EVALUATION OF AT-PLANTING FUNGICIDE TREATMENTS FOR CONTROL OF *RHIZOCTONIA SOLANI* ON SUGARBEET IN 2022

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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 of sugarbeet in Minnesota and North Dakota for over the past decade (Brantner and Windels 2009, 2011; Crane et al. 2013; Brantner 2015; Brantner and Chanda 2017, 2019; Lien et al. 2022). Disease can occur throughout the growing season and reduce plant stand, root yield, and quality especially when warm and wet soil conditions favor infection. Disease management options include rotating with non-host crops (small grains), 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 (Windels et al. 2009).

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 on a Hegne-Fargo silty clay soil with an organic matter content of 4.8%. Field plots were fertilized for optimal yield and quality. A moderately susceptible variety (Crystal 803RR) with a 2-year average Rhizoctonia rating of 4.7 (Brantner and Moomjian 2022) 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) (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 nontreated control did not include any seed or in-furrow fungicide treatment that would suppress or control Rhizoctonia. Prior to planting, soil was infested with *R. solani* AG 2-2-infested (a mixture of four isolates) 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, 30-ft rows) on May 25 at 4.5-inch seed spacing. Counter 20G (8.9 lb/A) was applied at planting 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 13, and Sequence (glyphosate + S-metolachlor, 2.5 pt/A) with additional glyphosate (8 fl oz/A) was applied on July 07. Cercospora leaf spot was controlled by Inspire XT + Manzate Pro-Stick (7 fl oz + 2 lbs/A) on July 18, Supertin + Topsin M (8 + 10 fl oz/A) on Aug 3, and Proline 480 SC + Manzate Pro-Stick (5.7 fl oz + 2 lbs/A) on Aug 17.

Plant stands were evaluated beginning June 06 (12 days after planting [DAP]) through July 14 (50 DAP) by counting the number of plants in the center two rows of each plot. On Sept 20, plots were defoliated and the center two rows of each plot were harvested mechanically and weighed for root yield. Data was also collected for root rot severity and number of harvested roots immediately following harvest. Twenty roots per plot 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 a 10% incremental increase per each unit of rating (i.e., 0=0%, 5 = 41-50%, 10=91-100%). Each rating was mid-point transformed to percent severity for statistical analysis. Ten representative roots from each plot were analyzed for sugar quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. Statistical analysis was conducted in SAS (version 9.4; SAS Institute, Cary, NC). A mixed-model analysis of variance was performed using the GLIMMIX procedure, with treatments defined as the fixed factor and replication as the random factor. Treatment means were separated based on the least square means test at the 0.05 significance level using the

LSMEANS statement. The CONTRAST statement was used to compare the means of seed treatments vs. in-furrow treatments.

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
Seed	Metlock Suite + Zeltera	Metconazole (3) + Tolclofos-methyl (14) Inpyrfluxam (7)	0.21 g a.i + 0.5 g a.i./unit seed 0.05 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	AZterknot	Azoxystrobin (11) + Extract of *Reynoutria sachalinensi* (P 05)	16.6 fl oz product/A
In-furrow	Headline SC	Pyraclostrobin (11)	9.0 fl oz product/A
In-furrow	Elatus WG	Azoxystrobin (11) + Benzovindiflupyr (7)	7.1 oz product/A
In-furrow	Proline 480 SC	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 67 and 70 g azoxystrobin, respectively; 16.6 fl oz AZterknot contain 102 g azoxystrobin and 59 g extract of *R. sachalinensi*; 9.0 fl oz Headline EC contain 67 g pryaclostrobin; 7.1 oz Elatus WG contains 60 g azoxystrobin and 30 g benzovindiflupyr; 5.7 fl oz Proline 480 SC contains 81 g prothioconazole; 13.6 fl oz Propulse contains 80 g each of fluopyram and prothioconazole; 6.7 fl oz Priaxor contains 33 g fluxapyroxad and 66 g pyraclostrobin

RESULTS AND DISCUSSION

The Northwest Research and Outreach Center, Crookston, MN, recorded a total rainfall of 5.82 and 4.73 in. for April and May, which was much greater than the 30-year average of 1.33 and 2.83 in., respectively. The saturated soils resulted in delayed planting; however, moist conditions at planting allowed for the rapid emergence of sugarbeet seedlings and generally high plant populations of 191 plants per 100 ft. of row averaged across all treatments in this trial on June 13 (19 DAP). Only a few rainfall events occurred in June, July, and August resulting in total rainfall of 2.78, 1.66, and 0.46 in., respectively; this is less than the 30-year average of 3.9, 3.19, and 2.72 in., respectively.

There were significant ($P < 0.05$) differences among treatments for plant stands at 12, 43, and 50 DAP; however, there were no significant differences by the time of harvest. On June 06 (12 DAP), Azteroid FC[3.3] had the highest plant stand of 159 plants per 100 ft of row and Kabina ST and Propulse had the lowest plant stands of 119 and 112, respectivley (Table 2). All other treatments had a similar number of plants after emergence. Generally, in-furrow treatments had a greater number of plants compared to seed treatments over the time period (Figure 1). Moist soils at planting typically contribute to lessening seedling injury associated with in-furrow products as seen in previous years (Chanda and Brantner 2016, 2017; Lien et al. 2020). However, it is not unusual for stand establishment to be reduced for in-furrow fungicides compared to seed treatments if planting conditions are dry (Brantner and Chanda 2018, 2020; Chanda and Brantner 2019; Lien et al. 2022).

Cooler temperatures and lack of rain in the early part of June did not favor the establishment of Rhizoctonia inoculum in the soil and resulted in moderately low disease pressure throughout the season in 2022. There were no significant differences ($P > 0.05$) among treatments for severity and incidence of Rhizoctonia crown and root rot (RCRR), % sucrose, yield, and recoverable sucrose. However, based on the contrast analysis, in-furrow treatments had statistically lower severity of RCRR than the seed treatments (Table 3) and numerically slightly higher yield and recoverable sucrose per acre.

Table 2. Effects of at-planting (seed treatment or in-furrow) fungicide treatments on emergence and stand establishment in a *Rhizoctonia*-infested field trial planted on May 25, 2022 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

	Plants per 100 ft row [y,x]					
Treatment and rate (Application type)[z]	June 06 12 DAP	June 13 19 DAP	June 20 26 DAP	June 30 36 DAP	July 07 43 DAP	July 14 50 DAP
§Quadris	148 ab	203	192	189	191 a	194 a
§Headline SC	155 ab	198	190	185	187 a-c	189 ab
§Priaxor	142 a-c	195	190	188	186 a-d	189 ab
§AZteroid FC[3.3]	159 a	200	191	187	188 ab	187 a-c
§Elatus WG	144 ab	203	189	186	185 a-e	185 a-d
¥Metlock Suite + Zeltera	137 a-c	190	183	178	179 a-f	181 a-e
§Proline 480 SC	134 b-d	191	183	175	175 b-f	180 a-e
§AZterknot	145 ab	192	181	178	180 a-f	180 a-e
¥Vibrance	131 b-d	197	188	181	182 a-e	179 b-e
¥Zeltera	134 b-d	182	178	173	173 c-f	175 b-e
Nontreated Control	149 ab	188	179	173	175 b-f	173 c-e
¥Kabina	119 cd	178	173	173	171 ef	172 de
¥Systiva	133 b-d	186	178	173	172 d-f	172 de
§Propulse	112 d	174	174	171	168 f	170 e
LSD	24	-	-	-	14	15
P-value	**0.0196**	0.1260	0.2851	0.1736	**0.0317**	**0.0367**

Contrast analysis of Seed Treatments vs. In-furrow Treatments [w]						
Mean of Seed treatments	131	187	180	176	175	176
Mean of In-furrow treatments	142	194	186	182	182	184
P-value	**0.0220**	0.0580	0.0599	**0.0354**	**0.0171**	**0.0070**

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

y Plant stands based on the number of plants in the center two rows of each plot

x Means followed by the same letter are not significantly based on LSMEANS test (*P*=0.05)

w 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

Table 3. 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[y]	Plant Loss (%)[x]	RCRR Severity (%)[w]	RCRR Incidence (%)[w]	Sugar (%)[t]	SLM (%)[t]	Sucrose (lb/ton)	Yield (tons/A)	Sucrose (lb/A)
§Priaxor	170	13.0	5.8	26.3	18.1	1.02	341	27.0	9186
§AZterknot	166	13.2	6.6	23.8	17.5	1.05	329	28.5	9382
§Elatus WG	174	14.4	7.1	20.0	17.5	1.08	329	27.9	9192
¥Zeltera	154	15.5	7.2	23.8	17.2	1.07	322	25.8	8301
§Quadris	169	16.5	5.7	21.3	17.3	1.15	322	29.0	9311
¥Systiva	155	16.9	11.6	35.0	17.6	1.03	331	27.2	8999
§Headline SC	163	17.1	13.4	33.8	17.1	1.23	317	28.7	9113
§Propulse	152	17.2	6.5	30.0	17.5	1.13	328	25.6	8409
§Proline 480 SC	157	17.6	7.6	26.3	17.1	1.09	320	27.7	8860
¥Kabina	147	17.9	12.5	30.0	17.4	1.13	326	27.6	8961
§AZteroid FC[3.3]	161	19.2	8.8	21.3	17.7	1.22	329	26.1	8562
¥Vibrance	158	19.4	16.1	37.5	16.9	1.07	317	28.4	9009
¥Metlock Suite + Zeltera	153	19.4	10.8	25.0	17.5	1.21	326	25.4	8295
Nontreated Control	152	19.4	11.9	30.0	18.0	1.03	340	27.5	9373
LSD	-	-	-	-	-	-	-	-	-
P-value	0.0708	0.9358	0.2745	0.4220	0.8480	0.3490	0.8370	0.2440	0.5206

[v] Contrast analysis of Seed Treatments vs. In-furrow Treatments

Mean of Seed treatments	153	17.8	11.6	30.3	17.3	1.10	324	26.9	8713
Mean of In-furrow treatments	164	16.0	7.7	25.3	17.5	1.12	327	27.6	9002
P-value	**0.0033**	0.3490	**0.0226**	0.1102	0.5828	0.6913	0.6531	0.2539	0.2092

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

y Plant stands are equivalent to number of plants per 100 ft of row

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

w Ratings and incidence Rhizoctonia crown and root rot are described in text

v 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

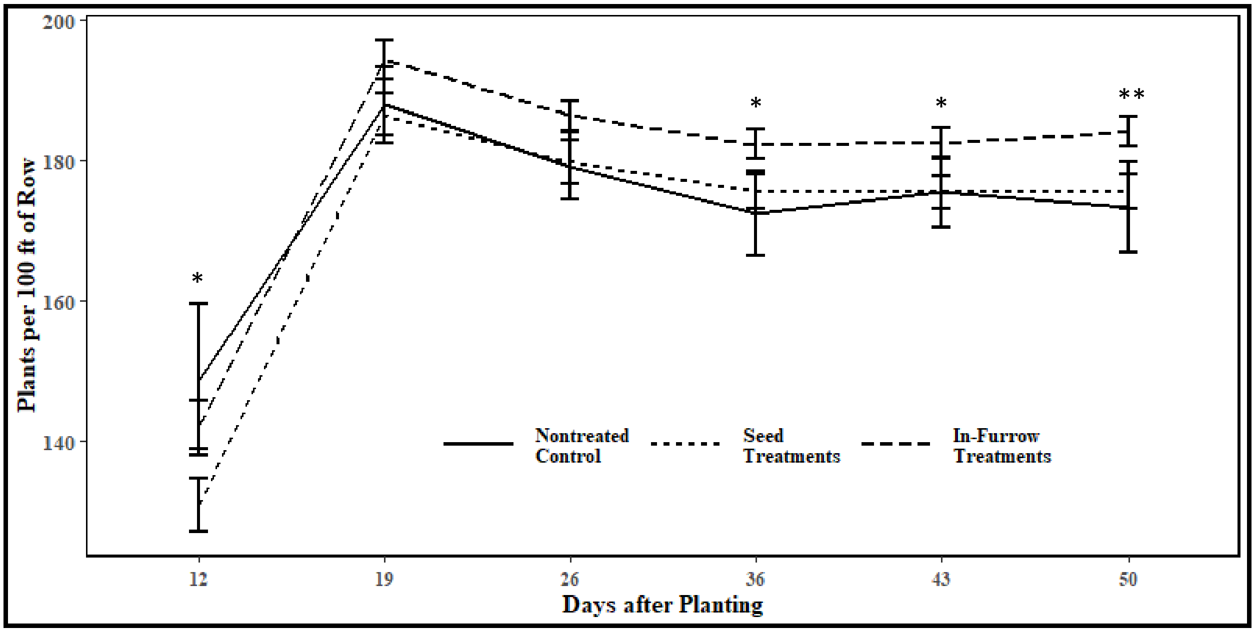

Figure 1. Emergence and stand establishment in 2022 comparing the averages of seed treatments and in-furrow fungicides compared to the nontreated control in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2 in Crookston, MN.

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