EVALUATION OF AT-PLANTING FUNGICIDE TREATMENTS FOR CONTROL OF *RHIZOCTONIA SOLANI* ON SUGARBEET IN 2021

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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 (1-3, 5,6, 10). Disease can occur throughout the growing season and reduce plant stand, root yield, and quality (4). 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 (4).

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 803RR) with a 2-year average Rhizoctonia rating of 4.8 (12) was used. Treatments were arranged in a randomized complete block design with four replicates. Seed treatments and rates are summarized in Tab. 1 and were applied by Germains Seed Technology, Fargo, ND. In-furrow fungicides (Tab. 1) (mixed in 3 gal water) mixed with starter fertilizer (3 gallons 10-34-0) were applied down the drip tube in 6 gallons total volume/A. The untreated control included no Rhizoctonia effective 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 (50 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 10 at 4.5-inch seed spacing. Counter 20G (8.9 lb/A) was applied at planting and Lorsban (2 pt/A) was applied June 08 for control of sugarbeet root maggot. For the control of weeds, glyphosate (4.5 lb ae/gallon, 28 fl oz/A) was applied on June 02, and Sequence (glyphosate + S-metolachlor, 2.5 pt/A) with additional glyphosate (8 fl oz/A) was applied on June 15 and June 29. Cercospora leaf spot was controlled by Provysol + Manzate Max (4 fl oz + 1.5 qt/A) on July 12, Supertin + Topsin M (8 + 10 fl oz/A) on July 27, and Minerva + Manzate Pro-Stick (13 fl oz + 2 lbs/A) on Aug 17.

Plant stands were evaluated beginning 15 days after planting (May 25) through 42 days after planting (Jun 22) by counting the number of plants in the center two rows of each plot. Data were collected for root rot severity, number of harvested roots, and yield at harvest. On Sept 24, plots were defoliated and the center two rows of each plot were harvested mechanically and weighed for root yield. Twenty roots per plot also were arbitrarily selected and root surfaces were rated for the severity of Rhizoctonia crown and root rot (RCRR) using a 0 to 10 scale with 10% incremental increase per each unit of rating (0 = healthy root, 10 = root completely rotted). Disease incidence was reported as the percent of rated roots with > 0% of rot on the root surface. Ten representative roots from each plot were analyzed for sugar quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. 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 (FRAC Group)	Rate[Y]
None	-	-	-
Seed	Kabina ST	Penthiopyrad (7)	14 g a.i./unit seed
Seed	Systiva	Fluxapyroxad (7)	5 g a.i./unit seed
Seed	Vibrance	Sedaxane (7)	1.5 g a.i./unit seed
Seed	Zeltera	Inpyrfluxam (7)	0.1 g a.i./unit seed
In-furrow	AZteroid FC 3.3	Azoxystrobin (11)	5.7 fl oz product/A
In-furrow	Quadris	Azoxystrobin (11)	9.5 fl oz product/A
In-furrow	Xanthion	Pyraclostrobin (11) + *Bacillus amyloliquefaciens* (BM02)	9.0 + 1.8 fl oz product/A
In-furrow	Elatus	Azoxystrobin (11) + Benzovindiflupyr (7)	7.1 oz product/A
In-furrow	Proline	Prothioconazole (3)	5.7 fl oz product/A
In-furrow	Propulse	Fluopyram (7) + Prothioconazole (3)	13.6 fl oz product/A
In-furrow	Priaxor	Fluxapyroxad (7) + Pyraclostrobin (11)	6.7 fl oz product/A

[Y] 5.7 fl oz AZteroid FC 3.3 and 9.5 fl oz Quadris contain 56 and 58 g azoxystrobin, respectively; 9 + 1.8 fl oz Xanthion contains 56 g pyraclostrobin + ~1.2 x 10^{12} viable spores of *Bacillus amyloliquefaciens* strain MBI 600; 7.1 oz Elatus contains 60 g azoxystrobin and 30 g benzovindiflupyr; 5.7 fl oz Proline contains 67 g prothioconazole; 13.6 fl oz Propulse contains 67 g each of fluopyram and prothioconazole; 6.7 fl oz Priaxor contains 27 g fluxapyroxad and 55 g pyraclostrobin

RESULTS AND DISCUSSION

Early part of the 2021 growing season was very dry at this site during the period of May-June resulting in none to low early season disease pressure. Rainfall was 0.95 in. during the month of May and 1.65 in. during the month of June compared to a 30-year average of 2.79 and 3.92 in., respectively. These dry conditions resulted in less than optimal stands of 141 plants per 100 ft. row averaged across all treatments in this trial at 28 days after planting (DAP). There could be possible stand reduction from use of 10-34-0 starter fertilizer under these dry conditions. There were significant ($p \leq 0.05$) differences among treatments for plant stands at 22, 28, 35 and 42 days after planting (DAP) (Fig. 1). Nevertheless, the differences were generally small and there was no difference in stands among treatments by harvest. Zeltera seed treatment and Xanthion in-furrow had higher stands numerically over the time period. Among all treatments, Systiva had lowest recoverable sugar T^{-1}. When seed treatments and in-furrow fungicides were compared as two groups, stands at 22 and 28 DAP were significantly higher for seed treatments compared to in-furrow fungicides. For harvest parameters, % sugar and recoverable sugar T^{-1} were higher for in-furrow fungicides compared to seed treatments. There was no difference among treatments for other harvest parameters. Similar results were obtained in 2016, 2017 and 2019 (7-9). Lack of sufficient early-season soil moisture resulted poor establishment of Rhizoctonia inoculum in soil and subsequently resulted in very low disease pressure throughout the season in 2021.

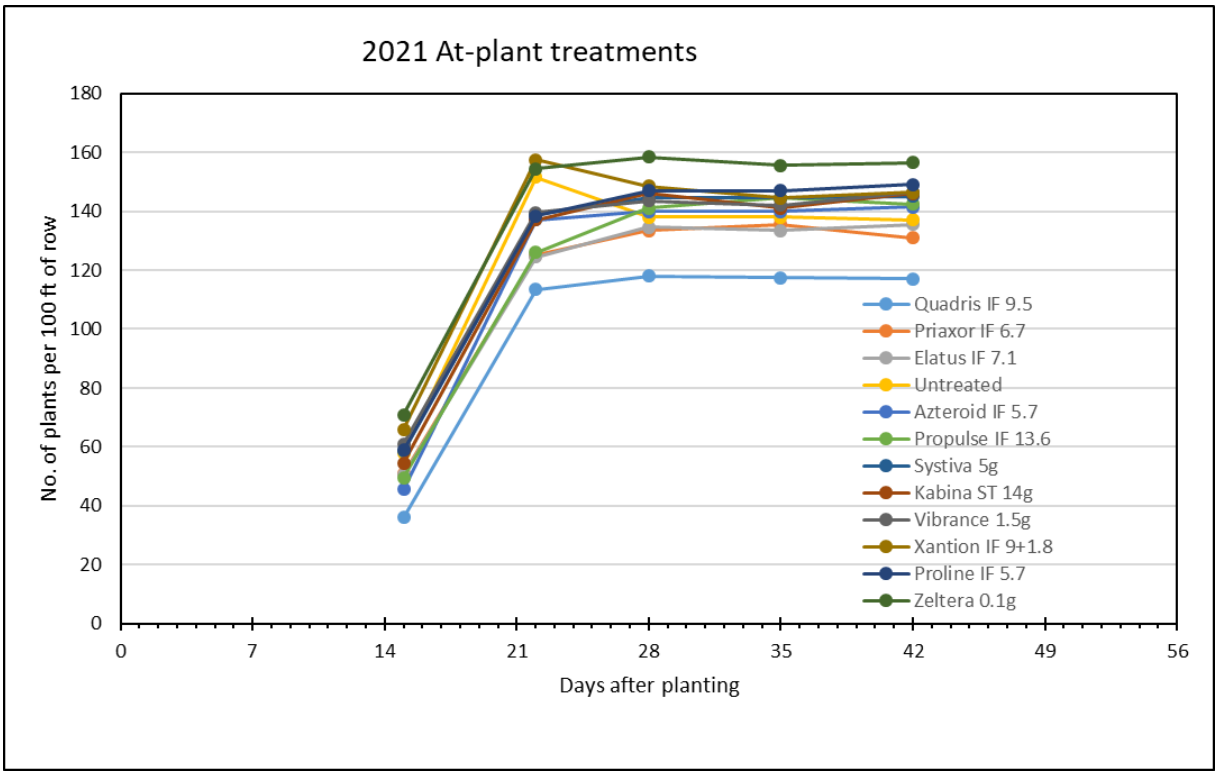

Fig. 1. Emergence and stand establishment for seed treatments and in-furrow fungicides compared to a nontreated control in a sugarbeet field trial infested with Rhizoctonia solani AG 2-2 at the University of Minnesota, NWROC, Crookston. In-furrow treatments were applied at-planting with 6 gallons total volume/A; There were significant (P < 0.05) differences among treatments for plant stands at 22, 28, 35 and 42 days after planting.

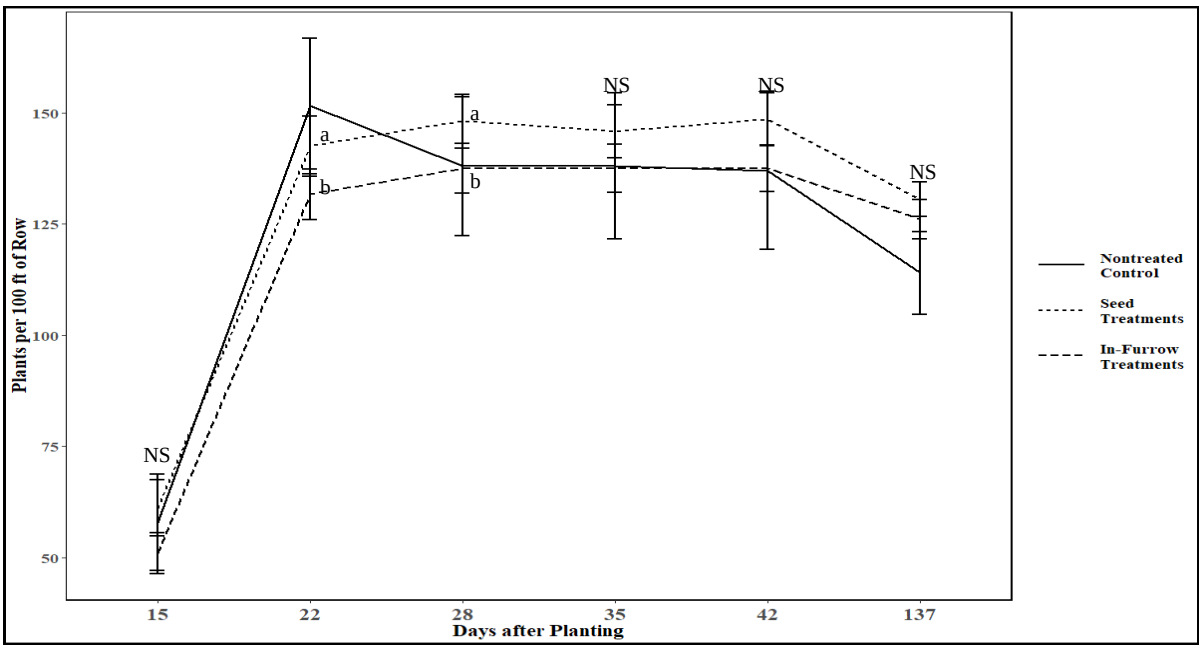

Fig. 2. Emergence and stand establishment for seed treatments and in-furrow fungicides compared to a nontreated control in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2 at the University of Minnesota, NWROC, Crookston. In-furrow treatments were applied at-planting with 6 gallons total volume/A; For each stand count date, treatments with the same letter are not significantly different. There were no significant (P = 0.05) differences among treatments for plant stand at 15, 35, 42, and 137 days after planting.

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.

Treatment and rate (Application type)[z]	Plant Stand at Harvest	Plant Loss (%)[y,t]	RCRR Severity (0-10)[x]	RCRR Incidence (%)[w]	Sugar (%)[t]	SLM (%)[t]	Yield (tons/A)	RST (lb/ton)[v,t]	RSA (lb/A)[u]
[¥]Vibrance	127	13.2 bcd	0.31	10.0	17.6 ab	1.24	26.1	327 ab	8538
[¥]Kabina	132	12.1 bcd	0.24	12.5	17.2 b	1.23	25.7	320 b	8240
[§]AZteroid FC 3.3	134	7.4 cd	0.24	6.3	17.4 ab	1.18	24.9	325 ab	8110
[§]Xanthion	131	18.7 ab	0.16	5.0	17.5 ab	1.23	24.7	326 ab	8072
[§]Propulse	135	7.8 cd	0.56	15.0	17.6 ab	1.26	24.6	326 ab	8034
[¥]Zeltera	134	16.0 abc	0.13	6.3	17.5 ab	1.24	24.6	326 ab	8026
[§]Quadris	115	5.6 d	0.25	12.5	18.0 a	1.19	23.8	336 a	8017
[§]Proline 480 SC	133	12.2 bcd	0.18	10.0	17.7 ab	1.19	24.2	330 ab	8006
Nontreated Control	114	24.5 a	0.71	15.0	17.5 ab	1.20	23.3	327 ab	7602
[§]Elatus	121	11.6 bcd	0.45	10.0	17.9 ab	1.21	22.8	333 ab	7602
[§]Priaxor	116	14.8 bcd	0.41	8.8	17.5 ab	1.19	23.3	325 ab	7566
[¥]Systiva	130	10.7 bcd	0.28	6.3	16.6 c	1.27	23.8	307 c	7301
LSD	-	9.27	-	-	0.64	-	-	13.3	-
P-value	0.1736	0.0168	0.3277	0.5563	0.0250	0.7870	0.5099	0.0234	0.5551
Seed vs in-furrow contrast analysis[s]									
Mean of Seed treatments	131	13.0	2.38	8.8	17.2	1.24	25.0	320	8026
Mean of In-furrow treatments	126	11.2	3.21	9.6	17.6	1.21	24.1	329	7915
P-value	0.2902	0.3700	0.4125	0.6987	**0.0071**	0.1310	0.1260	**0.0049**	0.6292

[z] Treatments were applied as seed treatment or in-furrow application

[y] Plant loss percent equals 100 * (Maximum number of live plants – number of harvested roots) / (Maximum number of live plants)

[x] Percent severity of Rhizoctonia crown and root rot based on ratings described in text

[w] Percent incidence of rated roots with > 0% of rot on the root surface

[v] Recoverable sucrose per ton

[u] Recoverable sucrose per acre equals yield * RST

[t] Means followed by the same letter are not significantly based on Fisher's least significant difference (LSD) test at the 0.05 significance level

[s] Contrast analysis of seed versus in-furrow treatments does not include nontreated control

[¥] Seed treatments applied by Germains Seed Technology, Fargo, ND

[§] In-furrow fungicide application applied down a drip tube in 6 gallons total volume/A

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