BAND-APPLICATION OF FUNGICIDES TO CONTROL RHIZOCTONIA CROWN AND ROOT ROT

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Rhizoctonia crown and root rot (RCRR), caused by *Rhizoctonia solani* AG 2-2, is becoming a more frequent and widespread disease in the sugarbeet-growing regions of Minnesota and North Dakota. In this region, symptoms of RCRR typically begin after the last cultivation (near canopy closure, when soil is deposited in the crown) and continue to develop until harvest. As inoculum densities increase in soil, *R. solani* AG 2-2 also can cause damping-off and early-season root rot. Integrated disease management strategies are available including sowing partially resistant varieties, using cultural practices (e.g., rotation with non-host crops, slow cultivation to avoid throwing soil into crowns), and applying fungicides.

OBJECTIVES

The objectives of this trial were to determine effectiveness of band applications of various fungicides before row closure for a.) control of Rhizoctonia crown and root rot and b.) sugarbeet yield and quality. The 2008 growing season is the first year of this trial.

MATERIALS AND METHODS

The trial was established in the Rhizoctonia Nursery at the University of Minnesota, Northwest Research and Outreach Center, Crookston. Plots were fertilized with nitrogen and urea, phosphorus, and potassium to attain recommended soil fertility levels. On May 13, 2008, sugarbeet seed of 'VDH 46531' was sown every 2.6-inches in 30-ft rows, 22-inches apart. Each plot was 11-ft wide (six rows) and 30-ft long and replicated four times in a randomized block design. Plots were thinned to the equivalent of 175 plants per 100-ft row on June 23.

The insecticide Counter was applied modified in-furrow at planting (9.5 lb A^{-1}). Microrates of Betanex + Upbeet + Stinger + Clethodim + MSO (0.5pt + 0.125 oz + 25-30 ml + 70-130 ml + 1-1.25 pt A^{-1}, respectively) were applied on June 4, 8, 15, 25 and 30. Betamix (0.75-1.5 pt A^{-1}) was substituted for Betanex on the second through fifth applications and Stinger was included in the first and third applications. Fungicides were applied to control Cercospora leaf spot on August 2 (SuperTin, 5 oz A^{-1}), August 13 (Eminent, 13 oz A^{-1}), and September 9 (Headline, 9 oz A^{-1}) with a tractor-mounted sprayer with TeeJet 8002 flat fan nozzles (20 gallons A^{-1}, 100 psi).

On July 14, four center rows of each plot (~ 10-leaf stage) were treated with BAS 556F (metconazole + pyraclostrobin), Carumba (metconazole), Headline (pyraclostrobin), two rates of Inspire XT (propiconazole + difenoconazole), Moncut (flutolanil, 70%), Proline (prothioconazole), or Quadris (azoxystrobin) at rates shown in Table 1. The amounts listed are equal to the amount of fungicide per acre when applied in a band. Twenty-four hours after fungicide application, plants were inoculated with *R. solani* AG 2-2 IIIB 87-36-4, a virulent isolate. The fungus was grown on sterilized barley grain for 3 weeks, dried, and ground in a Wiley mill (#3 round-hole screen, 1/8-inch mesh). A 28-g quantity of ground, *R. solani*–infested barley grain was spread over each 30-ft row by two, 0.65 mile per hour passes with a Gandy granule applicator (setting number 30, a standard method of inoculation). There were two controls: one was not inoculated or treated with fungicide and the other was inoculated with *R. solani* and not treated with fungicide. Plots were deep-cultivated immediately after inoculation to throw soil into crowns to favor development of disease.

Two center rows of each plot were mechanically harvested on October 2. Roots (20 per plot) were rated for RCRR with a 0 to 7 scale where 0 = root clean and no scars (rare, even in disease-free fields); 1 = superficial, scurfy, non-active lesions/scarring (typical, even in disease-free fields); 2 = shallow rot, dry rot cankers, or active lateral lesions affecting $\leq$ 5% of root; 3 = deep, dry canker at crown or extensive lateral lesions affecting 6-25% of root, usually

cracks or cankers present; 4 = extensive rot, 26–50% of tap root with cankers, lesions up to 5-mm deep; 5 = $\geq$ 50% of tap root rotted with rot extended into interior; 6 = entire root rotted except for tip; and 7 = root 100% rotted and foliage dead. Ten roots were randomly selected from each plot and analyzed for sucrose and quality by the American Crystal Sugar Company Quality Laboratory, East Grand Forks, MN.

Data were subjected to analysis of variance and if significantly different (P = 0.05 or = 0.10), means were separated by Least Significant Difference. Correlations were calculated between RCRR ratings and root yield and between RCRR ratings and recoverable sucrose per acre.

RESULTS

Rhizoctonia crown and root rot. There were no obvious above ground symptoms of RCRR (yellowing, wilting, darkening of petioles, collapse of foliage on the soil surface) during the growing season. Nor were there significant differences in number of roots harvested per treatment (Table 1).

When roots were dug, symptoms of RCRR were observed (Table 1). At P = 0.05, disease ratings were equally low in the no fungicide non-inoculated control (RCRR = 2.3) and in inoculated plots treated with Quadris (RCRR = 2.4); at this disease rating ~ 5% of root surface has superficial lesions or scarring. Disease was highest and equally severe in the *R. solani*-inoculated control plots (RCRR = 4) and in inoculated plots treated with Proline (3.6), Carumba (3.7), and both rates of Inspire XT (3.7 and 4.3); at this disease rating, from 6 to 25% of the root is affected by a deep, dry rot canker at crown or extensive lesions, usually with cracks or cankers. Inoculated plots treated with Headline, Moncut or BAS 556F had intermediate disease ratings between both controls.

When P = 0.10, disease ratings were equal and significantly lower for the non-inoculated control and inoculated plots treated with Quadris compared to the inoculated control (Table 1). The other fungicides had intermediate root rot ratings, except for the low rate of Inspire XT, which had the most disease.

Sugarbeet yield and quality. There was a significant (P = 0.05) negative correlation (r = -0.7676) between root rot ratings and root yield (increases in disease decreased root yield). When P = 0.05, root yields were the same and significantly higher for both controls and the inoculated plots treated with fungicides compared to *R. solani*-inoculated plots treated with the low rate of Inspire XT (Table 1). When P = 0.10, the non-inoculated control had a significantly higher root yield than inoculated plots treated with BAS 556F or both rates of Inspire XT (Table 1). Inoculated plots treated with the other fungicides had intermediate root yields, except for plots treated with the low rate of Inspire XT, which had significantly lower yields than all inoculated fungicide treatments and both controls.

There were no differences among inoculated plots treated with fungicides and both controls for percent sucrose and pounds of sucrose per ton at P = 0.05 or 0.10.

There was a significant (P = 0.01) negative correlation (r = -0.8316) between root rot rating and pounds of recoverable sucrose per acre (increases in disease decreased recoverable sucrose). At P = 0.05, there were no significant differences among fungicide-treated and control plots for pounds of recoverable sucrose (Table 1). When P = 0.10, pounds of recoverable sucrose per acre were significantly higher for the non-inoculated control compared to *R. solani*-inoculated plots treated with Headline, BAS 556F or both rates of Inspire (Table 1). Inoculated plots treated with the other fungicides had intermediate values, except for plots treated with the low rate of Inspire XT, which yielded significantly less sucrose than both controls and the other fungicide treatments.

DISCUSSION

There were no clear-cut benefits in disease control with band applications of most fungicides, with the exception of Quadris (azoxystrobin), which reduced RCRR and increased root yield similar to the non-inoculated control. Overall, there was a tendency for the Quinone outside inhibitor (strobilurin) fungicides and the carboxamide (Moncut) to be somewhat more effective than the DeMethylation Inhibitors (DMIs, triazoles) in controlling RCRR and/or increasing sugarbeet yields. Stump and Franc (1) and Kirk et al. (2) reported that Proline reduced RCRR nearly as effectively as Quadris. It is unknown why performance of Proline in our trial was not as promising as studies in Wyoming (1) and Michigan (2). Our results are based on one year will have to be repeated.

Table 1. Severity of Rhizoctonia crown and root rot (RCRR) and yield and quality of sugar beet 'VDH 46531'. Crowns were treated at the 10-leaf stage with a 7-inch band application of the several fungicides and 24 hr later, inoculated with *R. solani* AG 2-2; a control was inoculated with *R. solani* (no fungicide) and another control was not treated with fungicide or inoculated. The trial was conducted at the University of Minnesota, Northwest Research and Outreach Center, Crookston and sown on May 13 and harvested on October 2, 2008.
NOTE: Table is based on one year of data.

Treatment and rate (7-inch band)[W]	Group name [X] (common name)	No. harv. root/60-ft [Z]	RCRR (0-7)[YZ]	Yield T/A[Z]	Sucrose[Z] %	lb/ton	lb recov/A
Control (non-inoculated)	No fungicide	89	2.3 a A	28.3 a A	16.1	302	8553 A
Inoculated with *R. solani*							
Quadris @ 14.25 fl oz	QoI (azoxystrobin)	89	2.4 ab A	27.2 a AB	15.6	291	7890 AB
Headline @ 12 fl oz	QoI (pyraclostrobin)	88	3.5 abc BC	25.5 a AB	15.3	283	7234 B
Moncut @ 1.1 lb prod	Carboxamides (flutolanil)	91	3.3 abc AB	26.7 a AB	15.3	285	7558 AB
BAS 556F @ 11 fl oz	DMI + QoI (metconazole+pyraclostrobin)	85	3.6 bc BC	24.8 a B	15.6	292	7230 B
Proline @ 5.7 fl oz	DMI (prothioconazole)	83	3.6 c BC	25.2 a AB	15.7	293	7322 AB
Carumba @ 17 fl oz	DMI (metconazole)	88	3.7 c BC	26.3 a AB	15.3	283	7480 AB
Inspire XT @ 7 fl oz	DMI (propiconazole+difenoconazole)	89	3.7 c BC	24.9 a B	15.4	286	7115 B
Inspire XT @ 2.23 fl oz	DMI (propiconazole+difenoconazole)	75	4.3 c C	19.3 b C	15.3	283	5527 C
Control (no fungicide)		91	4.0 c BC	25.5 a AB	15.3	285	7292 AB
LSD ($P = 0.05$)		NS	1.4	4.5	NS	NS	NS
LSD ($P = 0.10$)		NS	1.1	3.7	NS	NS	1411

[W] Each treatment (6, 30-ft rows/treatment) replicated four times in a randomized block design. Fungicides applied on July 14 in a 7-inch band into the crown; rate equals total amount of fungicide A^{-1} applied in a band. Inoculum of *R. solani* AG 2-2 (grown on sterile barley grain and ground in a Wiley mill) was applied on July 15 with a Gandy granule applicator (28 g of inoculum per 30-ft row, four center rows of each plot).

[X] QoI = Quinone outside Inhibitors, DMI = DeMethylation Inhibitors.

[Y] RCRR = Rhizoctonia crown and root rot; rated on a 0 to 7 scale where 0 is root healthy and no scarring and 7 = root completely rotted and foliage dead. **Note to above table:** rating of ~2 = ≤ 5% of root surface affected by superficial lesions or scarring; rating ~ 4 = 6- 25% of root affected by a deep, dry rot canker at crown or extensive lesions, usually with cracks or cankers.

[Z] LSD = Least significant difference; when $P = 0.05$, for each column, numbers followed by the same "lower case" letter(s) are not significantly different; when $P = 0.10$, for each column, numbers followed by the same "upper case (capitol)" letter(s) are not significantly different; NS = not significantly different

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Benefits of fungicide treatments may have been more evident if disease had been more severe, however, increases in RCRR ratings correlated with decreased root and sucrose yields. Nevertheless, under moderate disease pressure, Quadris significantly reduced RCRR and tended to increase yield and sucrose compared to other fungicides. The Rhizoctonia Nursery is inoculated every year near canopy closure and then cultivated so soil is thrown into crowns to ensure uniform disease. The Rhizoctonia Nursery is not irrigated (no access to water), but plots typically sustain a high level of disease. In 2008, there was no significant rainfall until 1 week after inoculation (0.4-inches on July 23) and again, a week later (0.83 inches on July 29). These conditions may have adversely affected survival and/or infectivity of inoculum. The September 9 application of the strobilurin Headline for control of Cercospora leaf spot may have adversely affected development of RCRR, but impact likely was minimal because of the late date of application.

Some of these products will be re-evaluation for control of RCRR in 2009.

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