BAND-APPLIED FUNGICIDES TO CONTROL RHIZOCTONIA CROWN AND ROOT ROT

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Rhizoctonia crown and root rot (RCRR) caused by *Rhizoctonia solani* AG 2-2 is an increasingly common and widespread disease of sugarbeet in Minnesota and North Dakota. The disease progresses throughout the season and reduces stands and sucrose yield and quality. Adoption of several practices can reduce RCRR including partially resistant/tolerant varieties, cultural practices (early planting, rotation with cereal crops, etc.), and fungicides.

OBJECTIVES

An experiment was established to determine effectiveness of band applications of fungicides with different chemistries when applied at the 4- leaf and/or at the 8-leaf stage for control of RCRR and on sugarbeet yield and quality.

MATERIALS AND METHODS

Sugarbeet seed of 'Crystal 539RR' (susceptible to RCRR, disease rating = 4.3) was sown 2.6 inches apart (22-inch rows) on May 30, 2009 at the University of Minnesota, Northwest Research and Outreach Center, Crookston. Populations were thinned to the equivalent of 175 plants per 100-ft row on June 23 and then plots were designated for treatments (Table 1). Each treatment plot was 6-rows wide and 30 ft long and arranged in a randomized complete block design of four replicates. The experiment was maintained following standard production practices.

On June 24 (4-leaf stage), four center rows of plots were treated with the fungicides Quadris, Acanto, or LEM17 (full rates) and Moncut (half rate and full-rate) in 7-inch bands with a bicycle sprayer equipped with TeeJet 8002 flat fan nozzles at 13 gallons A^{-1} and 30 psi (Table 1, rates = total applied in bands A^{-1}). Within 24 hours, all fungicide-treated rows were inoculated with *R. solani* AG 2-2 IIIB (grown on sterilized barley grain for 3 weeks, dried, and ground in a Wiley mill). A total of 28 g of *R. solani* inoculum per row was deposited in sugarbeet crowns in the four middle rows with a Gandy granule applicator (setting number 30) by two, 0.65 mile per hour passes; plots then were cultivated to throw soil into crowns and cover inoculum. On July 8, Quadris (full rate) and Moncut (half rate) also were applied to certain plots treated with the same fungicide on June 24 (Table 1), but these plots were NOT re-inoculated with *R. solani*. On July 8, other plots were first treated with Quadris, Moncut, or Carumba (full-rate), when plants were in the 8-leaf stage (Table 1); these plots and a control were inoculated with *R. solani* AG 2-2 IIIB within 24 hours, as previously described. Treated rows were cultivated to throw soil into crowns and favor development of RCRR. In another set of plots treated with Quadris at the 4-leaf stage, a broadcast application of Proline + Induce was made on August 14 when rows closed (to protect against Cercospora leaf spot [CLS] and for secondary control of RCRR. Remaining plots were treated with a broadcast application of Eminent for CLS control.

Stand counts were made in the two middle rows of plots on July 7, 10, 21, 29, and August 4 (= 13, 16, 27, 35, and 41 days after inoculation [DAI], respectively). Two center rows of each treatment were mechanically harvested on October 13, 2009. Twenty roots were arbitrarily selected per plot 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.

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

***R. solani* inoculated at 4-leaf stage**. Stands were the same on June 24 when treatments were applied at the 4-leaf stage (Fig. 1). By July 7 (13 DAI), significant stand loss had occurred in the *Rhizoctonia*-inoculated check compared

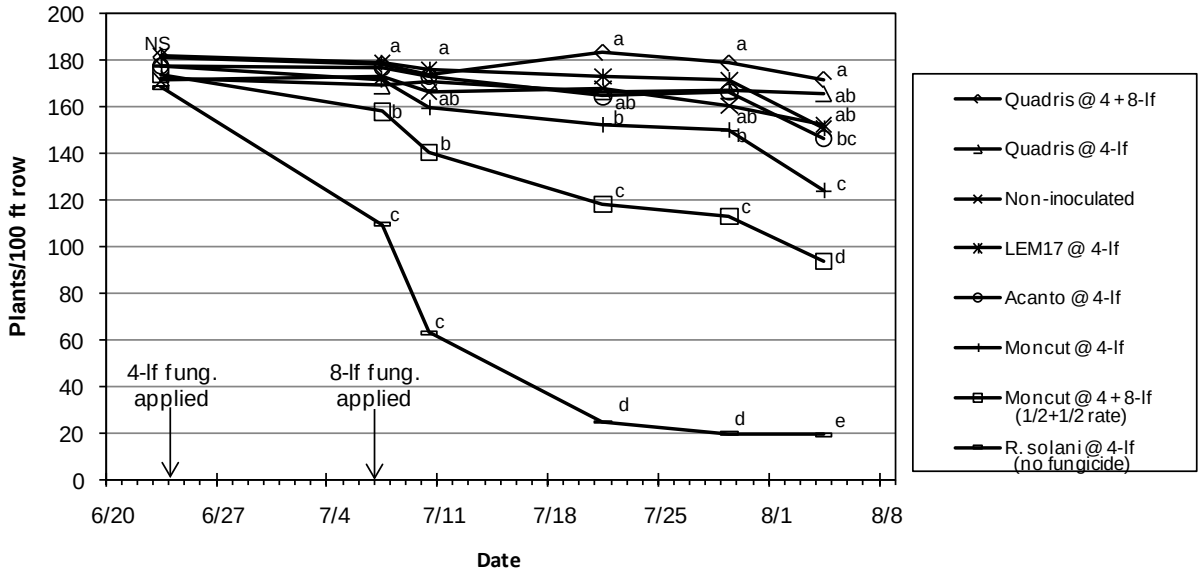

Fig. 1. Sugarbeet stands in plots treated with fungicides (fung.) in a 7-inch band on June 24, 2009 (plants at the 4-leaf stage) and inoculated with *Rhizoctonia solani* AG 2-2 within 24 hours at 28 g per 30-ft row; there were two checks (non-inoculated and another inoculated with *R. solani*). A second, full rate of application of Quadris and a half-rate application of Moncut were made at the 8-leaf stage.

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to all fungicide treatments and the non-inoculated check. The half-rate application of Moncut also suffered some stand loss, and had significantly lower stand than the other fungicides and the non-inoculated check. Minor to significant losses in plant populations occurred throughout the season, depending upon the treatment. By August 4 (41 DAI), the non-inoculated check had lost only 10% stand and the inoculated check had lost 88%. All fungicide treatments had significantly higher plant populations than the *R. solani*-inoculated check, but there were differences in effectiveness among fungicides. Treatment with Quadris (4-leaf stage, 4- and 8-leaf stage), LEM17, and Acanto resulted in excellent stands that were the same as the non-inoculated check and were significantly higher than Moncut. The full-rate of Moncut applied at the 4-leaf stage had significantly higher stands than split rates of Moncut (applied at the 4- and 8-leaf stages).

At harvest (Table 1, see section under "*R. solani* inoculated at 4-leaf stage"), ratings for RCRR were significantly lower for most fungicide treatments compared to the *Rhizoctonia*-inoculated check. All Quadris treatments had RCRR ratings equal to the non-inoculated check and were significantly lower than other fungicide treatments. Ratings for RCRR were highest for the split and full rates of Moncot and were the same as the inoculated check; RCRR was intermediate for Acanto and LEM 17, which were equal.

By harvest, plant stands and root and sucrose yields were significantly higher for all fungicides compared to the inoculated check (Table1). Among fungicide treatments, stands and yields were equally high for all treatments with Quadris and the non-inoculated check; lowest for the full and split rates of Moncut; and intermediate for Acanto and LEM17, which were equal. A broadcast application of Proline at row closure following treatment with Quadris at the 4-leaf stage did not reduce RCRR or increase numbers of harvested roots or yields above a single application of Quadris at the 4-leaf stage (Table 1).

R. solani inoculated at 8-leaf stage. Severity of RCRR, harvested stand, and root and sucrose yields were similar for fungicide-treated plots inoculated at the 4- or 8-leaf stages but not in the inoculated checks where harvested stand and root and sucrose yields were higher for the 8-leaf inoculation than for the 4-leaf inoculation (Table 1). For plants inoculated at the 8-leaf stage (Table 1, see section under "*R. solani* inoculated at 8-leaf stage"), the best yields and lowest RCRR ratings were in plots treated with Quadris (equal to the non-inoculated check) compared to the other fungicides and the inoculated check. Yields were equally low and RCRR ratings high in plots treated with Carumba and the inoculated check and were intermediate for plots treated with a full rate of Moncut.

Table 1. Effect of fungicides when product and *Rhizoctonia solani* were applied at the 4- and/or 8-leaf stage for controlling disease and for sugarbeet yield and quality.

Treatment, rate (product/A), timing[w]	Group name (common name)[x]	RCRR (0-7)[y]	No. harvested roots/60-ft row	Yield T/A	Sucrose %	Sucrose lb/T	Sucrose lb recov./A
Non-inoculated check (no fungicide)		1.6	97	32.4	14.7	265	8,496
R. solani inoculated @ 4-leaf stage							
Check (no fungicide)		6.5	16	9.4	12.2	202	1,922
Quadris 2.08SC (14.25 fl oz) A	QoI (azoxystrobin)	1.7	99	34.1	15.3	279	9,508
Quadris 2.08SC (14.25 + 14.25 fl oz) A + B	QoI (azoxystrobin)	1.6	99	34.7	14.5	260	9,044
Quadris 2.08SC (14.25 fl oz) A + Proline 480SC (5.7 fl oz) + Induce (0.125%)	QoI (azoxystrobin) + DMI (prothioconazole)	1.7	101	33.9	14.2	253	8,583
Acanto 250SC (1.3 fl oz) A	QoI (picoxystrobin)	4.2	68	23.2	13.9	244	5,784
LEM 17EC (1.6 fl oz) A	Carboximides (penthiopyrad)	4.1	72	26.7	13.5	237	6,523
Moncut 70-DF (1.1 lb) A	Carboximides (flutolanil)	5.7	42	18.6	13.2	231	4,272
Moncut 70-DF (0.55 + 0.55 lb) A + B	Carboximides (flutolanil)	5.6	42	19.4	13.4	234	4,595
R. solani inoculated @ 8-leaf stage							
Check (no fungicide)		5.8	62	20.7	12.9	217	4,533
Quadris 2.08SC (14.25 fl oz) B	QoI (azoxystrobin)	2.4	96	34.8	14.6	262	9,113
Moncut 70-DF (1.1 lb) B	Carboxamides (flutolanil)	4.3	81	28.1	13.1	228	6,434
Carumba 90 G/L SL (14 fl oz) B	DMI (metconazole)	5.0	75	23.9	13.6	238	5,712
LSD (*P*=0.05)[z]		0.8	14	6.0	1.0	24	1,656

[w] Fungicides applied in a 7-inch band; A = first date of application when plants were in the 4-leaf stage (July 24); B = second date of application when plants were in the 8 to 10-leaf stage (July 8). All plants in the four middle rows of six-row plots were inoculated with ground barley grain inoculum of *R. solani* AG 2-2 IIIB (28 g per 30 ft row) within 24 hr after fungicide application. Proline was applied as a broadcast fungicide for control of Cercospora leaf spot on August 14, and remaining plots were treated with a broadcast application of Eminent.

[x] QoI = Quinone outside Inhibitors; DMI = DeMethylation Inhibitors.

[y] RCRR = Rhizoctonia crown and root rot, 0-7 scale, 0 = root healthy, 7 = root completely rotted and foliage dead.

[z] LSD = Least Significant Difference, *P*=0.05.

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DISCUSSION

RCRR was severe enough to discern differences among fungicides applied at the 4- and/or 8-leaf stage of sugarbeet development. Fungicides applied at the 4-leaf stage appeared to be effective in controlling RCRR for the remainder of the growing season. By harvest, RCRR ratings were statistically the same in checks inoculated at the 4- or 8-leaf stages (ratings averaged 6.5 and 5.8, respectively) although yields were higher when inoculated at the 8-leaf stage because there was less time for disease to develop. Quadris was the most effective fungicide in controlling RCRR, regardless of time of application, and a single application was just as effective as two. Other fungicides (except Carumba) applied at the 4- and/or 8-leaf stage provided some protection from RCRR and provided increases in root and sucrose yield compared to the inoculated checks. Carumba applied at the 8-leaf stage had RCRR, harvest stand, and root and sucrose yields not significantly different from the inoculated check.

Broadcast application of Proline (which has activity against *R. solani*) at canopy closure for control of Cercospora leaf spot did not provide additional protection from RCRR. This is because the previous application of Quadris at the 4-leaf stage was highly effective in controlling RCRR. Thus, the proposed benefit of this combination was not supported by our data.

ACKNOWLEDGEMENTS

We thank American Crystal Sugar Co., Moorhead, MN for providing seed; BASF Corporation, Bayer CropScience, DuPont Crop Protection, Gowan Co. LLC, and Syngenta for providing products and grants-in-aid; University of Minnesota, Northwest Research and Outreach Center, Todd Cymbaluk and Jeff Nielsen for plot maintenance and student workers Chloe Danielson, Jackie Reitmeier, Katie Baird, and Chelsie Solheim for technical assistance; and American Crystal Sugar Co., East Grand Forks, MN for quality analysis.