EVALUATION OF AT-PLANTING FUNGICIDE TREATMENTS FOR CONTROL OF *RHIZOCTONIA SOLANI* ON SUGARBEET

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Rhizoctonia damping-off and crown and root rot (RCRR) caused by *Rhizoctonia solani* AG 2-2 have been the most common root diseases on sugarbeet in Minnesota and North Dakota for several years (2-4, 6,7, 11). Disease can occur throughout the growing season and reduce plant stand, root yield, and quality (5). Warm and wet soil conditions favor infection. Disease management options include rotating with non-host crops (cereals), planting partially resistant varieties, planting early when soil temperatures are cool, improving soil drainage, and applying fungicides as seed treatments, in-furrow (IF), and/or postemergence. An integrated management strategy should take advantage of multiple control options to reduce Rhizoctonia crown and root rot (5).

OBJECTIVES

A field trial was established to evaluate various at-planting fungicide treatments (seed treatment and in-furrow) for 1) control of early-season damping-off and RCRR and 2) effect on plant stand, yield and quality of sugarbeet.

MATERIALS AND METHODS

The trial was established at the University of Minnesota, Northwest Research and Outreach Center (NWROC), Crookston. Field plots were fertilized for optimal yield and quality. A moderately susceptible variety (Crystal 572RR) with a 2-year average Rhizoctonia rating of 4.5 (13) was used. Treatments were arranged in a randomized complete block design with four replicates. Seed treatments and rates are summarized in Table 1 and were applied by Germains Seed Technology, Fargo, ND. In-furrow fungicides (Table 1) (in 3 gal water) and starter fertilizer (3 gallons 10-34-0) were applied down the drip tube in 6 gallons total volume A^{-1}. The untreated control included no Rhizoctonia active seed or in-furrow fungicide treatment at planting. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley (40 kg/ha) by hand-broadcasting in plots, and incorporating with a Rau seedbed finisher. The trial was sown in six-row plots (22-inch row spacing, 25-ft rows) on May 15 at 4.5-inch seed spacing. Counter 20G (8.9 lb A^{-1}) was applied at planting and Lorsban (2 pt A^{-1}) was applied June 11 for control of sugarbeet root maggot. Glyphosate (4.5 lb product ae/gallon) was applied on June 4 (22 oz/A) and June 24 (28 oz/A) and Sequence (glyphosate + S-metolachlor, 2.5 pt/A) was applied on June 13 for control of weeds. Cercospora leafspot was controlled by Minerva Duo (16 fl oz/A) on August 1 and Supertin + Topsin M (6 + 10 oz/A) on August 21 applied in 20 gallons water/A at 100 psi.

Stand counts were done beginning ~2 weeks after planting through 7 weeks after planting. The trial was harvested on September 19. Data were collected for number of harvested roots, yield, and quality. Twenty roots per plot also were arbitrarily selected and rated for severity of RCRR using a 0 to 7 scale (0 = healthy root, 7 = root completely rotted and foliage dead). Disease incidence was reported as the percent of rated roots with a root rot rating > 2. Data were subjected to analysis of variance using SAS Proc GLM (SAS Institute, Cary, NC). Treatment means were separated using Fisher’s protected least significant difference (LSD) test at a 0.05 level of significance. Orthogonal contrasts were used to compare seed treatment versus in-furrow fungicides and seed treatment and in-furrow fungicides versus the untreated control.

Table 1. Application type, product names, active ingredients, and rates of fungicides used at planting in a field trial for control of *Rhizoctonia solani* AG 2-2 on sugarbeet. Standard rates of Allegiance + Thiram and 45 g/unit Tachigaren were on all seed. In-furrow fungicides in 3 gal water mixed with 3 gal 10-34-0 were applied down the drip tube in a total volume of 6 gal/A.

Application	Product	Active ingredient	Rate[Y]
None	-	-	-
Seed	Kabina ST	Penthiopyrad	14 g a.i./unit seed
Seed	Metlock Suite + Kabina ST	Metconazole + Rizolex + Penthiopyrad	0.21 + 0.5 + 7 g a.i./unit seed
Seed	Metlock Suite + Vibrance	Metconazole + Rizolex + Sedaxane	0.21 + 0.5 + 1.0 g a.i./unit seed
Seed	Systiva	Fluxapyroxad	5 g a.i./unit seed
Seed	Vibrance	Sedaxane	1.5 g a.i./unit seed
Seed + in-furrow	Kabina ST + Quadris	Penthiopyrad + azoxystrobin	14 g a.i./unit + *6 fl oz prod A^{-1}
In-furrow	AZteroid	Azoxystrobin	5.7 fl oz product A^{-1}
In-furrow	Quadris	Azoxystrobin	9.5 fl oz product A^{-1}
In-furrow	Xanthion	Pyraclostrobin + *Bacillus amyloliquefaciens*	9.0 + 1.8 fl oz product A^{-1}
In-furrow	Elatus[Z]	Azoxystrobin + Benzovindiflupyr	7.1 oz product A^{-1}
In-furrow	Proline	Prothioconazole	5.7 fl oz product A^{-1}
In-furrow	Propulse	Fluopyram + prothioconazole	13.6 fl oz product A^{-1}

[Y] 5.7 fl oz AZteroid, 6 and 9.5 fl oz Quadris contain 67, 44 and 70 g azoxystrobin, respectively; 9 + 1.8 fl oz Xanthion contains 67 g pyraclostrobin + ~1.2 x 10^{12} viable spores of *Bacillus amyloliquefaciens* strain MBI 600; 7.1 oz Elatus contains 61 g azoxystrobin and 30 g benzovindiflupyr; 5.7 fl oz proline contains 81 g prothioconazole; 13.6 fl oz Propulse contains 80 g each of fluopyram and prothioconazole

[Z] Elatus is not currently registered for use on sugarbeet

* Quadris rate is less than minimum labeled rate of 9.5 fl. oz product/A, only included for research purpose

RESULTS AND DISCUSSION

Emergence in plots with Rhizoctonia seed treatment fungicides was similar to the untreated control. By 3 weeks after planting, emergence was mostly completed and stands were greater than 200 plants per 100 ft of row (Fig. 1). Emergence in plots with in-furrow fungicides was reduced compared with the seed treatments and untreated control with just over 180 plants per 100 ft of row at 3 weeks after planting (Fig. 1). Stand was significantly lower during the 7-week stand count period for in-furrow treatments compared with seed treatments. It is not unusual for stand establishment to be reduced for in-furrow fungicides compared to seed treatments at this location if planting is followed by dry conditions. After 3 weeks, stand remained steady for plots with seed treatment or in-furrow fungicides, but declined slightly in the untreated control plots, indicating very low disease pressure from *R. solani*. Lack of disease pressure during the period after emergence when seedlings are very susceptible to Rhizoctonia damping-off was likely due to low soil moisture. Rainfall at the NWROC for the months of May and June was 1.38 and 1.39 inches, respectively, compared to 30-year averages of 2.83 and 4.05 inches for the same months. Stand establishment at 7 weeks after planting for individual treatments is shown in Table 2. Stand was highest for plots with seed treatment fungicides and the untreated control, lowest for plots receiving AZteroid or Quadris in-furrow, and intermediate for plots with Kabina ST plus the 6 fl oz rate of Quadris and plots receiving Xanthion, Elatus, Proline, or Propulse in-furrow (Table 2). It appears that the lower rate of Quadris with an effective Rhizoctonia seed treatment may be a possible way to reduce stand loss. However, the efficacy of this treatment combination could not be evaluated in this trial because of lack of disease pressure. It is also important to know that certain isolates of *R. solani* AG 2-2 have low sensitivity to Quadris on artificial media (1,13), and still can be managed with labeled field rates of Quadris under greenhouse conditions (1).

Rainfall was much higher during the months of July through September but disease pressure remained low and variable throughout the trial area. The number of harvested roots was not significantly different among treatments (Table 2). Rhizoctonia crown and root rot ratings and incidence were significantly lower for in-furrow treatments compared to seed treatments (Table 2). Among individual treatments, all seed treatments were statistically similar to the untreated control while all in-furrow fungicides except Proline had lower disease ratings and incidence compared to the untreated control (Table 2). Root and sucrose yields were not significantly different among treatments. Root yields ranged from 22.4 to 25.4 ton A^{-1} and percent sucrose ranged from 17.2 to 18.0 %. Lack of significant differences for root and sucrose yield in 2019 is similar to 2017 and 2018 when late-season disease pressure was low but in contrast with typical years with higher disease pressure, where in-furrow fungicides resulted in lower root rot ratings and higher yields at harvest compared to seed treatments (8-10).

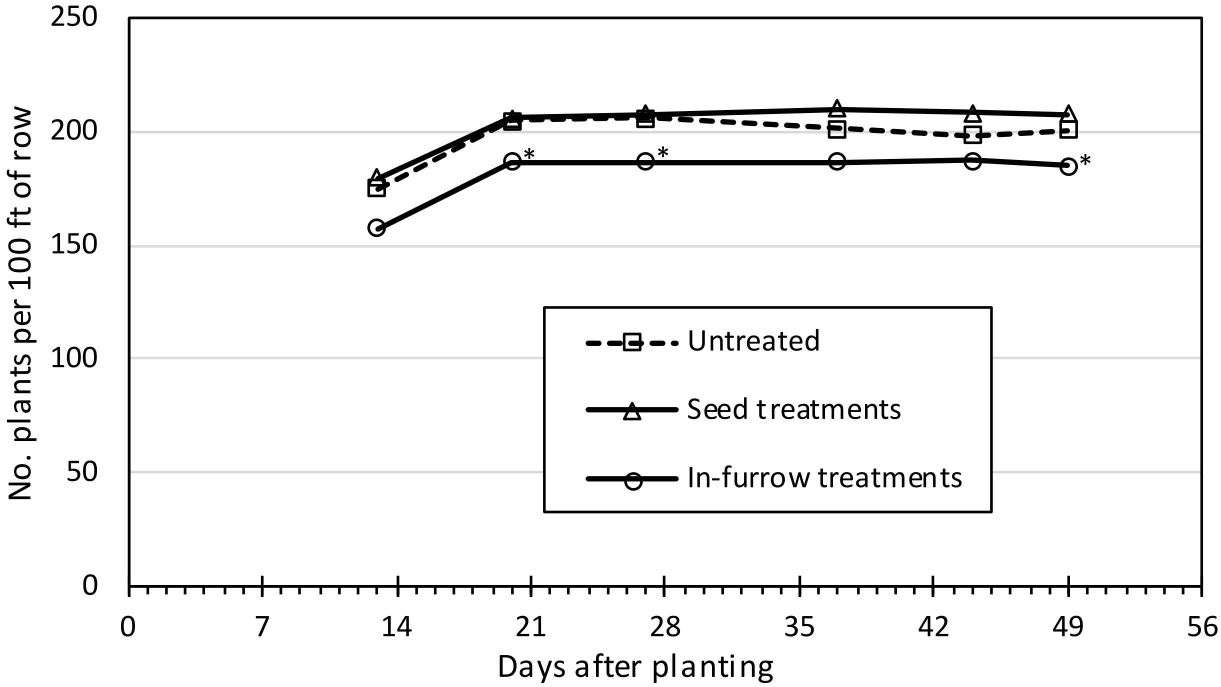

Fig. 1. Emergence and stand establishment for seed treatment and in-furrow fungicides compared to an untreated control in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2. For each stand count date, symbols marked with an asterisk indicate stands significantly (P = 0.05) different than the untreated control (dotted line).

Table 2. Effects of at-planting (seed treatment or in-furrow) fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a *Rhizoctonia*-infested field trial at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

						Sucrose[V]		
Treatment	7-wk stand Plants/100 ft[V]	No. harv. Roots/100 ft[V]	RCRR (0-7)[VW]	RCRR % incidence[VX]	Yield[V]	%	lb ton^{-1}	lb A^{-1}
Untreated control	201 abcd	168	1.6	35	23.7	17.2	322	7640
Kabina ST	212 ab	189	1.3	30	23.1	17.5	330	7630
Met. Suite + 7 g Kabina	218 a	181	1.6	38	24.1	17.6	331	7999
Met. Suite + 1 g Vibrance	202 abcd	167	1.2	29	22.5	17.4	325	7305
Systiva	207 abc	176	1.9	39	22.7	17.4	328	7459
Vibrance	201 abcd	181	1.1	24	25.4	17.4	328	8349
Kabina ST + *Quadris I-F 6 oz I-F	195 bcde	177	0.5	10	23.5	18.0	341	8023
AZteroid in-furrow	176 e	160	0.5	10	24.3	17.9	338	8209
Quadris in-furrow	177 e	155	0.4	9	22.4	17.6	331	7421
Xanthion in-furrow	195 bcde	168	0.7	15	23.1	17.3	323	7462
Elatus in-furrow[Y]	193 cde	172	0.5	13	25.4	17.8	335	8508
Proline in-furrow	186 de	168	1.3	29	24.9	17.3	325	8096
Propulse in-furrow	184 de	159	0.3	10	22.5	17.3	324	7267
ANOVA P-value	0.0012	0.3679	0.0002	<0.0001	0.5026	0.4473	0.3846	0.3722
LSD (P = 0.05)	19.2	NS	0.7	14.9	NS	NS	NS	NS
Contrast analysis[Z] Seed vs in-furrow								
Mean of Seed trts.	208	177	1.4	32	23.6	17.5	329	7748
Mean of In-furrow trts.	185	163	0.6	14	23.8	17.5	329	7827
P-value	<0.0001	0.0183	<0.0001	<0.0001	0.7623	0.7095	0.8143	0.7438

[V] Values represent mean of 4 plots, values within a column followed by same letter(s) are not statistically significant at P = 0.05, NS = not significantly different

[W] RCRR = Rhizoctonia crown and root rot; 0-7 scale, 0 = root clean, no disease, 7 = root completely rotted and plant dead

[X] RCRR = Rhizoctonia crown and root rot; percent of roots with rating > 2

[Y] Elatus is not currently registered for use on sugarbeet

[Z] Contrast analysis of seed versus in-furrow fungicides does not include untreated control or treatment with both Kabina ST and Quadris in-furrow

* Quadris rate is less than minimum labeled rate of 9.5 fl. oz product/A, only included for research purpose

ACKNOWLEDGEMENTS

We thank the Sugarbeet Research and Education Board of Minnesota and North Dakota for funding this research; BASF, Bayer, Mitsui Chemicals Agro, Inc., Syngenta, Valent, and Vive Crop Protection for providing products; Crystal Beet Seed for providing seed; Germains Seed Technology for treating seed; the University of Minnesota, Northwest Research and Outreach Center, Crookston for providing land, equipment and other facilities; Jeff Nielsen for plot maintenance; Derefaa Cline, Austin Lien, and Muira MacRae for technical assistance; American Crystal Sugar Company, Moorhead, MN for sugarbeet quality analysis.

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