Efficacy of Some Fungicides in Controlling Rhizoctonia Crown Rot of Sugarbeet*

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INTRODUCTION

Crown rot disease, caused by the soil-borne fungus *Rhizoctonia solani* Kuehn causes appreciable economic loss in sugarbeet (*Beta vulgaris* L.) in most areas of the USA where the crop is grown. Symptoms include: yellowing and wilting of the foliage, blackening of petioles, followed by extensive rotting of crown and root, usually culminating in death of the plant.

Cultural control measures have not adequately reduced crown rot losses and cultivars resistant to crown rot are not presently available to growers in all areas. Accordingly, we have investigated the use of fungicides to augment present control measures. In previously reported tests we found six among over 25 proprietary commerical and experimental fungicides, applied topically at various rates and schedules, that significantly reduced crown rot incidence (3,5,6,7). In a series of subsequent tests, from 1980 to 1982, we re-tested the more promising materials - in most cases in different formulations and at

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reduced rates - and tested some other materials for the first time. The results are presented in this report.

METHODS AND MATERIALS

Fungicide treatments - The following fungicides, included in our previous tests (3,5,6,7) were evaluated again: methyl 1-(butylcarbamoyl-2-benzimidazolecarbamate, benomyl; tetrachloroisophthalonitrile, chlorothalonil; pentachloronitrobenzene, PCNB; triphenyltin hydroxide, TPTH; 4-(4-chlorophenoxy)-3, 3-dimethyl-1-(1H-1,2,4-triazol-1-yl)-2-butanone, triadimefon; (dimethyl 4,4'-o-phenylenebis (3-thioallophanate), thiophanate-methyl. Materials tested for the first time included: sulfur; sulfur + copper; 3-(3,5-dichlorophenyl-N-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide, iprodione; N[(chlorophenyl)methyl-N-cyclopentyl-N-phenylurea, pencycuron (proposed name), tested under supplier's designation of Bay NTN 19701. Iprodione and pencycuron have been reported to control *Rhizoctonia* infection in soybeans (1) and cucumbers (8), respectively. Among the entries, the following are already registered for use on sugarbeet to control other diseases: benomyl, TPTH (*Cercospora* leaf spot); PCNB (*Rhizoctonia* seedling blight); sulfur, and sulfur + copper (powdery mildew).

Field plots - The tests were conducted in a field of Conover loam on the Michigan Agricultural Experiment Station, East Lansing, where a two-year navy bean-sugarbeet rotation was followed. Plots of commercial variety, USH20, were arranged in randomized blocks, each plot comprising one 7-m row with 71.1 cm between rows. Planting dates were 22 May 1980, 20 May 1981, and 13 May 1982.

Experimental procedures - Dried grain inoculum of *R. solani* was applied along the rows and into the crowns of all plants on 23 July 1980 (maize kernels), 16 July 1981 (barley), and 6 July 1982 (millet) using with previously described methods (2). After application of inoculum, plants were hilled with cultivation soil in order to enhance the likelihood of infection (4).

Fungicide treatments were applied either as aqueous

sprays (561 liters/ha) or as dry granules. Sprays were applied with a hand-operated, CO_2-activated sprayer, equipped with a single nozzle, and directed into the crown and bases of the plants at 103.4 kPa (15 psi) in a 20-cm band as the operater walked at a constant pace along the row. Granules were similarly applied, shaken from a hand-held cylindrical container. In each test, treatments were applied on two dates: 15 July and 25 August 1980; 15 and 30 July, 1981; 30 June and 20 July, 1982. The first application in each case, applied 1-8 days before inoculation of the plants, served as a protective treatment.

Disease evaluation - Stand counts were made immediately before plots were inoculated. At harvest, roots were dug up, examined, and each graded according to the following

Table 1. Efficacy of various fungicides in controlling Rhizoctonia crown rot of sugarbeet - 1980 test.

Chemical, formulation[a], and rate (kg/ha)	No. plants[b] inoculated	D.I.[bc] 1 October
Chlorothalonil (F), 0.40	18.0 A	1.48 BC
PCNB (W), 0.48	20.5 A	1.58 BC
Sulfur (F), 3.79	17.2 A	1.65 CD
Sulfur + Copper (L), 1.74 + 0.15	16.8 A	1.80 CD
Sulfur + Copper (L), 3.48 + 0.30	20.8 A	2.03 D
TPTH (W), 0.48	19.3 A	1.38 B
Triadimefon (W), 0.02	20.0 A	1.45 BCD
Triadimefon (W), 0.08	19.3 A	1.27 B
Triadimefon (G), 0.04	19.7 A	1.47 BCD
Triadimefon (G), 0.16	18.2 A	0.93 A
Control, untreated	17.3 A	1.83 CD
C.V.(%)[d]	19.4	21.9

[a]Formulations: F = flowable; G = granular; L = liquid; W = wettable powder

[b]Means of 6 replicated plots each comprising one 7-m row. Column means with a letter in common are not significantly different (P=0.05) according to Duncan's Multiple Range Test.

[c]Disease index (DI) = 0 (no symptoms) - 4 (dead).

[d]Coefficient of variation (C.V.) - standard diviation/general mean.

disease severity index: 0 (no symptoms); 1 (light); 2 (moderate); 3 (severe); 4 (moribund or dead). A plot disease index (DI) was computed according to the formula: DI = (no. plants in each class x class number)/no. plants inoculated.

In the 1981 and 1982 tests, additional early DI estimates were made on 7 August and 27 July, respectively, on the basis of above-ground symptoms.

RESULTS AND DISCUSSION

Disease incidence and severity progressively increased from the appearance of first symptoms, about 10 days after inoculation, until harvest. The general level of disease ranged from moderate in 1980 to extremely severe in 1982. In each test significant differences in DI among treatments and between various treatments were noted as early as 17-22 days after inoculation and at harvest (Tables 1, 2, and 3).

Table 2. Efficacy of various fungicides in controlling Rhizoctonia crown rot of sugarbeet - 1981 test.

Chemical, formulation[a], and rate (kg/ha)	No. plants inoculated[b]	D.I.[bc] 7 August	D.I.[bc] 4 November
Benomyl (W), 0.28	16.3 A	0.12 A	2.17 BCD
Benomyl (W), 0.56	18.9 A	0.59 CDE	2.72 EF
Chlorothalonil (F), 1.17	16.0 A	0.21 ABC	2.46 DEF
Chlorothalonil (F), 2.49	15.9 A	0.08 A	2.30 CDE
Iprodione (W), 0.28	17.7 A	0.15 AB	2.13 BCD
Iprodione (W), 0.56	17.7 A	0.05 A	1.92 ABC
PCNB (G), 1.68	18.6 A	0 A	1.86 ABC
PCNB (G), 3.36	18.4 A	0 A	1.68 AB
Thiophanate methyl (F), 0.39	17.1 A	0.83 E	2.55 DEF
Thiophanate methyl (F), 0.59	15.7 A	0.55 BCDE	2.34 CDE
TPTH (L), 0.33	18.1 A	0.17 AB	2.35 CDE
TPTH (L), 0.66	19.9 A	0.04 A	2.20 BCD
Triadimefon (W), 0.07	18.1 A	0.54 BCDE	2.77 EF
Triadimefon (W), 0.28	20.0 A	0.42 ABCD	2.54 DEF
Triadimefon (G), 0.14	18.7 A	0.10 A	2.02 BCD
Triadimefon (G), 0.56	15.3 A	0.02 A	1.50 A
Control, untreated	19.6 A	0.77 DE	2.94 F
C.V.(%)[d]	21.1	124.7	19.5

[a]Formulations: F = flowable; G = granular; L = liquid; W = wettable powder.
[b]Means of 5 replicated plots each comprising one 7-m row. Column means with a letter in common are not significantly different (P=0.05) according to Duncan's Multiple Range Test.
[c]Disease index (DI) = 0 (no symptoms) - 4 (dead).
[d]Coefficient of variation (C.V.) = standard deviation/general mean.

Three of the entries appeared promising in that they consistently reduced crown rot significantly below the level of the control. Chlorothalonil (2.49-2.64 kg/ha), triadimefon granules (0.16-0.56 kg/ha), and TPTH (0.10-

Table 3. Efficacy of various fungicides in controlling Rhizoctonia crown rot of sugarbeet - 1982 test.

Chemical, formulation[a], and rate (kg/ha)	No. plants[b] inoculated	D.I.[bc] 27 July	10 September
Benomyl (W), 0.28	20.2 A	2.62 DE	3.16 GH
Benomyl (W), 0.42	19.6 A	2.73 DE	3.24 GH
Chlorothalonil (F), 1.32	19.2 A	0.98 C	2.41 DEF
Chlorothalonil (F), 2.64	20.4 A	0.83 BC	2.49 DEF
Iprodine (W), 0.28	17.8 A	1.90 D	2.83 EFG
Iprodione (W), 0.56	19.0 A	2.31 DE	2.94 FGH
PCNB (EC), 1.12	17.8 A	2.95 E	3.47 GH
PCNB (EC), 2.24	18.2 A	2.09 DE	2.83 EFG
PCNB (EC), 3.36	17.0 A	2.22 DE	3.06 FGH
PCNB (EC), 4.48	20.0 A	2.37 DE	3.27 GH
Pencycuron (W), 1.12	17.2 A	0.04 A	1.12 BC
Pencycuron (W), 2.24	15.8 A	0.05 A	0.46 A
TPTH (L), 0.33	22.0 A	0.83 AB	1.99 CD
TPTH (L), 0.66	17.2 A	0.95 AB	2.25 DE
Triadimefon (W), 0.14	18.8 A	0.46 AB	2.06 D
Triadimefon (W), 0.28	20.2 A	0.08 AB	1.39 BC
Triadimefon (G), 0.07	18.8 A	1.92 D	3.03 FGH
Triadimefon (G), 0.14	20.0 A	2.61 DE	3.16 GH
Triadimefon (G), 0.21	16.4 A	1.99 D	2.85 EFG
Control, untreated	19.0 A	2.68 DE	3.57 H
C.V.(%)[d]	18.3	39.5	18.8

[a]Formulations: EC = emulsifiable concentrate; F = flowable; G = granular; L = liquid; W = wettable powder.
[b]Means of 5 replicated plots each comprising one 7-m row. Column means with a letter in common are not significantly different (P=0.05) according to Duncan's Multiple Range Test.
[c]Disease index (DI) = 0 (no symptoms) - 4 (dead).
[d]Coefficient of variation (C.V.) = standard deviation/general mean.

0.33 kg/ha) reduced DI to 79-70 percent, 79.8-51.0 percent, and 75.4-55.7 percent of control, respectively. PCNB granules and pencycuron spray treatments are also regarded as promising, but with reservation inasmuch as they were tested but once. Results with pencycuron were outstanding, which at 1.12 and 2.24 kg/ha reduced crown rot to 31 and 13 percent of control. respectively. Further studies toward development of control regimes with the above-mentioned fungicides, appear warranted. Other treatments, including benomyl, iprodione, PCNB (W and EC), thiophanate methyl, triademefon (W), sulfur, and sulfur + copper were either inconsistent in disease control or were not outstanding in performance. Hence these materials are

regarded as having less potential in controlling crown rot than the entries in the first group.

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