EVALUATION OF AT-PLANTING FUNGICIDE TREATMENTS FOR CONTROL OF *RHIZOCTONIA SOLANI* ON SUGARBEET, 2020

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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, 6-8). 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 574RR) with a 2-year average Rhizoctonia rating of 4.4 (10) 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 (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 12 at 4.5-inch seed spacing. Counter 20G (8.9 lb A^{-1}) was applied at planting and Lorsban 4E (2 pt A^{-1}) was applied June 5 for control of sugarbeet root maggot. Glyphosate (4.5 lb product ae/gallon, 28 oz A^{-1}) was applied on June 2 and July 29 and Sequence (glyphosate + S-metolachlor, 2.5 pt A^{-1}) with additional glyphosate (8 oz A^{-1}) was applied on June 19 for control of weeds. Cercospora leafspot was controlled by Minerva Duo (16 fl oz A^{-1}) on August 4 and Proline 480 SC + Supertin (5 + 8 oz A^{-1}) on August 24 applied in 20 gallons water A^{-1} at 100 psi.

Stand counts were done beginning 9 days after planting through 13 weeks after planting. Plots were defoliated mechanically and harvested using a mechanical harvest on September 17. The middle two rows of each plot were weighed for root yield and ten representative roots from each plot were analyzed for quality at the American Crystal Sugar Company Quality Tare Lab, East Grand Forks, MN. The number of harvested roots were counted per plot and twenty roots were rated for severity of RCRR using a 0 to 10 scale (0 = healthy root, 10 = 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	0.015 + 0.031 + 7 g a.i./unit seed
Seed	Metlock Suite + Vibrance	Metconazole + Rizolex + Sedaxane	0.015 + 0.031 + 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	Elatus[Z]	Azoxystrobin + Benzovindiflupyr	7.1 oz product A^{-1}
In-furrow	Priaxor	Pyraclostrobin + fluxapyroxad	6.7 fl 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}
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	Priaxor	Pyraclostrobin + fluxapyroxad	6.7 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 + ~1.2×10^{12} viable spores of *Bacillus amyloliquefaciens* strain MBI 600; 7.1 oz Elatus contains 61 g azoxystrobin and 30 g benzovindiflupyr; 6.7 fl oz priaxor contains 66 g pyraclostrobin and 33 g fluxapyroxad; 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 & DISCUSSION

Monthly rainfall (in inches) at Crookston was as follows: April (1.92), May (1.0), June (4.52), July (7.52), and August (3.02) with 30-year averages of 1.2, 2.4, 4.0, 3.3, and 2.81, respectively. By 2 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 and untreated control plots was higher compared with the seed treatments at 2 weeks after planting (Fig. 1). Stands were significantly lower during the 13-week stand count period for seed treatments compared with in-furrow treatments based on a contrast analysis. It is unusual for stand establishment to be reduced for seed treatments compared to in-furrow fungicides at this location if planting was followed by dry soil conditions. From 3 to 5 WAP there was no difference among seed treatments and in-furrow treatments for stands ($p \leq 0.05$). Until 9 WAP, the stand counts were steady for most treatments and similar to stands at 2 WAP indicating very low disease pressure during this time period. However, by 13 WAP, untreated control lost 14%, seed treatments lost 10 % and in-furrow treatments lost about 6% of stands compared to stands at 9 WAP, indicating the efficacy of in-furrow treatments could last a little longer compared to seed treatments. The SDHI fungicides that are currently labeled for Rhizoctonia provide excellent stand protection for 4 to 5 WAP depending on individual field conditions.

Rainfall in July helped some root rot development later in the season and resulted in statistical differences among treatments for root rot incidence and severity, root yield, % sucrose and recoverable sucrose per acre (RSA). Performance of individual treatments compared to untreated control is presented in Table 2. The in-furrow fungicides resulted in higher number of harvestable roots, lower root rot severity and incidence, higher root yield, and higher RSA. Even though the treatment including 6 fl oz rate of Quadris with Kabina (14 g per unit) could provide stand protection as well as higher RSA at the end of the season (Table 2), it is recommended to use 9.5 fl oz rate for Quadris in-furrow application. It is also important to know that certain isolates of *R. solani* AG 2-2 have low sensitivity to Quadris on artificial media (1,9), but) but could be managed with labeled field rates of Quadris under greenhouse conditions (1). While it is important to note that use of in-furrow fungicides comes with some risk of stand loss under dry and cool soil conditions, the benefits of stand protection and higher RSA will outweigh the risks in fields with severe Rhizoctonia history or risk.

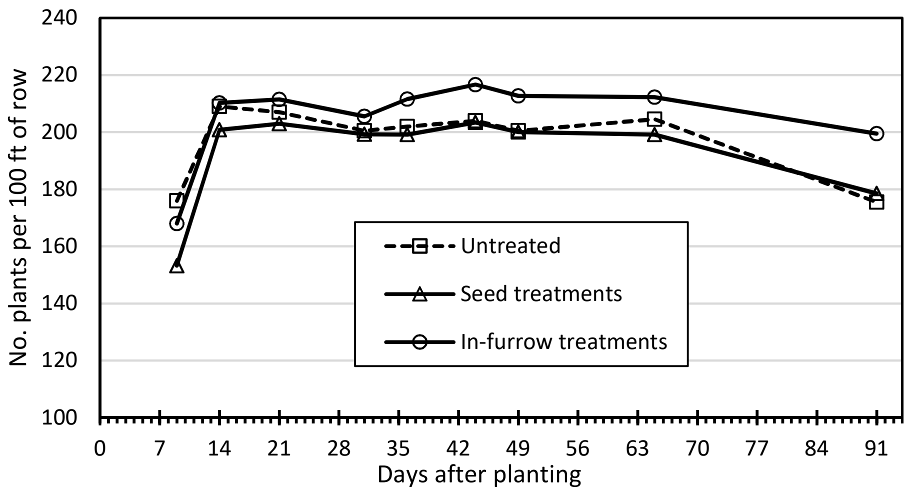

Fig. 1. Emergence and stand establishment for seed treatment and in-furrow fungicides compared to an untreated control in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2. For each stand count date, stands are significantly different (P=0.05) when comparing in-furrow treatments to seed treatments.

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	13-wk stand Plants/100 ft[V]	No. harv. Roots/100 ft[V]	RCRR (0-10)[VW]	RCRR % incidence[VX]	Yield[V]	Sucrose[V] %	Sucrose[V] lb A^{-1}	Sucrose[V] lb ton^{-1}
Untreated control	176 efd	157 e-h	3.0 d-g	55.0 b-f	24.9 def	15.9	7355 def	293
Kabina ST	195 bc	176 b-e	2.9 c-g	57.5 def	25.8 c-f	16.5	7871 b-f	305
Met. Suite + 7 g Kabina	183 b-e	165 c-f	3.3 d-g	61.3 efg	27.1 b-e	15.6	7717 c-f	284
Met. Suite + 1 g Vibrance	173 ef	139 gh	3.9 f-h	75.0 fg	23.3 fg	16.3	7034 fg	300
Systiva	175 efd	150 fgh	3.4 efg	66.3 efg	24.0 ef	16.5	7292 ef	305
Vibrance	182 b-e	161 c-f	4.1 gh	81.3 g	24.6 def	16.1	7287 ef	295
Kabina ST + *Quadris I-F (6 oz A^{-1})	204 ab	193 ab	1.1 ab	35.0 ab	28.9 abc	17.1	9206 a	319
AZteroid in-furrow	194 bc	177 b-e	1.3 ab	38.8 a-d	29.2 abc	16.7	9012 ab	309
Elatus in-furrow[Y]	215 a	203 a	0.9 a	21.3 a	31.3 a	16.1	9248 a	296
Priaxor in-furrow	195 bc	176 b-e	2.3 b-e	56.3 c-f	26.9 b-e	16.3	8075 a-f	300
Proline in-furrow	191 bcde	178 b-e	2.7 c-f	55.0 b-f	27.6 bcd	16.0	8164 a-f	295
Propulse in-furrow	207 ab	184 abc	2.0 abc	47.5 b-e	29.7 ab	16.1	8681 abc	294
Quadris in-furrow	203 ab	183 a-d	1.7 abc	36.3 abc	28.6 abc	16.3	8584 a-d	300
Xanthion in-furrow	193 bcd	165 c-f	2.2 b-e	52.5 b-e	28.1 a-d	16.4	8517 a-e	303
ANOVA P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.7519	<0.0001	0.7891
LSD (P = 0.05)	18.2	22.3	1.3	20.8	3.5	NS	1274.1	NS
Seed vs In-furrow Contrast analysis[Z]								
Mean of seed trmts	179	155	3.8	69.4	24.2	16.1	7176	296
Mean of in-furrow trmts	200	181	1.9	43.9	28.8	16.3	8612	300
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.5282	<0.0001	0.5812

[V] Values represent mean of 4 plots; treatments with the same letter are not significantly different; NS = not significantly different at P = 0.05
[W] RCRR = Rhizoctonia crown and root rot; 0-10 scale, 0 = root clean, no disease, 10 = 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

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