INTEGRATED MANAGEMENT OF RHIZOCTONIA ON SUGARBEET WITH RESISTANT VARIETIES, AT-PLANTING TREATMENTS, AND POSTEMERGENCE FUNGICIDES

Ashok K. Chanda[1], Jason R. Brantner[2], Mike Metzger[3], Mark Bloomquist[4] and David Mettler[5]

[1]Assistant Professor and Extension Sugarbeet Pathologist, [2]Senior Research Fellow
University of Minnesota, Department of Plant Pathology & Northwest Research and Outreach Center, Crookston, MN, [3]Research Agronomist, Minn-Dak Farmers Cooperative, Wahpeton, ND
[4]Research Director, [5]Research Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, MN

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, 3-4,6). Disease can occur throughout the growing season and reduces plant stand, root yield, and quality. 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), or postemergence. An integrated management strategy should take advantage of multiple control options to reduce Rhizoctonia crown and root rot.

OBJECTIVES

A field trial was established to evaluate an integrated management strategy consisting of a resistant (R) and a moderately susceptible (MS) variety with new available seed treatments alone and in combination with two postemergence azoxystrobin application timings for 1) control of early-season damping-off and RCRR and 2) effect on yield and quality of sugarbeet.

MATERIALS AND METHODS

The trial was established at three locations, one at the University of Minnesota, Northwest Research and Outreach Center, Crookston, one at Wahpeton (MDFC), ND and one at Renville (SMBSC), MN. All locations were fertilized for optimal yield and quality. At each location, a combination of a R and MS variety treated with penthiopyrad (Kabina ST), fluxapyroxad (Systiva), sedaxane (Vibrance), or untreated was planted in four replicate plots. Plots were set up in a split-split plot design at all 3 locations. Main plots were varieties, the first split was seed treatments, and the last split was postemergence azoxystrobin timings. Seed treatments and rates are summarized in Table 1 and were applied by Germains Seed Technology, Fargo, ND. Each variety by seed treatment combination was planted in triplicate, so that at the 4- or 8-leaf stage, one plot of each variety by seed treatment combination received a postemergence 7-inch band application of azoxystrobin (14.3 fl oz product A^{-1}) while one was left as a stand-alone treatment. Controls for each variety included no seed treatment at planting with each postemergence azoxystrobin timing and without postemergence azoxystrobin. Two-year average Rhizoctonia ratings in American Crystal Sugar Company tests for the R and MS varieties were 4.0 and 4.7, respectively (7).

NWROC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley broadcast at 35 kg ha^{-1} and incorporated with a Rau seedbed finisher. The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 10 at 4.5-inch seed spacing. Counter 20G (8 lb A^{-1}) was applied at planting for control of sugarbeet root maggot. Glyphosate (4.5 lb product ae/gallon) was applied on May 15 (22 oz A^{-1}), June 1, 7, and 12 (28 oz A^{-1}), and July 5 (32 oz A^{-1}) for control of weeds. The June 1 application also included *S*-metolachlor (0.94 lb a.i. A^{-1}). Postemergence azoxystrobin timings were applied in a 7-inch band in 10 gallon/A using 4002 nozzles and 34 psi on June 12 (4-leaf stage, ~4.5 weeks after planting) or June 20 (8-leaf stage, 6 weeks after planting). Cercospora leaf spot was controlled by Supertin + Topsin M (6 + 10 oz product in 19 gallons of water A^{-1}) applied with 8002 flat fan nozzles at 100 psi on July 24 and Inspire (7 oz product in 19 gallons of water A^{-1}) on August 8.

MDFC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley (35 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 26 at 4.5-inch seed spacing. Glyphosate (4.5 lb product ae/gallon) tank-mixed with N-tense (9.6 oz A^{-1}) was applied on May 31. This weed control application was repeated again on June 20 and July 03 (plus Outlook 12 oz A^{-1}). Postemergence azoxystrobin was applied in a 7-inch band on June 16 (4-leaf stage, 3 weeks after planting) or June 29 (8-leaf stage, 5 weeks after planting). Cercospora leafspot was controlled by separate applications of TPTH+Topsin (8 & 10 oz A^{-1}, respectively) on July 13, Inspire XT+Badge SC (7 & 32 oz A^{-1}, respectively) on July 25, TPTH + Manzate (8 & 38.4 oz A^{-1}, respectively) on August 04, Minerva Duo (16 oz A^{-1}) on Aug 15 and TPTH+ Badge SC (8 & 32 oz A^{-1}, respectively) as last application on Aug 29. All fungicides for CLS control were applied utilizing a 3pt-mounted sprayer dispersing the products in broadcast pattern at a water volume of 15 GPA with TeeJet 8002 flat fan nozzles at 80 psi.

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 = 4.0) 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^{-1}) 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	Kabina ST	Penthiopyrad	14 g a.i./unit seed
Seed	Systiva	Fluxapyroxad	5 g a.i./unit seed
Seed	Vibrance	Sedaxane	1.5 g a.i./unit seed

Table 2. Monthly precipitation in inches at three sites during 2017 crop season based on weather stations.

	Precipitation in inches		
Month	NWROC	MDFC	SMBSC
May	0.94	1.33	2.42
June	3.41	3.64	1.18
July	1.42	2.62	1.97
August	0.77	5.00	6.92
September	4.01	4.31	1.34
Total	**10.55**	**16.91**	**13.83**

SMBSC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley (35 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 12 at 4.6-inch seed spacing. Weeds were controlled by application of Powermax (28 oz A^{-1}) + Dual magnum (16 oz A^{-1}) on June 5 and Powermax (22 oz A^{-1}) on July 06. Postemergence azoxystrobin timings were applied on June 09 (4-leaf, ~4 weeks after planting), or June 20 (8-leaf, ~5 weeks after planting) as 7 inch bands using 80002E nozzles at 40 psi. Fungicides were applied for controlling Cercospora leaf spot on July 10 (TPTH + Topsin, 8 & 20 oz A^{-1}, respectively), July 21 (Inspire XT + Badge SC, 7 & 32 oz A^{-1}, respectively), July 31 (TPTH + Dithane F-45, 8 & 51.2 oz A^{-1}, respectively), Aug 12 (Minerva + Dithane F-45, 13 & 51.2 oz A^{-1}, respectively), Aug 23 (TPTH + Badge SC, 8 & 32 oz A^{-1}, respectively) and Sept 06 (Proline + Dithane F-45, 5.7 & 51.2 oz A^{-1}, respectively). All fungicides for CLS control were applied in a water volume of 19.3 GPA with 11002 nozzles at 70 psi.

At NWROC stand counts were done beginning 2 weeks after planting through 8 weeks after planting. At MDFC stand counts were done 2 through 6 weeks after planting. At SMBSC stand counts were done 3, 5, and 8 weeks after planting. The trial was harvested on September 20 at the NWROC, Sept 19 at Renville and October 09 at Wahpeton. Data were collected for number of harvested roots (NWROC only), 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). Disease incidence was reported as the percent of rated roots with a root rot rating of > 2.

Data were subjected to analysis of variance using SAS Proc GLM (SAS Institute, Cary, NC) for main effects of variety, at-plant treatment, postemergence azoxystrobin application, and all possible interactions. Means were separated by Fisher's Protected Least Significant Difference (P = 0.05).

RESULTS AND DISCUSSION

NWROC site: 2017 growing season was drier and cooler at the NWROC during the period of May - August. Rainfall at the NWROC was just 0.94 inch during the month of May compared to a 30-year average of 3.04 inches for May. Average four-inch bare soil temperatures at the NWROC were 52.4 °F and 61.9 °F for the months of May and June, respectively. Average four-inch soil temperature did not cross 65 °F until July 04. There were no significant ($P > 0.05$) two way or three way interactions for stand data. For harvest data there was a significant seed treatment x postemergence application interaction ($P < 0.05$) for root rot rating and incidence (Tab. 3). Resistant and moderately susceptible variety had similar stands from 2 to 8 weeks after planting (WAP). At-planting (seed) treatments and untreated control had similar stands at 2 WAP and by 3 WAP all the seed treatments had higher stands compared to untreated control. At 5 WAP, Vibrance had highest stands, Kabina and Systiva had intermediate, and untreated control had lowest stands (Fig. 1). Total rainfall for the months of May - August was 6.54 inches in 2017 compared to a 30-year average of 12.88 for the same time period. Soil moisture remained low throughout the growing season, resulting in low Rhizoctonia disease pressure in this trial. As a result, there were no significant differences among treatments for Rhizoctonia root rot or yield and quality parameters between varieties and also untreated control and seed treatments. There were no significant differences between two varieties for harvest data (Tab. 3). Yield, percent sucrose, recoverable sucrose A^{-1} (RSA), percent sucrose and recoverable sucrose T^{-1} (RST) were not significantly different for the seed treatments and untreated control (Tab. 3). Yield, percent sucrose, RSA and RST were not significantly different between Quadris (4- or 8-leaf) and no Quadris application. Some rainfall in September created slight disease pressure in the plots leading to minor differences in disease severity between no Quadris and 4-8 leaf Quadris applications. Root rot severity and percent incidence (percent of roots with a disease rating of > 2.0) was slightly higher in the no Quadris treatments for control and all seed treatments, intermediate in 4-leaf Quadris treatments for control and all seed treatments, and lowest in 8-leaf Quadris for control, Kabina, and Vibrance treatments (Figs. 2A and 2B). Similar benefit from postemergence Quadris application was also evident in 2016 (5).

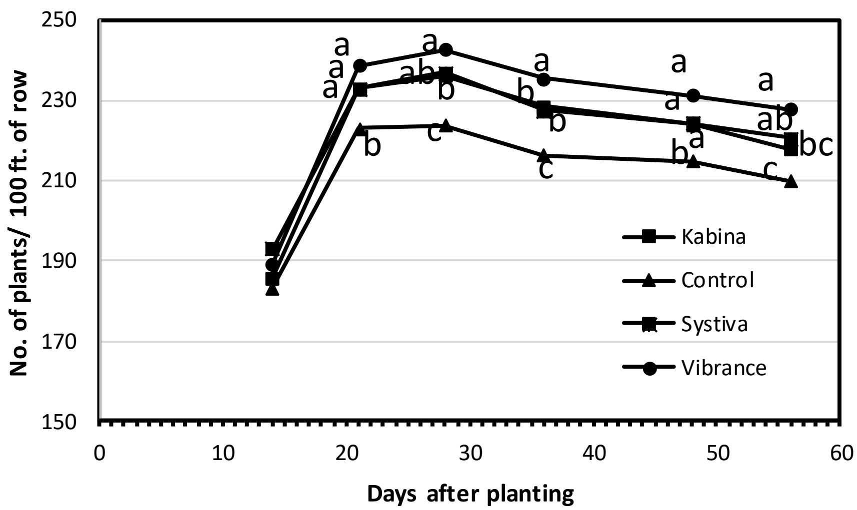

Fig. 1. NWROC site: Emergence and stand establishment for fungicide treatments on seed or untreated control. For each stand count date, values sharing the same letter are not significantly different ($P = 0.05$); NS = not significantly different. Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

Table 3. **NWROC site:** Main effects of variety, at-planting (seed), and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial sown May 10, 2017.

Main effect (Apron + Maxim on all seed)	No. harv. roots/100 ft[T]	RCRR (0-7)[TU]	RCRR % incidence[TV]	Yield ton A^{-1T}	Sucrose[T] %	Sucrose[T] lb ton^{-1}	Sucrose[T] lb A^{-1}
Variety[W]							
Resistant	184	0.6	4.6	19.3	18.3	345	6630
Moderately Susceptible	196	0.7	11.4	20.8	17.8	333	6890
ANOVA p-value	0.1026	0.5862	0.3881	0.4668	0.2156	0.1528	0.642
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS	NS
At-planting treatments[X]							
Untreated control	185	0.8	9	20.6	18.0	339	6969
Kabina ST @14 g a.i./unit	189	0.7	10	20.0	18.0	338	6724
Systiva @ 5 g a.i /unit	190	0.7	9	19.7	18.0	338	6665
Vibrance @ 1.5 g a.i./unit	196	0.4	4	19.7	18.1	340	6681
ANOVA p-value	0.3296	0.2454	0.2666	0.5700	0.8385	0.9038	0.4313
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]							
None	185	1.0 a	14 a	19.5	18.0	338	6581
4-leaf Quadris @ 14.3 fl. oz./A	192	0.5 b	7 b	20.2	18.2	341	6874
8-leaf Quadris @ 14.3 fl. oz./A	192	0.4 b	4 b	20.3	18.0	338	6825
ANOVA p-value	0.0539	<0.0001	<0.0001	0.2045	0.2846	0.3927	0.1113
LSD (*P* = 0.05)	NS	0.19	3.2	NS	NS	NS	NS
Vty x Seed	NS	NS	NS	NS	NS	NS	NS
Vty x Post	NS	NS	NS	NS	NS	NS	NS
Seed x Post	NS	**0.0206**	**0.0086**	NS	NS	NS	NS
Vty x Seed x Post	NS	NS	NS	NS	NS	NS	NS

[T] Numbers followed by the same letter are not significantly different; LSD = Least Significant Difference, *P* = 0.05; NS = not significantly different

[U] RCRR = Rhizoctonia crown and root rot; 0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead

[V] RCRR = Rhizoctonia crown and root rot; percent of roots with rating greater than two

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

[X] Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

[Y] Values represent mean of 32 plots (4 replicate plots across 2 varieties and 4 at-planting treatments)

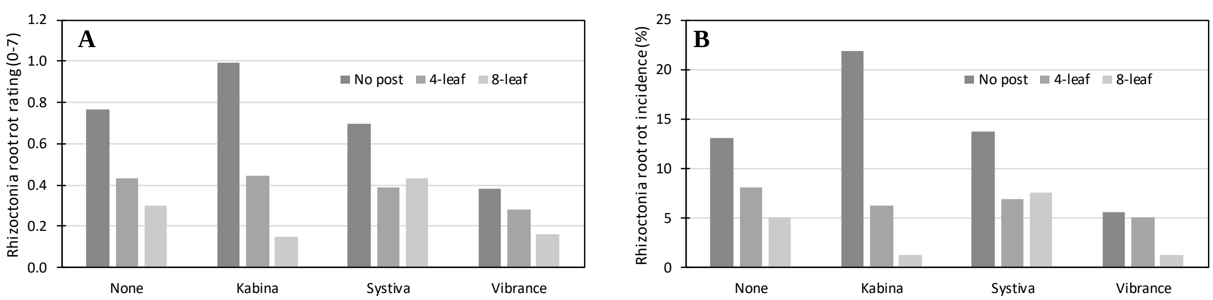

Fig. 2. NWROC site: Effect of seed and postemergence treatments on **A)** Rhizoctonia root rot severity (0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead) and **B)** Rhizoctonia root rot incidence (percent of roots with rating greater than two).

MDFC site: This site received below normal rainfall during May – July and above normal rainfall during August-September. Average 4-inch bare soil temperatures for May (59 °F) and June (68 °F) were lower compared to 2016 (64 °F and 74 °F for May and June, respectively). Average four-inch soil temperature was over 65 °F on June 02, reached ~ 70 °F for a week followed by a ~65 °F from June 17 until July 03. Low early season soil moisture coupled with lower soil temperatures did not create heavy disease pressure at this site. There were significant (P < 0.05) variety x seed treatment interactions and variety x seed treatment x postemergence three way interactions interactions for percent sugar, purity, and RST; variety x postemergence interactions for root rot rating (Tab. 4). Both varieties had similar stands until 6 WAP and had similar yield, percent sucrose, RST, and RSA (Tab. 4). There were no significant differences for stands between seed treatments and untreated control until 6 WAP. Yield was not significantly different between untreated control and seed treatments. Some rainfall in August and September created slight disease pressure in the plots leading to minor differences in disease severity and some harvest parameters between no Quadris and 4-8 leaf Quadris applications. Yield was not significantly different between no Quadris and 4- or 8-leaf application. RSA was higher in 8-leaf Quadris application compared to 4-leaf or no Quadris application. Root rot incidence was lower in 4- or 8-leaf application compared to no Quadris. For resistant variety, percent sucrose and RST were highest for untreated control and lowest for Systiva, whereas for moderately susceptible variety Systiva had highest percent sucrose and RST with lowest for Kabina (Figs. 3A and 3B). For resistant variety root rot severity was lowest for 4-leaf Quadris application, intermediate for 8-leaf and highest for no Quadris application (Fig. 3C). For moderately susceptible variety root rot severity was lower for 4- or 8-leaf Quadris application compared to no Quadris application (Fig. 3C). Similar benefit from postemergence Quadris application was also evident in 2016 (5).

Table 4. **MDFC site:** Main effects of variety, at-planting (seed), and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial sown May 26, 2017.

Main effect (Apron + Maxim on all seed)	RCRR (0-7) [TU]	RCRR % incidence [TV]	Yield ton A^{-1} [T]	Sucrose [T] %	Sucrose lb ton^{-1}	Sucrose lb A^{-1}
Variety [W]						
Resistant	0.3	6.1	27.0	16.2	266	7195
Moderately Susceptible	0.6	11.3	27.0	15.3	248	6698
ANOVA p-value	0.1203	0.1754	0.9775	0.0587	0.0756	0.2039
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS
At-planting treatments [X]						
Untreated control	0.5	10.8	27.2	15.9	262	7116
Kabina ST @14 g a.i./unit	0.4	7.9	26.5	15.5	252	6690
Systiva @ 5 g a.i /unit	0.4	7.9	27.3	15.8	257	7016
Vibrance @ 1.5 g a.i./unit	0.4	8.1	26.9	15.9	259	6963
ANOVA p-value	0.6365	0.5959	0.6152	0.4018	0.3529	0.2540
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS
Postemergence fungicide [Y]						
None	0.8 a	15.2 a	26.4	15.6 b	254 b	6720 b
4-leaf Quadris @ 14.3 fl. oz./A	0.3 b	5.0 b	27.1	15.7 b	255 b	6916 b
8-leaf Quadris @ 14.3 fl. oz./A	0.3 b	5.9 b	27.4	16.0 a	263 a	7203 a
ANOVA p-value	<0.0001	<0.0001	0.0612	0.0008	0.0002	0.0008
LSD (*P* = 0.05)	0.18	4.0	NS	0.18	4.28	240
Vty x Seed	NS	NS	NS	**0.0491**	**0.0485**	NS
Vty x Post	**0.0454**	NS	NS	NS	NS	NS
Seed x Post	NS	NS	NS	NS	NS	NS
Vty x Seed x Post	NS	NS	NS	**0.0209**	**0.0067**	NS

T Numbers followed by the same letter are not significantly different; LSD = Least Significant Difference, *P* = 0.05; NS = not significantly different

U RCRR = Rhizoctonia crown and root rot; 0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead

V RCRR = Rhizoctonia crown and root rot; percent of roots with rating greater than two

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

X Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

Y Values represent mean of 32 plots (4 replicate plots across 2 varieties and 4 at-planting treatments)

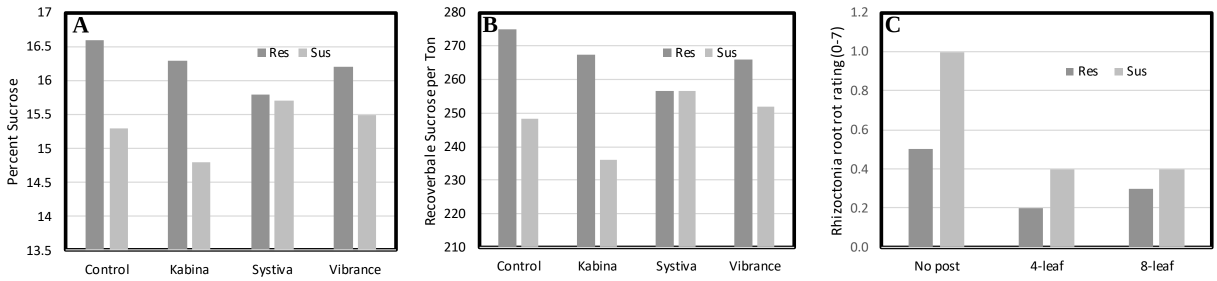

Fig. 3. MDFC site: Effect of variety and seed treatments on **A)** percent sucrose and **B)** recoverable sucrose per ton. Effect of variety and postemergence treatments on **C)** Rhizoctonia root rot severity (0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead).

Table 5. SMBSC site: Main effects of variety, at-planting (seed), and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial sown May 12, 2017.

Main effect	RCRR	RCRR %	Yield	Sucrose[T]		
(Apron + Maxim on all seed)	(0-7) [TU]	incidence[TV]	ton A^{-1T}	%	lb ton^{-1}	lb A^{-1}
Variety[W]						
Resistant	0.2	4	27.9	15.4	255	7117
Moderately Susceptible	0.7	14	29.8	14.4	232	6875
ANOVA p-value	0.5720	0.5290	0.0167	0.0256	0.0301	0.2042
LSD (*P* = 0.05)	NS	NS	1.2	0.78	19	NS
At-planting treatments[X]						
Untreated control	0.4	9	29.2	15.1	248	7211
Kabina ST @14 g a.i./unit	0.5	9	29.5	14.8	239	7014
Systiva @ 5 g a.i /unit	0.4	8	28.3	15.1	246	6974
Vibrance @ 1.5 g a.i./unit	0.5	9	28.3	14.8	241	6785
ANOVA p-value	0.7040	0.9277	0.8082	0.2471	0.2165	0.7068
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]						
None	0.6 a	11 a	29.1	14.9	242	7024
4-leaf Quadris @ 14.3 fl. oz./A	0.5 a	10 a	28.5	15.0	245	6950
8-leaf Quadris @ 14.3 fl. oz./A	0.3 b	5 b	29.0	14.9	244	7014
ANOVA p-value	0.0086	0.0043	0.4935	0.7539	0.6955	0.8390
LSD (*P* = 0.05)	0.19	3.7	NS	NS	NS	NS
Vty x Seed	NS	NS	NS	NS	NS	NS
Vty x Post	NS	NS	NS	NS	NS	NS
Seed x Post	**0.0138**	**0.0222**	NS	NS	NS	NS
Vty x Seed x Post	NS	NS	NS	NS	NS	NS

[T] Numbers followed by the same letter are not significantly different; LSD = Least Significant Difference, *P* = 0.05; NS = not significantly different

[U] RCRR = Rhizoctonia crown and root rot; 0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead

[V] RCRR = Rhizoctonia crown and root rot; percent of roots with rating greater than two

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

[X] Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

[Y] Values represent mean of 32 plots (4 replicate plots across 2 varieties and 4 at-planting treatments)

SMBSC site: This site received only 5.52 inches rainfall May-July in 2017 compared to 13.63 inches in 2016 making the early part of growing season on the drier side. The month of August received 6.92 inches rainfall followed by very dry September (1.34 inches and 4.84 inches in 2017 and 2016, respectively). Average four-inch bare soil temperatures at SMBSC were 57.7 °F and 70.2 °F for the months of May and June, respectively. Average four-inch bare soil temperature crossed 65 °F on June 01 which is typical for southern Minnesota. Low soil moisture during the growing season resulted in very low disease pressure at this site. There were significant ($P < 0.05$) seed treatment x postemergence application interactions for root rot rating and incidence and no three way interactions (Tab. 5). From 2 to 9 WAP there were no differences in stand between two varieties. However, by harvest, moderately susceptible variety had higher yield. Resistant variety had higher percent sugar and RST compared to moderately susceptible variety (Tab. 5). Stand data and harvest data were not different between seed treatments and untreated control (Tab. 5). Heavy rainfall in August created slight disease pressure in the plots leading to minor differences in disease severity and incidence between no Quadris and 4-8 leaf Quadris applications. Yield, percent sugar, RSA and RST were not significantly different between Quadris (4- or 8-leaf) and no Quadris application. Root rot severity and percent incidence (percent of roots with a disease rating of > 2.0) was higher for no Quadris and 4-leaf Quadris compared to 8-leaf Quadris for untreated control; highest for no Quadris, intermediate for 8-leaf and lowest for 4-leaf Quadris application for Kabina; higher for 4-leaf Quadris application compared to no or 8-leaf Quadris for Systiva; highest for no Quadris, intermediate for 4-leaf and lowest for 8-leaf Quadris application for Vibrance seed treatment (Figs. 4A and 4B).

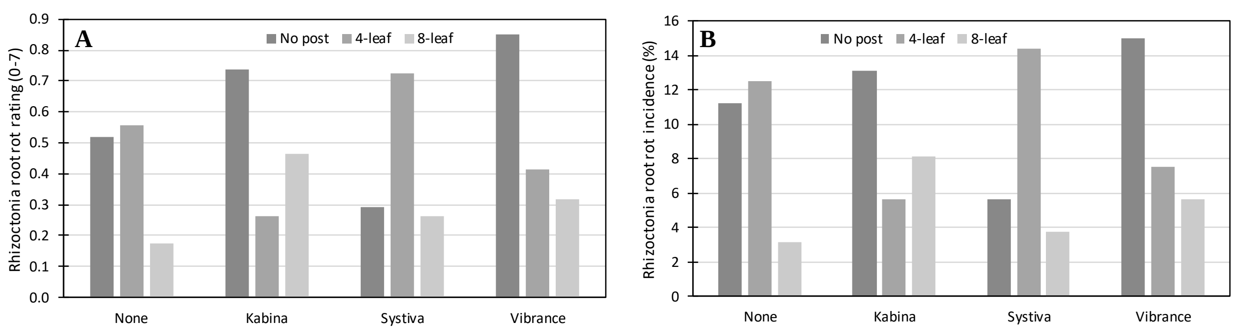

Fig. 4. SMBSC site: Effect of seed and postemergence treatments on **A)** Rhizoctonia root rot severity (0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead) and **B)** Rhizoctonia root rot incidence (percent of roots with rating greater than two).

ACKNOWLEDGEMENTS

We thank the Sugarbeet Research and Education Board of Minnesota and North Dakota for funding this research; BASF, Mitsui Chemicals Agro, Inc., and Syngenta for providing products; Crystal Beet Seed for providing seed; Germains Seed Technology for treating seed; staff from the Minn-Dak Farmers Cooperative for plot maintenance and harvest at the Wahpeton site; staff from the Southern Minnesota Beet Sugar Cooperative for plot maintenance and harvest at the Renville site; the University of Minnesota, Northwest Research and Outreach Center, Crookston for providing land, equipment and other facilities; Jeff Nielsen for plot maintenance; Hal Mickelson, Tim Cymbaluk, Brandon Kasprick, and Muira MacRae for technical assistance; Minn-Dak Farmers Cooperative, Wahpeton, ND for the Wahpeton site sugarbeet quality analysis; Southern Minnesota Beet Sugar Cooperative, Renville, MN for the Renville site sugarbeet quality analysis; and American Crystal Sugar Company, East Grand Forks, MN for NWROC site sugarbeet quality analysis.

LITERATURE CITED

1. Brantner, J.R. 2015. Plant pathology laboratory: summary of 2013-2014 field samples. 2014 Sugarbeet Res. Ext. Rept. 44:138-139.
2. Brantner, J.R., H.R. Mickelson, and E.A. Crane. 2014. Effect of *Rhizoctonia solani* inoculum density and sugarbeet variety susceptibility on disease onset and development. 2013 Sugarbeet Res. Ext. Rept. 44:203-208.
3. Brantner, J.R. and C.E. Windels. 2011. Plant pathology laboratory: summary of 2009-2010 field samples. 2010 Sugarbeet Res. Ext. Rept. 41:260-261.
4. Brantner, J.R. and C.E. Windels. 2009. Plant pathology laboratory: summary of 2007-2008 field samples. 2008 Sugarbeet Res. Ext. Rept. 39:250-251.
5. Chanda, A. K., Brantner, J. R., Metzger, M., Bloomquist, M., and Groen, C. 2017. Integrated Management of Rhizoctonia on Sugarbeet with Varietal Resistance, At-Planting Treatments and Postemergence Fungicides. 2016 Sugarbeet Res. Ext. Rept. 47:174-179.
6. Crane, E., Brantner, J.R., and Windels, C.E. 2013. Plant pathology laboratory: summary of 2011-2012 field samples. 2012 Sugarbeet Res. Ext. Rept. 43:169-170.
7. Niehaus, W.S. 2017. Results of American Crystal's 2016 Official Coded Variety Trials. 2016 Sugarbeet Res. Ext. Rept. 47:207-259.