2 g (4 oz)	29.6 bc[2]	23.2 ab	26.4 bc
Carboxin 75W, 2.24 kg (2 lb)	13.6 ab	19.1 ab	16.4 ab
Chlorothalonil 75W, 1.68 kg (1.5 lb)	7.6 a	9.2 a	8.4 a
TPTH 47.5W, 332.8 g (4.75 oz)	17.8 abc	21.3 ab	19.6 ab
Control	33.8 c	37.9 b	35.9 c
Foam treatment mean (control not included)	17.2	18.2	

[1]Means of four plots, 10.1 m long.
[2]Entries followed by same letter do not differ significantly at the 5% level.

when applied at a rate within the limits approved for leafspot control; carboxin, chlorothalonil, and PCNB reduced the disease when applied at rates recommended by their suppliers. Benomyl, conversely was effective only when applied at rates above the 282 g/ha (4 oz/acre) limit approved for leaf spot control.

Our tests demonstrated reduction of crown rot with the combination treatment: carboxin + thiram. The activity of the carboxin component against *Rhizoctonia* has already been shown (4, 5). Thiram alone in the 1972 test did not significantly reduce crown rot.

The results of the tests were variable and inconsistent in that treatments that significantly reduced crown rot in some trials failed to do so in others. On the basis of these trials, recommendation of any of the described treatments as a control measure is not yet warranted. The inconsistent results, on the other hand, indicate a need for more effective ways of applying chemicals that have the potential for controlling crown rot. The use of improved spraying systems and spray adjuvants may be advantageous. Although the foam additive that we tested failed to significantly improve the efficacy of all the fungicide treatments, it did not, on the other hand, impair the efficacy of any. In addition to foaming agent, there are other materials to be considered as aids in the application of sprays for crown rot control, including drift retardants and sticker-spreaders.

Summary

In a series of tests in field plots artificially infested with *Rhizoctonia solani*, fungicides were sprayed at various rates into the crowns and at the bases of the plants. Fungicides showing potential for reducing crown rot incidence included: benomyl (420 g/ha), carboxin (1.68 kg), chlorothalonil (1.68 kg), TPTH (332.8 g), PCNB (2.24 kg), and carboxin + thiram (840.6 g + 840.6 g). Inconsistent and variable control with most of the treatments indicates a need for improved methods of application. A foam additive slightly increased the efficacy of one of four fungicidal sprays with which it was tested.

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