EFFECT OF IN-FURROW FUNGICIDE APPLICATION METHOD ON CONTROL OF RHIZOCTONIA AND SUGARBEET STAND ESTABLISHMENT

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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 postemergence.

The registered fungicides Quadris (azoxystrobin, Syngenta Crop Protection, Inc.), Headline (pyraclostrobin, BASF), and Vertisan (penthiopyrad, DuPont) control RCRR when applied in-furrow. These fungicides can be applied in-furrow by two methods: 1) down a drip-tube (often mixed with starter fertilizer) or 2) in a t-band behind disc openers (with starter fertilizer applied down the drip-tube). Questions have arisen about the relative efficacy in controlling *Rhizoctonia* and safety on seedling emergence when these fungicides are applied with these two in-furrow methods in combination with starter fertilizer.

OBJECTIVES

A field trial was established to evaluate in-furrow fungicides applied down the drip tube or in a t-band when starter (10-34-0) fertilizer is also applied for control of *Rhizoctonia* and effect on sugarbeet emergence, yield, and quality.

MATERIALS AND METHODS

The trial was established at two locations, one at the University of Minnesota, Northwest Research and Outreach Center, Crookston and another near Foxhome, MN. Both locations were fertilized for optimal yield and quality. The trial was sown at both locations in six-row plots (22-inch row spacing) at a 4.5-inch seed spacing. Counter 20 G (9 lb A^{-1}) was applied at planting for control of root maggot. At both locations, Headline, Quadris, and Vertisan were applied in-furrow at 0.5, 0.6, and 1.2 fl oz product per 1,000 ft of row (= 12, 14.5, and 28.5 fl oz product A^{-1}), respectively by two methods. Each in-furrow fungicide was applied down the in-furrow drip tube or in a t-band directly behind the disc openers 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. No-fungicide controls with and without postemergence Quadris applications also were included. Treatments were arranged in a randomized block design with four replicates.

NWROC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley (35 kg ha^{-1}). The trial was sown on May 9 with a *Rhizoctonia*-susceptible variety (2011 rating = 4.6). Glyphosate (4.5 lb product ae/gallon, 22 oz A^{-1}) was applied on June 13 and July 8 for control of weeds. Postemergence application of Quadris for control treatment was made on June 12 (35 days after planting). Cercospora leaf spot was controlled by application of 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 August 23. Stand counts were taken 2-7 weeks after planting. The center two rows of plots were harvested September 19 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).

Foxhome site. The trial was sown on May 16 with a *Rhizoctonia*-susceptible variety (2011 rating = 4.7). Glyphosate (4.5 lb product ae/gallon) tank-mixed with AMS (8.5 lbs A^{-1}) and Fusilade DX (12 oz A^{-1}) was applied on June 13. This weed control application was repeated again on July 1 (less the graminicide). Postemergence application of Quadris for control treatment was made on June 24 (39 days after planting). Cercospora leafspot was controlled by separate applications of Inspire (7 oz A^{-1}) on July 25 and TPTH/Topsin (5 & 7.6 oz A^{-1}, respectively) on August 9. All fungicides for CLS control were applied utilizing a UTV-mounted sprayer dispersing the products in broadcast pattern at a water volume of 15 GPA with TeeJet 8002 flat fan nozzles at 80 psi. Stand counts were taken 2-7 weeks after planting. Three rows of each plot were harvested October 1 and data were collected for 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 interaction of fungicide x application method using SAS (SAS Institute, Cary, NC).

RESULTS AND DISCUSSION

NWROC site. There were significant (P = 0.05) in-furrow fungicide by application method interactions for stand at 43 days after planting and for the number of harvested roots. These interactions are illustrated in the early-season stand graphs for each in-furrow fungicide in Fig. 1. When Headline or Vertisan were the in-furrow fungicide, Fig. 1 A and C, respectively, stands were similar regardless of application method and higher than the no fungicide control. However, when Quadris was applied in-furrow (Fig. 1B), stand was lower with the t-band application and similar to stand with no fungicide compared to stand with the drip-tube application. This was likely due to phytotoxicity with Quadris applied by t-band as we have seen in previous trials, especially when starter fertilizer was used as it was in this trial (1, 2).

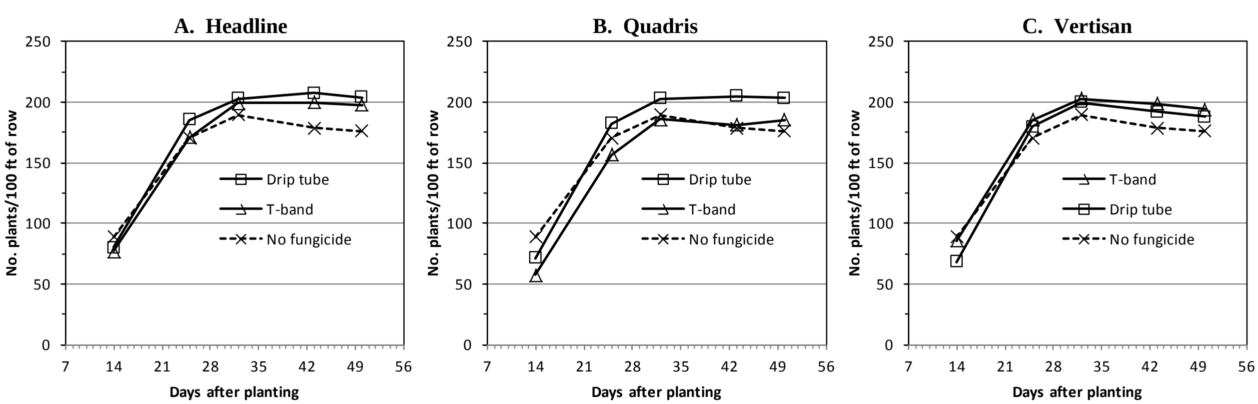

Fig. 1. Emergence and stand establishment of sugarbeet plots treated with **A)** Headline, **B)** Quadris, or **C)** Vertisan in-furrow in a t-band or down the drip tube in trials sown on May 9, 2013 at the University of Minnesota, NWROC; there were significant (P = 0.05) in-furrow fungicide x application method interactions for stand at 43 days after planting.

Table 1. Main effects of in-furrow fungicide and application method compared to no-fungicide controls for Rhizoctonia crown and root rot (RCRR), yield, and quality of sugar beet planted May 9, 2013 at the University of Minnesota, NWROC.

Main effect	No. harv. root/100 ft	RCRR (0-7)	Yield T A^{-1}	Sucrose %	Sucrose lb ton^{-1}	Sucrose lb recov. A^{-1}
Controls[W]						
Non-inoculated	178	1.2	27.3	17.7	334	9104
No fungicide	142	1.5	25.5	16.7	314	8005
No in-furrow fungicide, Quadris PE	151	1.2	28.1	16.1	304	8515
In-furrow fungicide[X]						
Headline	175	1.2	27.8	17.1	323	8927
Quadris	161	1.3	26.5	16.6	312	8257
Vertisan	166	1.4	27.2	17.0	321	8735
ANOVA p-value[Y]	0.052	0.259	0.466	0.498	0.482	0.297
Application method[Z]						
Drip tube	173	1.4	27.0	16.6	313	8458
T-band	162	1.3	27.3	17.2	324	8821
ANOVA p-value[Y]	0.023	0.129	0.785	0.132	0.175	0.313
Fungicide x application method[Y]	0.029	0.443	0.722	0.461	0.566	0.491

[W] Control treatments are not included in the statistical analysis to keep treatments balanced for factorial analysis but values are shown for comparison; data represent mean of 4 replicate plots.

[X] Main effect of in-furrow fungicide; data represent mean of 8 plots averaged across application method.

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

[Z] Main effect of in-furrow fungicide application method, in-furrow fungicides applied in-furrow either down drip tube or via t-band (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); data represent mean of 12 plots averaged across in-furrow fungicide.

There were no significant in-furrow fungicide by application method interactions for RCRR rating, yield, or sucrose, and main effects of in-furrow fungicide and application method are summarized in Table 1. The control data was not included in the statistical analysis in order to keep treatments balanced for the factorial analysis, but is shown for comparison and indicates a low level of disease pressure early in the season that reduced stand (see also Fig. 1) and affected the number of harvested roots. The middle and later portion of the growing season were very dry, and thus disease pressure was low. There were no significant main effects of in-furrow fungicide or fungicide application method for any of the harvest parameters (Table 1). The relative efficacy of fungicides applied down the drip-tube compared to t-band could not be determined due to lack of disease pressure. Rhizoctonia crown and root rot ratings averaged 1.3 for the trial and ranged from 1.2 to 1.5 (on a 0-7 scale) among all treatments. These ratings are too low to cause any yield or quality damage to sugarbeet.

Foxhome site. There were no significant in-furrow fungicide by application method interactions for either stand (Fig. 2) or harvest data (Table 2). In contrast to the NWROC site where stand was lower with Quadris applied via the t-band (Fig. 1B), the stand data shown in Fig. 2 indicates similar stand for both drip-tube and t-band application methods for all three fungicides. Clearly, there is variability in the detrimental effect of Quadris applied in combination with starter fertilizer among different soils and environments. In addition, the stand in plots with no fungicide application was similar to stand in fungicide-treated plots indicating a lack of any early-season disease pressure.

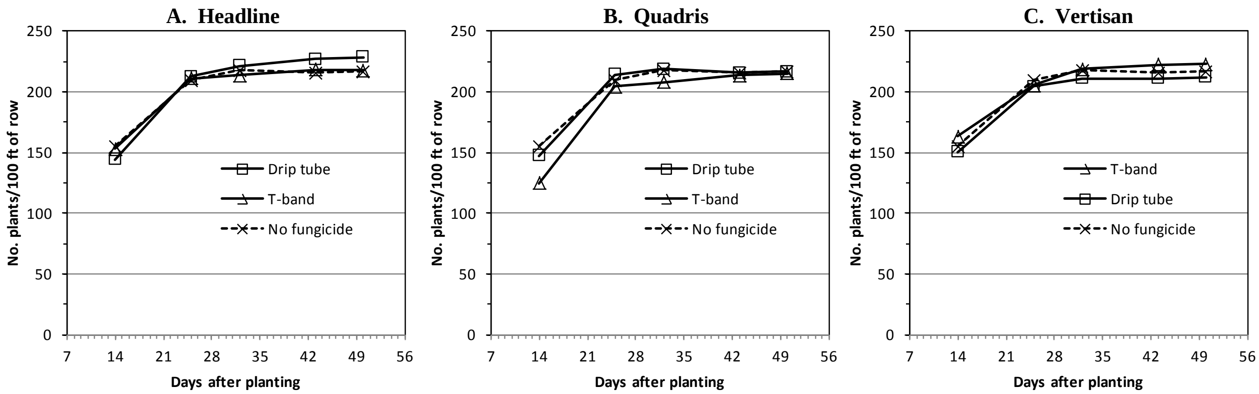

Fig. 2. Emergence and stand establishment of sugarbeet plots treated with **A)** Headline, **B)** Quadris, or **C)** Vertisan in-furrow in a t-band or down the drip tube in trials sown on May 16, 2013 near Foxhome, MN; there were no significant (*P* = 0.05) in-furrow fungicide x application method interactions.

Table 2. Main effects of in-furrow fungicide and application method compared to no-fungicide controls for Rhizoctonia crown and root rot (RCRR), yield, and quality of sugar beet planted May 16, 2013 near Foxhome, MN.

Main effect	RCRR (0-7)	Yield T A^{-1}	Sucrose %	Sucrose lb ton^{-1}	Sucrose lb recov. A^{-1}
Controls[W]					
No fungicide	1.3	25.3	16.6	278	7032
No in-furrow fungicide, Quadris PE	1.3	24.7	16.3	270	6668
In-furrow fungicide[X]					
Headline	1.2	24.8	16.7	279	6924
Quadris	1.2	25.7	16.5	276	7071
Vertisan	1.2	25.5	16.8	283	7220
ANOVA p-value[Y]	0.842	0.177	0.525	0.366	0.256
Application method[Z]					
Drip tube	1.2	25.3	16.6	278	7038
T-band	1.2	25.3	16.7	281	7106
ANOVA p-value[Y]	0.723	0.947	0.834	0.491	0.631
Fungicide x application method[Y]	0.842	0.582	0.534	0.574	0.492

[W] Control treatments are not included in the statistical analysis to keep treatments balanced for factorial analysis but values are shown for comparison; data represent mean of 4 replicate plots.

[X] Main effect of in-furrow fungicide; data represent mean of 8 plots averaged across application method.

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

[Z] Main effect of in-furrow fungicide application method, in-furrow fungicides applied in-furrow either down drip tube or via t-band (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); data represent mean of 12 plots averaged across in-furrow fungicide.

The lack of disease pressure at Foxhome resulted in average RCRR ratings of 1.2 for the whole trial with a range of 1.2 to 1.3 among treatments. Similar to the NWROC site, these ratings are much too low to cause any yield or quality damage to sugarbeet. As a result, there were no significant main effects of in-furrow fungicide or application method at Foxhome (Table 2), and the relative efficacy of in-furrow application methods could not be determined.

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