IN-FURROW FUNGICIDES APPLIED WITH AND WITHOUT STARTER FERTILIZER

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Damping-off and Rhizoctonia crown and root rot (RCRR) of sugarbeet, caused by the soilborne fungus *Rhizoctonia solani* AG 2-2, is increasing in prevalence and severity in Minnesota and North Dakota. This increase is due to a buildup of pathogen populations over many years of growing sugarbeet and susceptible rotation crops, as well as occurrence of warm and wet weather favorable for disease development. There is a need for effective and economical control methods. Current control methods include planting partially resistant varieties, cultural practices (i.e., non-host crops in the rotation), and application of fungicides in-furrow or post-emergence.

The registered fungicides Quadris (azoxystrobin, Syngenta Crop Protection, Inc.) and Headline (pyraclostrobin, BASF) control RCRR when applied in-furrow. Vertisan (penthiopyrad, DuPont) is a new fungicide that also controls RCRR and may be registered in 2012. Although these fungicides provide excellent early-season control of *Rhizoctonia*, questions have arisen concerning their safety on seedling emergence especially when applied with starter fertilizer.

OBJECTIVES

A field trial was established to evaluate in-furrow fungicides applied with and without starter (10-34-0) fertilizer for effect on sugarbeet emergence, yield, and quality.

MATERIALS AND METHODS

The trial was established at the University of Minnesota, Northwest Research and Outreach Center, Crookston on a site naturally infested with low population densities of *R. solani*. The trial was sown on two planting dates (May 16 and May 25) with a *Rhizoctonia*-susceptible variety (rating = 4.4) in six-row plots (22-inch row spacing) at a 4.7-inch seed spacing. Counter 20 G (6.8 lb A^{-1}) was applied at planting for control of root maggot. Glyphosate (4.5 lb product ae/gallon, 22 oz A^{-1}) was applied on June 9 (planting date 1 only), June 16 and July 1 for control of weeds. Treatments are shown in Table 1 and included the in-furrow fungicides Quadris, Headline, and Vertisan at 0.6, 0.5, and 1.6 fl oz product per 1,000 ft of row (= 14.5, 12, and 38 fl oz product A^{-1}), respectively. A no fungicide control also was included. Each in-furrow fungicide was applied by two different methods (down the in-furrow drip tube or in a t-band directly behind the disc openers) by itself or with starter fertilizer (10-34-0, 3 GPA). The starter fertilizer was always applied down the in-furrow drip tube. Liquids applied down the drip tube go into the furrow as a constant stream directly over the seed while liquids applied in the t-band go into the furrow as a narrow (~4-inch) band directly over the seed. Treatments were arranged in a randomized block design with four replicates. Cercospora leaf spot was controlled by Inspire XT (7 oz product), Super Tin 80WP + Topsin M 4.5F (5 oz + 10 fl oz product) and Headline (9 oz product) in 20 gallons of water A^{-1} with a tractor-mounted sprayer with TeeJet 8002 flat fan nozzles at 100 psi on July 29, August 18 and September 7, respectively.

Stand counts were taken 8, 11, 16, 24, and 46 days after planting date 1 and 9, 12, 15, 23, and 35 days after planting date 2. The center two rows of plots were harvested September 26 and 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).

Statistical analysis. Data were subjected to analysis of variance (ANOVA) for comparison of main effects of fungicide, application method, and starter fertilizer and interactions of fungicide by application method, fungicide by starter fertilizer, and fungicide by application method by starter fertilizer using SAS (SAS Institute, Cary, NC).

Table 1. In-furrow fungicide, application method, and starter fertilizer (10-34-0, 3 GPA) treatment combinations used in a field trial testing effect of in-furrow fungicides on sugarbeet emergence, yield, and quality.

In-furrow fungicide	Application method	Starter (10-34-0)
No fungicide	-	-
	-	+
Quadris @ 14.3 fl oz/A	Down drip tube	-
	Down drip tube (mixed with starter)	+
	t-band	-
	t-band	+
Headline @ 12 fl oz/A	Down drip tube	-
	Down drip tube (mixed with starter)	+
	t-band	-
	t-band	+
Vertisan @ 38 fl oz/A	Down drip tube	-
	Down drip tube (mixed with starter)	+
	t-band	-
	t-band	+

RESULTS

Overall, emergence was much higher in planting one (Fig. 1A) than planting two (Fig. 1B) due to warmer soil temperatures the week following May 16 vs. May 25. For all stand count data in both planting dates, there were significant (*P* = 0.05) interactions for fungicide by application method, but no interactions for fungicide by starter fertilizer or fungicide by application method by starter fertilizer. Specifically, with Headline and Vertisan, stands were better when applied with the t-band than down the drip tube, but with Quadris, stands were better when applied down the drip tube than with the t-band for both planting dates (Fig. 1, A and B). No obvious symptoms of foliar phytotoxicity (stunting, discoloration of foliage) on sugarbeet seedlings were observed for any fungicide or method of application at either planting date.

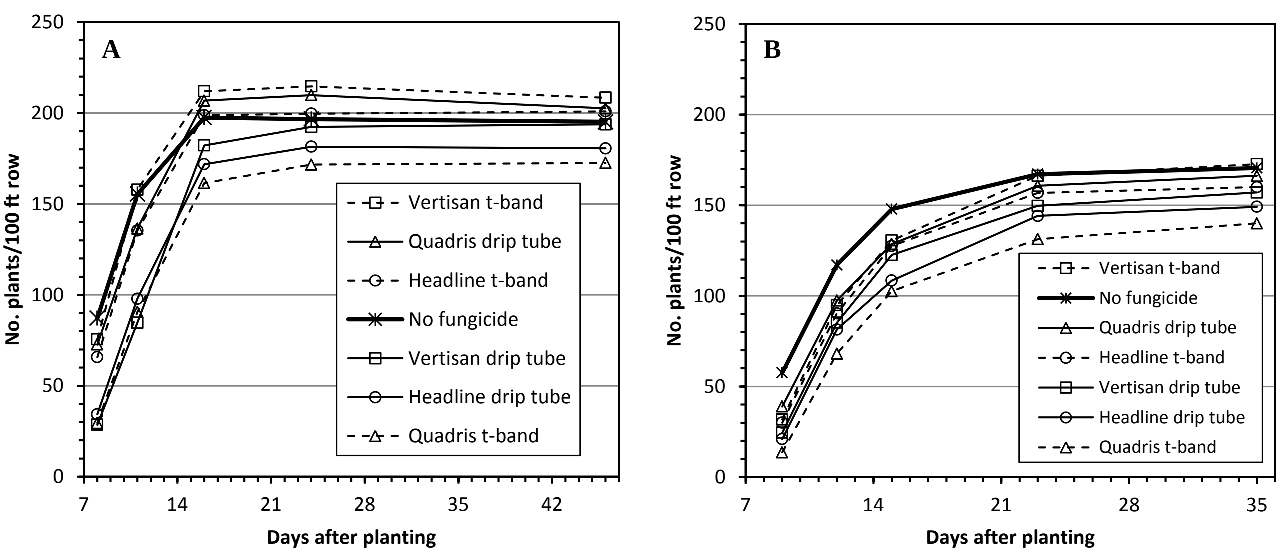

Fig. 1. Emergence and stand establishment of sugarbeet plots treated with in-furrow fungicides in a t-band or down the drip tube in trials sown **A**) May 16 and **B**) May 25 (data are averaged across starter fertilizer/no starter fertilizer treatments).

Table 2. Main effects of in-furrow fungicide, application method, and starter fertilizer (10-34-0) on Rhizoctonia crown and root rot (RCRR) and yield, quality, and revenue of sugar beet planted May 16, 2011.

Main effect	RCRR (0-7)	Yield T/A	Sucrose %	Sucrose lb/ton	Sucrose lb recov./A	Revenue ($/A)
In-furrow fungicide[W]						
No fungicide	1.2	22.1	18.4	341	7496	1335
Headline	1.1	23.9	17.9	332	7916	1379
Quadris	1.2	23.8	18.3	339	8052	1430
Vertisan	1.2	23.9	18.3	341	8142	1456
ANOVA p-value[X]	0.387	0.986	0.086	0.057	0.557	0.222
Application method[Y]						
Drip tube	1.2	23.5	18.2	338	7936	1406
T-band	1.1	24.2	18.1	337	8138	1437
ANOVA p-value[X]	0.216	0.166	0.716	0.691	0.243	0.397
Starter fertilizer (10-34-0)[Z]						
None	1.1	24.0	18.0	334	8039	1411
3 GPA	1.2	23.6	18.3	340	8034	1433
ANOVA p-value[X]	0.639	0.382	0.066	0.077	0.975	0.545
Fungicide x application method[X]	0.055	0.839	0.338	0.476	0.538	0.399
Fungicide x starter fertilizer[X]	0.244	0.434	0.633	0.641	0.263	0.244
Fungicide x application x starter[X]	0.663	0.781	0.021	0.028	0.741	0.291

W Main effect of in-furrow fungicide; the no fungicide treatment was not included in the statistical analysis to keep treatments balanced but values are shown for comparison; data represent mean of 16 plots averaged across application method and starter fertilizer treatment.

X ANOVA = Analysis of Variance, *P*-values less than 0.05 indicate significant differences among treatment main effects or significant interactions

Y Main effect of in-furrow fungicide application method; data represent mean of 24 plots averaged across fungicide and starter fertilizer.

Z Main effect of starter fertilizer; data represent mean of 24 plots averaged across fungicide and application method.

For planting date one, there were no significant interactions for fungicide by application method or fungicide by starter fertilizer for any harvest variables. There were significant interactions for fungicide by application method by starter fertilizer only for percent sugar and pounds of sugar per ton (Table 2). In addition, main effects of in-furrow fungicide, application method, and starter fertilizer were not significant for any harvest variable (Table 2).

For planting date two, there were no significant two- or three-way interactions except for a fungicide by starter fertilizer interaction on percent sugar (Table 3). There were no significant main effects for in-furrow fungicide or starter fertilizer. There was a significant effect of application method on RCRR ratings (Table 3). Plots receiving drip tube applications of fungicides averaged a root rot rating of 1.3 compared to plots receiving t-band applications of fungicides, which averaged 1.1, both extremely low disease ratings. Other harvest variables were not significantly (P = 0.05) different for fungicide application method, but there was a trend for plots receiving t-band applications to be higher in sucrose yields and revenue (Table 3).

DISCUSSION

The most important result in this trial was a significant (P = 0.05) in-furrow fungicide by application method effect on stand. Current hypothesis based on conventional wisdom is that in-furrow fungicides will have less detrimental effect on sugarbeet emergence when applied in a t-band verses down the drip tube. This is because with a t-band, the fungicide is spread out in a narrow band in the furrow so theoretically, less of the fungicide comes in contact with the seed. In this trial, results for Headline and Vertisan fit this hypothesis, but results for Quadris were the opposite. Stands were higher in plots receiving Quadris down the drip tube than in plots receiving Quadris in a

Table 3. Main effects of in-furrow fungicide, application method, and starter fertilizer (10-34-0) on Rhizoctonia crown and root rot (RCRR) and yield, quality, and revenue of sugar beet planted May 25, 2011.

Main effect	RCRR (0-7)	Yield T/A	Sucrose %	Sucrose lb/ton	Sucrose lb recov./A	Revenue ($/A)
In-furrow fungicide[W]						
No fungicide	1.2	23.2	17.6	324	7508	1276
Headline	1.3	21.5	17.7	325	6961	1186
Quadris	1.2	22.4	17.5	321	7168	1206
Vertisan	1.2	22.1	17.2	314	6946	1146
ANOVA p-value[X]	0.513	0.297	0.119	0.142	0.479	0.411
Application method[Y]						
Drip tube	1.3	21.8	17.3	316	6885	1143
T-band	1.1	22.2	17.6	324	7166	1216
ANOVA p-value[X]	0.037	0.385	0.079	0.092	0.099	0.056
Starter fertilizer (10-34-0)[Z]						
None	1.3	22.0	17.3	318	6977	1164
3 GPA	1.2	22.0	17.6	322	7073	1195
ANOVA p-value[X]	0.182	0.962	0.134	0.323	0.566	0.395
Fungicide x application method[X]	0.387	0.264	0.178	0.261	0.823	0.905
Fungicide x starter fertilizer[X]	0.561	0.553	0.042	0.053	0.236	0.095
Fungicide x application x starter[X]	0.234	0.459	0.171	0.220	0.163	0.108

W Main effect of in-furrow fungicide; the no fungicide treatment was not included in the statistical analysis to keep treatments balanced but values are shown for comparison; data represent mean of 16 plots averaged across application method and starter fertilizer treatment.

X ANOVA = Analysis of Variance, *P*-values less than 0.05 indicate significant differences among treatment main effects or significant interactions

Y Main effect of in-furrow fungicide application method; data represent mean of 24 plots averaged across fungicide and starter fertilizer.

Z Main effect of starter fertilizer; data represent mean of 24 plots averaged across fungicide and application method.

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t-band. The same equipment was used for application of all three fungicides and was rinsed well between each fungicide. These results were consistent for both plantings of this trial, but are not consistent with anecdotal evidence from Michigan where growers use t-band applications of Quadris in-furrow to reduce detrimental effects on stand.

This trial was set up in a low disease pressure site since it was intended to assess possible phytotoxic effects of in-furrow fungicide and starter combinations. Although there were effects on stand, there were no other visible effects of phytotoxicity (stunting, discoloration) on seedling foliage. Plants compensated for early stand differences and by harvest, the same fungicide by application method interactions did not occur.

Phytotoxic effects on sugarbeet seedling stands by in-furrow fungicides and application method are likely to vary with environmental conditions such as soil moisture, temperature, and soil type. Caution should be exercised in making conclusions based on this trial in one location. A modification of this trial will be repeated in 2012.

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