CONTROL OF RHIZOCTONIA CROWN AND ROOT ROT ON SUGARBEET BY FUNGICIDES IN ROUNDUP READY AND CONVENTIONAL HERBICIDE SYSTEMS

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Rhizoctonia crown and root rot (RCRR), caused by *R. solani* AG 2-2, has been increasing in prevalence in Minnesota and North Dakota in recent years. As a consequence, many questions are being raised about application of fungicides to control the disease. In addition, the introduction of Roundup Ready sugarbeet varieties has led to questions about their susceptibility to RCRR when glyphosate is applied to control weeds compared to conventional varieties treated with microrates of herbicides.

In conventional sugarbeet systems, the fungicides azoxystrobin (Quadris) and prothioconazole (Proline) effectively control RCRR (3,4,7). Information on effectiveness of fungicides in the Roundup Ready sugarbeet systems in field trials is incomplete. Reports by Larson et al. (5) and Hanson et al. (2) from greenhouse trials, showed that an application of Roundup (glyphosate) to Roundup Ready sugarbeet varieties increased RCRR in *Rhizoctonia*-resistant varieties but not in susceptible varieties.

OBJECTIVES

A field experiment was conducted to evaluate the fungicides Quadris and Proline in a Roundup Ready and conventional sugarbeet system for: 1.) efficacy in controlling RCRR and 2.) affects on yield and quality.

MATERIALS AND METHODS

An experiment was established at the University of Minnesota, Northwest Research and Outreach Center, Crookston in a split-plot design with four replications. Main plots were a Roundup Ready sugarbeet variety treated with Roundup (glyphosate) for weed control and a conventional variety treated with microrate herbicides. The Roundup Ready and conventional variety were moderately resistant to RCRR and averaged ratings of 2.7 and 2.5, respectively (6). The experiment was fertilized to obtain maximum yield and sugarbeet quality. Seed was sown on May 31, 2009 at a 2.6-inch spacing (30-ft rows) and thinned on June 24 to the equivalent of 175 plants per 100-ft row. Glyphosate (4.5 lb ae/gal) was applied to the Roundup Ready variety on June 18 and July 6 (24 oz and 32 oz A^{-1}, respectively). Microrate herbicides were applied to the conventional variety on June 13 (0.5 pt Betanex + 1/8 oz UpBeet + 25 ml Stinger + 9 oz Select Max + 1 pt MSO A^{-1}), June 20 (0.5 pt Betanex, 1/8 oz UpBeet, 9 oz Select Max + 1 pt MSO A^{-1}), and July 6 (0.7 pt Betamix, ¼ oz UpBeet, 40 ml Stinger, 12 oz Select Max, 1.25 pt MSO A^{-1}).

When plants were at the 8-leaf stage, main plots were divided into four subplots (six rows wide) for application of fungicides and inoculation with *Rhizoctonia solani* AG 2-2. Subplot treatments were 1.) non-inoculated (no fungicide), 2.) inoculated (no fungicide), 3.) inoculated and treated with Quadris (azoxystrobin), and 4.) inoculated and treated with Proline (prothioconazole) + Induce. Each fungicide was applied on July 13 over the four middle rows of subplots and inoculated with an aggressive isolate of *R. solani* AG 2-2 IIIB within 24 hours. The fungus was grown on sterile barley grain for 3 weeks, air-dried, ground in a Wiley mill, and applied in the four middle rows of subplots with a Gandy applicator that dispensed inoculum over the row and into the crown (28 g of *R. solani*-infested inoculum per 30-ft row). Inoculated rows were cultivated to favor disease development and the following day, 1.38 inches of rainfall occurred.

Two center rows of each treatment were mechanically harvested on October 14, 2009. Twenty roots were arbitrarily selected per subplot and rated for RCRR with a 0 to 7 scale where 0 = root clean and 7 = root 100% rotted and foliage dead. Ten roots were analyzed for yield and quality by the American Crystal Sugar Company Quality Laboratory, East Grand Forks, MN.

Table 1. Efficacy of fungicides in controlling Rhizoctonia crown and root rot and sugarbeet yield and quality in a conventional variety-microrate herbicide system compared to a Roundup Ready-glyphosate system.

Treatment and rate (7-inch band)[w]	Common Name	RCRR (0-7)[x]	% of Non-inoculated control[y] No. harv. root/60 ft	Yield T/A	Sucrose %	Sucrose lb/ton	Sucrose lb/recov./A	Revenue ($/A)
Conventional variety								
Non-inoculated control	No fungicide	2.3 a	100 a	100 a	100	100	100 a	100 a
Inoculated with *R. solani*								
Control	No fungicide	4.3 b	74 b	70 b	94	93	65 b	60 b
Quadris 14.25 fl oz	Azoxystrobin	2.0 a	95 a	97 a	97	97	94 a	90 a
Proline 5.7 fl oz + Induce	Prothioconazole	2.6 a	91 a	96 a	99	99	96 a	95 a
LSD (P=0.05)[z]		0.8			NS	NS		
Roundup Ready variety								
Non-inoculated control	No fungicide	2.2 a	100 a	100 a	100	100	100 a	100 a
Inoculated with *R. solani*								
Control	No fungicide	4.4 b	80 b	80 b	93	93	75 b	68 b
Quadris 14.25 fl oz	Azoxystrobin	2.0 a	99 a	107 a	96	95	102 a	96 a
Proline 5.7 fl oz + Induce	Prothioconazole	2.4 a	102 a	104 a	97	96	100 a	95 a
LSD (P=0.05)[z]		0.6			NS	NS		

[w] Fungicides applied in a 7-inch band on July 13 and within 24 hours, plots were inoculated with *Rhizoctonia solani* AG 2-2 IIIB grown on barley grain and applied over the row with a Gandy applicator (28 g inoculum per 30-ft row).

[x] RCRR = Rhizoctonia crown and root rot, 0 to 7 scale where 0 = root clean and healthy and 7 = root completely rotted and foliage dead.

[y] For each variety, harvest data were calculated based on percent of values for the non-inoculated control.

[z] LSD = Least significant difference, P = 0.05; LSD value provided for disease ratings only; for each variety, columns followed by the same letter are not significantly different; NS = not significantly different.

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Data were subjected to analysis of variance (General Linear Model) and if significantly different (P = 0.05), means were separated by Fisher's protected Least Significant Difference.

RESULTS

Inoculation with *R. solani* AG 2-2 IIIB caused considerable RCRR, which was equally severe in the inoculated controls of the conventional and Roundup Ready systems and averaged 4.3 and 4.4, respectively (Table 1). For both varieties, disease was significantly higher in the inoculated control compared to the equally low disease ratings in the non-inoculated control and in inoculated plots treated with fungicides. Quadris and Proline were equally effective in controlling RCRR, regardless of variety.

Stand and yield of the conventional variety was adversely affected by a herbicide contaminant in the tank during the July 6 application of microrates, which compromised comparison of varieties. Thus, for each variety, data for numbers of harvested roots, yield, quality and revenue per acre were calculated based on percent of the non-inoculated control (Table 1). In the *Rhizoctonia*-inoculated control of the conventional and Roundup Ready systems, there were significantly lower numbers of harvested roots, root yields, sucrose recovery, and revenue compared to the non-inoculated control and inoculated plots treated with fungicides. There were no significant differences among treatments of either variety for percent sucrose or pounds of sucrose per ton.

DISCUSSION

This research trial shows that registered fungicides (Quadris and Proline) are highly effective in controlling RCRR in a conventional variety-microrate system and a Roundup Ready-glyphosate system. Our study was limited by planting only one conventional and one glyphosate-resistant variety and it is possible that variety response to herbicides could differ and result in increases or decreases of RCRR. A report from field experiments in Wyoming (1) indicated that severity of RCRR was affected by glyphosate. On the other hand, Sprague et al. (8) found that weed management strategies in the field did not affect severity of RCRR on four Roundup Ready varieties, but that a combination of plant resistance and fungicides were important in reducing disease severity.

With widespread planting of glyphosate-resistant sugarbeet varieties, and increases in *Rhizoctonia* diseases across the Red River Valley and southern Minnesota, growers with a history of *Rhizoctonia* should implement best management strategies. These include: avoiding bean crops at least one year before sugarbeet, selecting varieties with tolerance to RCRR, planting early, and applying fungicides early (4- to 6-leaf stage) before infections occur.

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