INTEGRATED MANAGEMENT OF RHIZOCTONIA ON SUGARBEET WITH RESISTANT VARIETIES, AT-PLANTING TREATMENTS, AND POSTEMERGENCE FUNGICIDES 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 (1,2). These diseases can occur throughout the growing season and reduce plant stand, root yield, and quality (3-6). Warm and wet soil conditions favor infection by *R. solani*. 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), or postemergence. An integrated approach involving multiple strategies should help managing Rhizoctonia crown and root rot (4-6).

OBJECTIVES

A field trial was established to evaluate an integrated management strategy consisting of a resistant (R) and a moderately susceptible (MS) variety with at-panting treatments alone and in combination with two different postemergence azoxystrobin application timings 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. Plots were set up in a split-split plot design; main plots were varieties, the first split was at-panting treatments, and the last split was postemergence azoxystrobin timings. A combination of a moderately susceptible variety (Crystal 803RR; 2-year average Rhizoctonia rating of 4.8) and a resistant variety (Crystal 804RR; 2-year average Rhizoctonia rating of 3.8) with fluxapyroxad (Systiva) seed treatment, in-furrow azoxystrobin (Quadris) on fluxapyroxad (Systiva), nontreated seed, or in-furrow azoxystrobin (Quadris @ 9.5 fl oz/A as dribble in-furrow) on nontreated seed was planted in four replicated plots (Table 1). Systiva was used at 5 g ai/unit seed and applied by Germains Seed Technology, Fargo, ND. Each variety by at-planting treatment combination was planted in triplicate, so that at the 4- or 8-leaf stage, one plot of each variety by at-planting treatment combination received a 7-inch band postemergence application of azoxystrobin (14.3 fl oz product/A) while one was left as a stand-alone treatment. Controls for each variety included no at-planting treatment with each postemergence azoxystrobin timing and without postemergence azoxystrobin. Postemergence azoxystrobin was applied in a 7-inch band in 10 gallon/A using 4002 nozzles and 34 psi on June 10 (4-leaf stage, 34 days after planting) or June 21 (8-leaf stage, 45 days after planting).

The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 07 at 4.5-inch seed spacing. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley at 50 kg/ha by hand broadcast. Additionally, Ethotron (4 pt/A) was applied with a spray boom mounted to the front of a Rau seedbed finisher the width of individual plots to incorporate both the pre-plant herbicide and *Rhizoctonia*-infested barely, and prepare the seedbed with one pass in the direction of the rows. Starter fertilizer (3 gallons/A 10-34-0) was applied in-furrow across all treatments. Counter 20G (8.9 lb/A) was applied at planting and Lorsban (2 pt/A) was applied on June 08 to control sugar beet root maggot. For the postemergence control of weeds, glyphosate (4.5 lb ae/gallon, 32 oz/A) was applied on May 27, and Sequence (glyphosate + S-metolachlor, 2.5 pt/A) with additional glyphosate (8 oz/A) was applied on June 08 and June 28. 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 18 days after planting (May 25) through 46 days after planting (Jun 22) by counting the number of live 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 27, plots were defoliated and the center two rows of each plot were harvested mechanically and weighed for root yield. 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 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. Statistical analysis was conducted in R (v 4.1.2, R Core Team 2021) with the package *agricolae* (v 1.3-5). The *ssp.plot* function was used for the variance analysis of a split-split plot design, which is divided into three parts: the plot-factor analysis, the subplot factor analysis, and the sub-subplot analysis. Fisher's least significant difference (LSD) was used for post hoc analysis at a 0.05 level of significance with the respective error terms.

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. Each at-plant treatment was used in combination with a Rhizoctonia resistant (2-year average rating = 3.8) and moderately susceptible (2-year average rating = 4.8) variety, and all treatment combinations in triplicate, with one set receiving a postemergence 7-inch band application of azoxystrobin (14.3 fl oz/A) at 4- or 8-leaf stage. Standard rates of Apron + Thiram and 45 g/unit Tachigaren were on all seed.

Application	Product	Active ingredient	Rate
None	-	-	-
Seed	Systiva	Fluxapyroxad	5 g a.i./unit seed
In-furrow (dribble)	Quadris	Azoxystrobin	9.5 fl oz product/A

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 just 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 168 plants per 100 ft. row averaged across all treatments in this trial. There could be possible stand reduction from use of 10-34-0 starter fertilizer under these dry conditions. There were no significant stand differences between resistant (R) and moderately susceptible (MS) varieties from 2.5 to 6.5 weeks after planting (WAP) (Fig. 1A). There were no significant stand differences between nontreated, Systiva ST, Quadris in-furrow, Systiva ST + Quadris in-furrow at-planting treatments (Fig. 1B). There were no significant stand differences between no post and 4- or 8-leaf postemergence applications (Fig 1C.). Slight to no root rot severity and very low root rot incidence (< 10%) were observed for all treatments in this trial (Table 2). A two-way interaction of variety x post treatment was observed for number of harvestable roots and recoverable sugar A^{-1} (RSA). Both 4- and 8-leaf postemergence applications resulted in an increase of ~500 lbs sucrose (Fig. 2) and more (~10 per 100 ft. of row) harvestable roots (Tab. 2) in the moderately susceptible variety only compared to the no postemergence treatment. For percent sucrose, sugar loss to molasses, and recoverable sucrose T^{-1} (RST), no significant differences were observed between varieties or at-panting treatments or postemergence treatments in 2021 (Table 2). No two-way or three-way interactions were observed for the above harvest parameters. 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.

Table 2. Main effects of variety, at-planting, and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2 at the University of Minnesota, NWROC, Crookston

Main effect	Plant Stand at Harvest[V]	Plant Loss (%)[U]	RCRR Severity (0-10)[T]	RCRR Incidence (%)[S]	Sugar (%)	SLM (%)	Yield (tons/A)	RST (lb/ton)[R]	RSA (lb/A)[Q]
Variety[Y]									
Resistant	129	20.4	0.11	8.3	17.6	1.33	22.1	325	7167
Susceptible	138	20.3	0.18	8.6	18.1	1.24	22.0	337	7399
P-value	0.168	0.961	0.102	0.876	0.086	0.072	0.592	0.075	0.228
LSD[Z]	-	-	-	-	-	-	-	-	-
At-planting[X]									
Untreated	129	22.0	0.12	7.3	17.7	1.30	22.3	329	7334
Systiva	135	21.7	0.12	7.3	18.0	1.27	21.3	334	7102
Quadris	135	18.3	0.16	10.4	17.8	1.26	22.8	331	7524
Systiva + Quadris	133	19.2	0.17	9.0	17.8	1.30	21.7	330	7171
P-value	0.516	0.087	0.727	0.620	0.280	0.336	0.189	0.209	0.282
LSD	-	-	-	-	-	-	-	-	-
Postemergence[W]									
None	131	21.5	0.18	9.4	17.8	1.28	21.7	331	7167
Quadris 4-leaf	134	20.1	0.12	8.6	17.8	1.28	22.0	331	7285
Quadris 8-leaf	135	19.4	0.13	7.5	17.8	1.29	22.4	331	7397
P-value	0.329	0.278	0.273	0.504	0.967	0.796	0.256	0.987	0.314
LSD	-	-	-	-	-	-	-	-	-
Variety x at-planting[¥]	NS	NS	NS	NS	NS	NS	NS	NS	NS
Variety x Post[¥]	**0.049**	NS	NS	NS	NS	NS	**0.042**	NS	**0.036**
At-planting x Post[¥]	NS	NS	NS	**0.012**	NS	NS	NS	NS	NS
Variety x At-planting x Post[¥]	NS	NS	NS	NS	NS	NS	NS	NS	NS

[Z] LSD = Least Significant Difference, $P = 0.05$

[Y] Values represent mean of 48 plots (4 replicate plots across 4 at-planting treatments and 3 postemergence treatments)

[X] Systiva @ 5 g a.i /unit and Quadris In-furrow @ 9.5 fl oz./A via drip tube; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

[W] Quadris Postemergence @ 14.5 fl oz./A in a 7 inch band; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 at-planting treatments)

[V] Plants per 100 ft of row

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

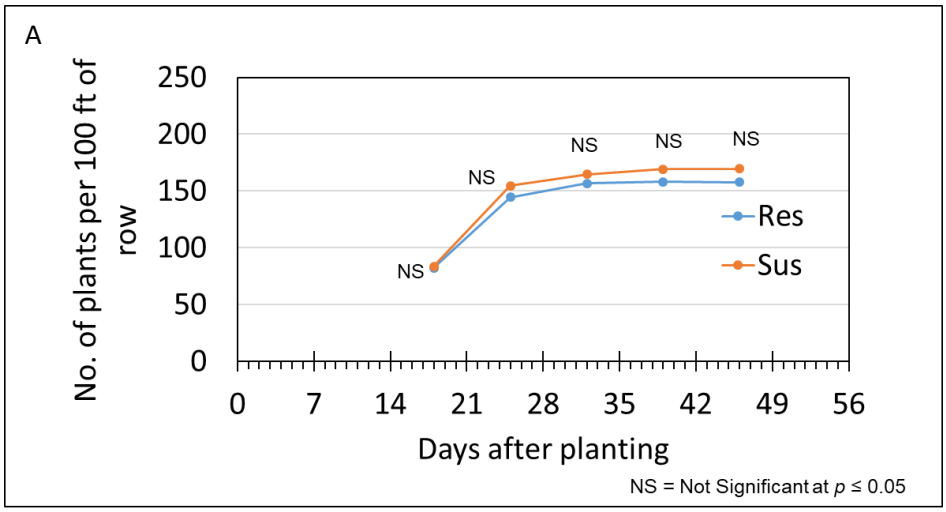
[T] Percent severity of Rhizoctonia crown and root rot based on ratings described in text

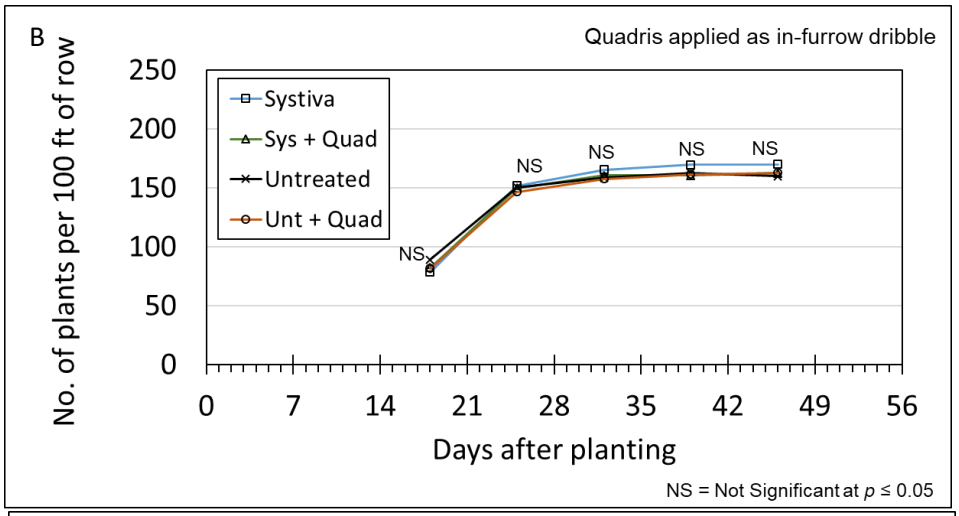
[S] Percent incidence of rated roots with > 0% of rot on the root surface

[R] Recoverable sucrose per ton

[Q] Recoverable sucrose per acre equals yield * RST

[¥] *P*-values < 0.05 indicate a statistically significant interaction; NS = not significantly different





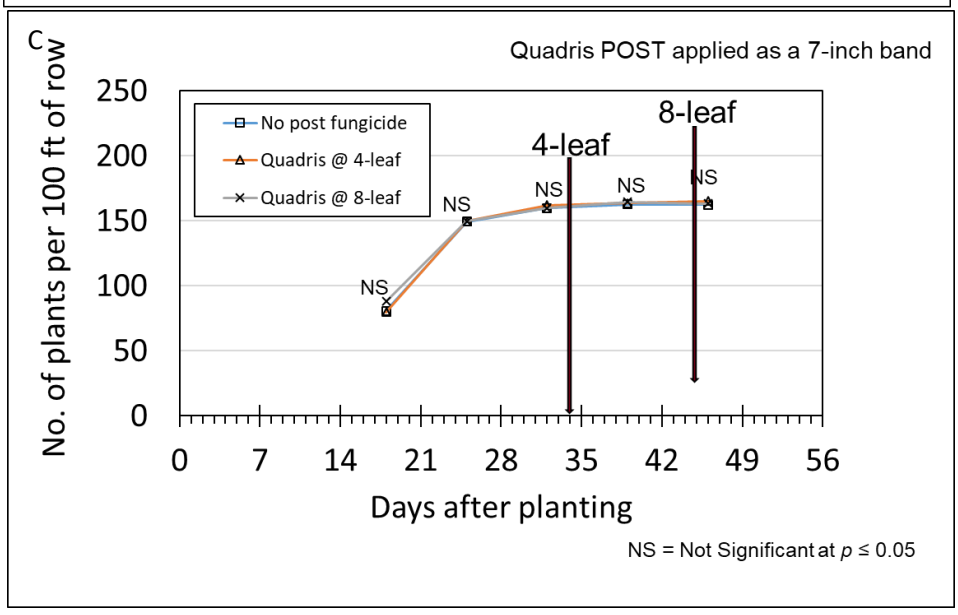


Fig. 1. Effects of **A**) sugarbeet varieties; Res = 3.8 rating, Sus = 4.8 rating for Rhizoctonia **B**) at-planting treatments, Sys = Systiva seed treatment @ 5 g/unit seed, Quad = Quadris in-furrow dribble at 9.5 fl oz/A, and **C**) postemergence treatments on stand establishment from 18 to 46 days after planting (DAP) Postemergence azoxystrobin (Quadris) was applied in a 7-inch band in 10 gallon/A using 4002 nozzles at 34 psi on June 10 (4-leaf stage, 34 days after planting) or June 21 (8-leaf stage, 45 days after planting). NS indicates no statistical significance between treatments on a given day at $p < 0.05$.

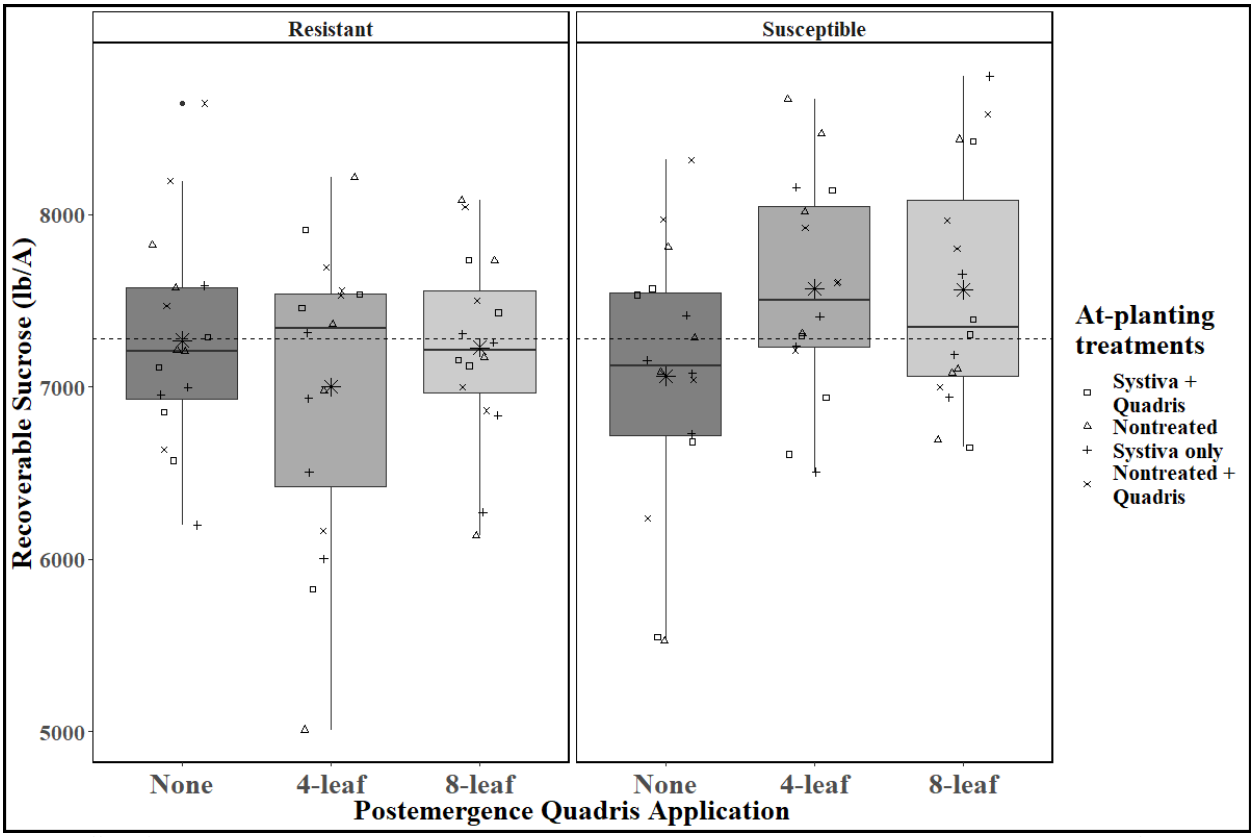


Fig. 2. Effect of variety x postmergence Quadris application on recoverable sucrose per acre (RSA). Data shown represents mean of 16 plots averaged across all at-planting treatments. Each boxplot represents the inter-quartile range, each solid line represents the median, and asterisks represents the mean of each treatment. Individual points above or below a box plot represent potential outliers. The horizontal dotted line represents the mean of all treatments.

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