RHIZOCTONIA ROOT ROT OF SUGARBEET AS AFFECTED BY RATE AND NITROGEN FERTILIZER CARRIER*

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INTRODUCTION

Sugarbeet (Beta vulgaris L.) crop losses from root rot caused by Rhizoctonia solani Kuhn have been and continue to be of great concern to sugarbeet producers and processors in the U. S. Various sugarbeet cultural practices and conditions have been studied in relation to rhizoctonia root rot. Four- or five-year crop rotations, with cereals or preferably corn preceding sugarbeet, currently is the most common cultural practice for control of this disease. There is no commercially useful chemical control. Hecker and Ruppel reported on development of genetic resistance (2) and utilization of resistance in hybrids (1). Resistant varieties have the potential for greatly reducing losses, but adapted productive resistant varieties are not yet widely available.

Effects of nitrogen (N) fertility on rhizoctonia root rot have been observed and subjected to limited experimentation. Under conditions of natural Rhizoctonia infection, Hills and Axtell (4) in California reported a lower incidence of infection in plots fertilized with any of several forms of N than in nonfertilized plots. Relying on natural infection, Schuster and Harris (7) in Nebraska did not detect an N effect on 3-, 4-, and 6-year rotations, but in 2-year rotations they found significantly more rhizoctonia root rot in their nonfertilized plots. These reports indicate that plants

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Numbers in parentheses refer to literature cited.

provided with adequate N tolerated or avoided Rhizoctonia infection to some degree, probably owing to vigor associated with adequate nutrition. In an inoculated experiment in 1978, Hecker and Ruppel (3) reported no beneficial effects by increasing preplant application of N and side-dressed N from deficient to excess amounts. Therefore, there remains some question about the effect of time of N fertilization and source of inoculum on the incidence of rhizoctonia root rot.

Effects of rates and forms of N on severity of plant diseases are widely recognized (5). Nitrification inhibition with nitrapyrin has been beneficial in reducing losses to some soilborne fungal diseases (5). Nitrapyrin [2-chloro-6-(trichloromethyl) pyridine] is selectively active against Nitrosomonas species which cause a reduction in the rate of nitrification of the applied ammonium form of N.

In our continuing research to identify cultural factors affecting rhizoctonia root rot in beet, we have conducted several field experiments to determine the effects of N quantity, form, nitrification inhibition, and also plant density on intensity of rhizoctonia root rot in sugarbeet and we reported them here.

MATERIALS AND METHODS

Three sprinkler-irrigated field experiments were conducted during 3 years at Fort Collins, Colorado, in which we tested the effect of time of application, quantity, and form of N fertilizer, as well as the effect of a nitrification inhibitor on incidence of rhizoctonia root rot. We conducted a fourth field experiment to test the effect of plant density on infection intensity.

EXPERIMENT 1

This experiment was designed to compare optimum and excess levels of N, all as preplant applications. In a previous experiment, we found no effect of extra side-dressed N on intensity of rhizoctonia root rot in our late-planted inoculated nursery (3). In this split-plot experiment (4 replications, main plots received preplant incorporated applications of 90 and 224 kg N/ha, and sub-plots were planted with Rhizoctonia-resistant, intermediate, and susceptible sugarbeets. There were about 90 kg residual N/ha in the top 60 cm of soil. The experiment was planted May 11 and inoculated July 12, by using the technique of Ruppel et al. (6) where ground barley inoculum was placed in the leaf rosettes.

EXPERIMENT 2

This experiment was designed to test the effect of N on rhizoctonia root rot under simulated commercial conditions. A *Rhizoctonia*-susceptible variety of sugarbeet, Mono Hy D2, was planted in early April in a *Rhizoctonia*-infested area. In addition to the rotted roots of the previous year that were plowed down, about 50 kg/ha of ground barley inoculum was broadcast and incorporated as a preplant application. In a randomized complete block experiment, two N treatments were applied (90 kg N/ha preplant, and 90 kg N/ha preplant combined with 110 kg N/ha side dressed June 4). There was about 120 kg residual N/ha in the top 60 cm of soil.

EXPERIMENT 3

A third experiment was designed to compare nitrate and ammonia forms of N with and without nitrapyrin. A 2 x 3 x 2 factorial experiment (3 replications) was planted April 20 on a *Rhizoctonia*-infested area, similar to the area described in Experiment 2. About 100 kg N/ha in residual nitrate was in the top 60 cm of soil. Two cultivars (a susceptible commercial hybrid, Mono Hy A1, and an intermediately resistant experimental hybrid, Susc. CMS x FC 703), were combined with three N treatments (no applied N, 112 kg N/ha as ammonia sulfate, and 112 kg N/ha as calcium nitrate), and each of these six combinations was combined with nitrapyrin (2.24 kg a.i./ha) or without nitrapyrin. The fertilizers and nitrapyrin were broadcast before planting and incorporated.

EXPERIMENT 4

This experiment was not directly related to the N experiments, but was designed to detect any effect of plant population density (competition) on severity of rhizoctonia root rot. Single-row plots of a resistant and an intermediately resistant cultivar were planted with a common competitor row between each cultivar row. Three within-plot plant spacings were 13, 25, and 38 cm.

The experiment was planted May 14 and inoculated July 14.

All four experiments received normal cultural treatments. In mid-September the roots were lifted and individually rated for amount of rot, with 0 = no infection and 7 = plant dead. A disease index (DI), mean of individual plant ratings, was calculated for each plot. The percentage harvestable roots were those rated 0 to 3; these were roots that were sufficiently sound to be included in a grower's harvest.

RESULTS AND DISCUSSION

EXPERIMENT 1

A preplant soil test for residual N in Experiment 1 detected about 90 kg N/ha as nitrate N in the upper 60 cm. Hence, our 90 kg N/ha preplant application, plus residual N, provided sufficient N for production of a normal crop. The 224 kg N/ha preplant application was in excess of the crop's needs; therefore, in this experiment there was no nitrogen deficient treatment. The data for Experiment 1 show no significant differences between the N treatments made as preplant applications when measured by disease index or percentage harvestable roots, (Table 1). There was, however, a tendency toward more rot in the resistant cultivars with excess N.

Table 1. Disease index (DI) for rhizoctonia root rot and % harvestable roots of two preplant N treatments and three cultivars in a late planted inoculated experiment.

	Preplant application of N					
	90 kg/ha		224 kg/ha		Mean	
Cultivar	DI	% Harvest.	DI	% Harvest.	DI	% Harvest.
FC 703; resistant	3.1 a[a]	61 a	3.4 a	55 a	3.2 a	58 a
FC 801; medium resistant	4.1 b	36 b	4.6 b	25 b	4.4 b	30 b
C 817; susceptible	6.3 c	5 c	6.3 c	4 c	6.3 c	4 c
Mean	4.5±.1	33±3.8	4.8±.1	30±3.8		

[a] Means within columns followed by the same letter are not significantly different (P = 0.05).

EXPERIMENT 2

Under conditions similar to a grower's field, in Experiment 2, where beets were planted early in <u>Rhizoctonia</u>-infested soil, the high N treatment produced significantly more harvestable roots (Table 2). The DI's, however, were not significantly different. The 90 kg N/ha of applied N provided adequate N, whereas 200 kg N/ha was excessive.

Table 2. Disease index (DI) and % harvestable roots of a susceptible sugarbeet hybrid, Mono Hy D2, grown under commercial conditions with preplant and side-dressed N.

Treatment	DI	% Harvestable
90 kg N/ha (all preplant)	6.0 a[a]	10 a
200 kg N/ha (90 kg preplant and 110 kg side dressed)	5.5 a	19 b

[a] Means within columns followed by the same letter are not significantly different (P = 0.05).

EXPERIMENT 3

Under conditions similar to those for commercially grown beets, there was no significant effect on disease intensity due to nitrogen source in beets planted early in Rhizoctonia-infested soil (Table 3). Likewise, nitrapyrin had no significant effect, and there were no significant first-order interactions.

The only significant effects in this experiment were under no nitrapyrin where additional N, either as ammonia or nitrate, had significantly more disease than the treatment where no N was added. This was somewhat contrary to the N response in our second experiment, and to results in the literature (4, 7). This difference did not occur in the nitrapyrin treatment; it does not appear likely to be a nitrapyrin effect. There was a relatively large amount of residual nitrate N in the soil (100 kg N/ha). Thus, in the calcium nitrate treatment, about 212 kg N/ha was available from planting as nitrate N, whereas about 100 kg N/ha as residual nitrate N and 112 kg N/ha as ammonia N were present in the ammonium sulfate treatment. The nitrapyrin would be expected to have reduced the nitrification rate of the ammonium well into the time of infection and disease initiation. This N form difference had no apparent influence on intensity of rhizoctonia rot rot. The total available N in this experiment was adequate for a normal beet crop.

Significant differences did occur between the susceptible and partially resistant cultivars with respective DI's of 4.9 and 3.7 and in % harvestable roots of 32 and 48.

Table 3. Mean disease index (DI) and % harvestable roots for preplant application of N and nitrapyrin treatments on Rhizoctonia-infested soil.

N form and quantity	Nitrapyrin DI	Nitrapyrin % Harvest.	No nitrapyrin DI	No nitrapyrin % Harvest.	Mean DI	Mean % Harvest.
Ammonium sulfate (112 kg N/ha)	4.3 a[a]	40 a	4.7 a	36 b	4.5 a	38 a
Calcium nitrate (112 kg N/ha)	3.9 a	45 a	4.8 a	34 b	4.3 a	40 a
No added N	4.3 a	41 a	3.9 b	45 a	4.1 a	43 a
Mean	4.2±.13	42±1.5	4.5±.13	38±1.5		

[a] Means within columns followed by the same letter are not significantly different.

EXPERIMENT 4

We found no effect of plant population density on incidence of rhizoctonia root rot in Experiment 4 (Table 4). Cultivars were different, but there were no cultivar X spacing interactions. Hence, sugarbeet stand should not be a factor in intensity of Rhizoctonia infestations. We did not test for an interaction of density and nitrogen fertility level, but there is no reason to expect one.

Table 4. Effect of plant population density on severity of rhizoctonia root rot in sugarbeet.

Cultivar	Within row spacing (cm)	Plants per ha	DI	% Harvestable
FC 703 (resistant)	13	140,800	2.6 a[a]	72 a
	25	70,400	3.0 a	59 a
	38	35,200	2.9 a	65 a
Susc. CMS x FC 703 (med. resistant)	13	140,800	4.4 b	24 b
	25	70,400	4.7 b	17 b
	38	35,200	4.4 b	18 b

[a] Means within columns followed by the same letter are not significantly different.

These experiments indicate that quantity and form of available N in the soil has no appreciable and consistent effect on the intensity of rhizoctonia root rot in sugarbeet. In our Experiment 2, there was less rot at the high fertility level as measured by percentage harvestable roots, but in Experiment 3 there was less rot at the low (deficient) N level. Because there were different cultivars involved, this implies a cultivar X N fertility interaction for rhizoctonia root rot intensity. But such an interaction was not present with the cultivars used in our Experiments 1 and 2. There were no N effects associated with the growth of beets in Rhizoctonia-infested soil versus topical inoculation with *R. solani*. The reports of Hills and Axtell (4) and Schuster and Harris (7) had shown more disease when no fertilizer N was added. They did not report the amount of residual N in their soils, but it appears likely that the disease may be more intense in certain genotypes under conditions of N deficiency. If this is true, it is important that beet producers use adequate but not excessive N. There appears to be no evidence that excessive N fertility provides any important or consistent control of rhizoctonia root rot.

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