RHIZOCTONIA CROWN AND ROOT ROT ON SUGARBEET FOLLOWING CORN

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Rhizoctonia crown and root rot (RCRR) of sugarbeet is caused by the soilborne fungus *Rhizoctonia solani*. The fungus is composed of genetically isolated populations called anastomosis groups or AGs (2). The AG population causing RCRR of sugarbeet is *R. solani* AG 2-2, which is further divided into the intraspecific groups (ISGs) AG 2-2 IIIB and AG 2-2 IV (2,4). While both ISGs cause RCRR on sugarbeet, AG 2-2 IV is reported as the primary cause (4) and AG 2-2 IIIB is reported as the more aggressive population (3).

Reports from Europe (1) indicate *R. solani* AG 2-2 IIIB is an aggressive root rot pathogen in rotations of corn and sugarbeet. In the southeastern U.S.A., *R. solani* AG 2-2 IIIB causes a crown root and brace root rot on corn. In recent field trials in the Red River Valley (RRV), we found that *R. solani* AG 2-2 IIIB caused lesions on roots of a conventional corn variety that displayed no aboveground symptoms of disease or effects on yield, while *R. solani* AG 2-2 IV rarely infected roots (7,8,9). Consequently, these reports have raise concerns about the presence and role of *R. solani* AG 2-2 IIIB and AG 2-2 IV in corn and sugarbeet rotations in the RRV and southern Minnesota.

A wide range of commercial corn varieties are sold in the RRV and southern Minnesota including conventional as well as transgenic (Roundup Ready and insect resistance - with traits for feed or ethanol production). Availability of short-season varieties in the RRV has resulted in increased corn acreage in recent years. In southern Minnesota, however, sugarbeet frequently follows field corn (75% acres), sweet corn (10%), soybean (10%), and other crops (5%). Producers in the RRV and southern Minnesota are reporting increases in RCRR of sugarbeet. The relationship of this disease to corn varieties grown the previous season is unknown.

OBJECTIVES

Field trials were established in the RRV and southern Minnesota to determine 1.) pathogenicity and survival of *R. solani* AG 2-2 IIIB and AG 2-2 IV on varieties of corn with different genetic traits, and 2.) effects on a subsequent sugarbeet crop.

MATERIALS AND METHODS

Field trials were established in 2007 at the University of Minnesota, Northwest Research and Outreach Center, Crookston (RRV) and in 2007 and 2008 by the Southern Minnesota Beet Sugar Cooperative in a field near Gluek, Minnesota. Main plots consisted of a non-inoculated control, inoculation with *R. solani* AG 2-2 IV, and inoculation with *R. solani* AG 2-2 IIIB (inoculum of *R. solani* was grown for 3 weeks on sterilized barley grain). Transgenic corn varieties (Roundup Ready, resistance to corn borer and root worm) with traits for feed or ethanol production were sown as subplots in each main plot (Table 1). Trials were arranged in a split-plot design with four replicates. Trials at both sites were sown to sugarbeet in 2008 and the repeat trial at Gluek will be sown to sugarbeet in 2009.

Field trial establishment: *Red River Valley*. At Crookston, main plots were 77 feet wide by 30 feet long. Plots were fertilized to 130 lb N A^{-1}acre; 30 lb P_2O_5 A^{-1} also was added. On May 17, 2007 main plots were inoculated with 26.4 oz of barley infested with *R. solani* AG 2-2 IV or *R. solani* AG 2-2 IIIB. *Rhizoctonia*-infested grains were sprinkled on the soil surface and incorporated with a Melroe multiweeder; control plots were not inoculated. Then, main plots were divided into seven, 11-ft wide subplots (6 rows, 22 inches apart), which were sown with six transgenic and one conventional corn variety (as sown in previous experiments [7,8,9]) (Table 1). The herbicide Volley (2.25 pints A^{-1}) was applied before emergence on May 25. Plots were cultivated June 21 and hand-weeded on June 28.

Southern Minnesota. At Gluek, main plots (inoculated with *R. solani* AG 2-2 IV or AG 2-2 IIIB and the non-inoculated control) were 66 feet wide by 35 feet long. Plots were fertilized, as recommended for the region. After

Table 1. Corn varieties planted at the University of Minnesota, Northwest Research and Outreach Center (NWROC), Crookston on May 17, 2007 and by the Southern Minnesota Beet Sugar Cooperative in a field near Gluek on May 15, 2007 and May 22, 2008. Plots had been inoculated with *Rhizoctonia solani* AG 2-2 IV or *R. solani* AG 2-2 IIIB a few hours before planting. The control was not inoculated.

NWROC (Red River Valley)		Southern Minnesota [X]			
Variety	Maturity (days)	Variety (2008)	Maturity (days)	Genetics[XY]	End use[Z]
Proseed GVRP80	80	DKC 38-92	88	RR	Feed
DKC 35-51	85	DKC 41-64 (43-31)	91 (93)	RR + Bt	Feed
DKC 41-57	91	DKC 41-57	91	RR + Bt + CRW	Feed
DKC 35-18	85	DKC 48-52 (48-46)	98	RR (RR + Bt)	Ethanol
DKC 33-11	83	DKC 42-95	92	RR + Bt	Ethanol
DKC 42-91	92	DKC 42-91	92	RR + Bt + CRW	Ethanol
Pioneer 39D81	81			Conventional	

X Some varieties were not available in 2008, so changes for 2008 are shown in parenthesis

Y RR = Roundup Ready, Bt = Bt gene for corn borer resistance, CRW = gene for corn root worm resistance

Z Feed varieties have no special processing characteristics; ethanol varieties are highly fermentable for ethanol processing

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plots were inoculated, six transgenic corn varieties were sown per plot (Table 1) on May 15, 2007, as described above. Plots were treated with Roundup to control weeds. The trial was repeated at Gluek in 2008. Plots were inoculated and sown to corn, as described above, on May 22, 2008. Corn varieties were the same except DKC 43-31 and DKC 48-46 replaced DKC 41-64 and DKC 48-52, respectively.

Corn disease assessment and yields: ***Red River Valley*.** To determine disease indices and isolate *R. solani* AG 2-2 from corn roots, 20 plants were dug within two rows of each corn variety on September 12 and 13, 2007. Roots were washed with a pressure washer and rated for disease with a 1-5 scale where 1 = less than 2% of roots were discolored or decayed and 5 = root system rotted and plant dead or dying (6). Three, 1-inch length segments of root from each plant were surface-treated in bleach for 15 sec, rinsed twice in sterile deionized water, and placed on a semi-selective medium for isolation of *R. solani*. Cultures of *R. solani* were transferred to potato dextrose agar for further identification.

Corn yield estimates were made by hand-harvesting all ears for 10 feet of the two center rows per plot on October 12. Ears were placed in a bin dryer. Yield was adjusted to 15.5% moisture and calculated based on 56 pounds per bushel.

***Southern Minnesota*.** Corn roots were sampled for root rot and recovery of *R. solani* as described above for the Red River Valley. Ears were harvested on October 3, as described above. In the repeated trial, corn roots were sampled for root rot and *Rhizoctonia* recovery on September 10, 2008 and ears were harvested on October 22, 2008.

Sugarbeet disease assessment and yield: ***Red River Valley*.** In 2008, plots previously sown to corn were fertilized to recommended levels on May 13 and sown to sugarbeet 'VDH 46519' at 1 7/8-inch spacing on May 14. Plots consisted of six 30-ft rows spaced 22 inches apart. The insecticide Counter (9.5 lb/A) was applied over the row at planting. Microrates of the herbicides Betamix (0.5-1.5 pt/A) + UpBeet (1/8 oz/A) + Stinger (30 ml/A) + clethodim (70-130 ml/A) + MSO (1-1.25 pt/A) were applied on June 8, 15, 23 and 30. Stinger was included only in the June 15 and 23 applications. Herbicides were applied with a tractor-mounted sprayer and TeeJet 8003 flat fan nozels at 30 psi. Stands were thinned to the equivalent of 175 plants per 100 feet of row on June 25. Cercospora leaf spot was controlled by applications of SuperTin (5 oz/acre), Eminent (13 oz/acre), and Headline (9 oz/acre) on August 2, 13, and September 9, respectively.

Stands were counted at regular intervals after emergence until plots were thinned. The two middle rows of each plot were harvested October 2, 2008. Twenty roots were randomly selected from each plot and rated for RCRR with a 0 to 7 scale, where 0 = healthy and 7 = root completely rotted and foliage dead. Ten roots were randomly selected and analyzed for yield and quality by American Crystal Sugar Company Quality Laboratory, East Grand Forks, MN.

Southern Minnesota. In 2008, plots previously sown to corn were fertilized to recommended levels and sown to sugarbeet 'HM 2467' at 2.5-inch spacing on May 21. Plots consisted of six 35-ft rows spaced 22 inches apart. Microrates of the herbicides Betamix (0.5-1.5 pt/A) + UpBeet (1/8 oz/A) + Stinger (30 ml/A) + clethodim (70-130 ml/A) + MSO (1-1.25 pt/A) were applied on May 26, June 6, and 17. Herbicides were applied with a tractor-mounted sprayer and TeeJet 8003 flat fan nozzles at 40 psi. Stands were thinned to the equivalent of 190 plants per 100 feet of row on June 20. Cercospora leaf spot was controlled by applications of Eminent (13 oz/A), SuperTin (5 oz/A), and Headline (9 oz/A) on August 8, 20, and September 4, respectively.

Stands were counted at regular intervals after emergence until plots were thinned. The two middle rows of each plot were harvested October 15, 2008. Twenty roots were randomly selected from each plot and rated for RCRR, as previously described. Roots were analyzed for yield and quality by Southern Minnesota Beet Sugar Cooperative, Renville, MN. Sugarbeet will be sown in 2009 in the repeated trial sown to corn in 2008.

Data analysis. Data were subjected to analysis of variance and if significant ($P = 0.05$), means were separated by Least Significant Difference (LSD).

RESULTS

Corn disease assessment and yields: For both locations (including 2007 and 2008 trials in southern Minnesota), there were no significant interactions between soil inoculum and corn variety, so these main treatments will be presented separately.

***Red River Valley*.** Root rot ratings of corn were low and similar among plots inoculated with *R. solani* AG 2-2 IV, AG 2-2 IIIB, and the non-inoculated control (Table 2). Isolation of *R. solani* from roots was unaffected by soil inoculation with either population of *R. solani* or in the non-inoculated control, although frequency of isolation tended to be highest in plots inoculated with *R. solani* AG 2-2 IIIB (Table 2). Corn yields were unaffected by inoculation of soil with *R. solani* compared to non-inoculated soil (Table 2).

Corn variety had no significant effect on root rot rating or percent isolation of *R. solani* from roots (Table 2). Yields were significantly higher for DKC 42-91 compared to Proseed GVRP80, DKC 33-11, and DKC 35-51 and the other varieties were intermediate (Table 2).

Southern Minnesota. In 2007, corn root rot ratings were slightly higher (Table 3) than at Crookston (Table 2) but overall, were low and similar among plots inoculated with either population of *R. solani* and the non-inoculated control. Rating was difficult because an early killing frost occurred about 4 weeks before plots were assessed for disease, so corn roots were discolored and senesced earlier than expected. Despite this problem, isolation of *R. solani* from roots was significantly higher in plots inoculated with *R. solani* AG 2-2 IIIB (19%) compared to plots inoculated with AG 2-2 IV (4%) and the non-inoculated control (6%) (Table 3). Corn yields were unaffected by inoculation of soil with *R. solani* compared to non-inoculated soil (Table 3).

In 2008, root rot ratings and recovery of *R. solani* from roots were low and there were no significant differences among inoculum treatments (Table 3). Corn yields were unaffected by inoculation of soil with *R. solani* compared to non-inoculated soil (Table 3).

In 2007 and 2008, root rot ratings were significantly different among corn varieties, and tended to follow similar trends in both years (Table 3). Isolation of *R. solani* from roots varied from 4 to 18% in 2007 and from 4 to 7% in 2008, but for each year, there were no significant differences among varieties (Table 3). Corn yields varied in both years, but were not statistically different among varieties (Table 3).

Table 2. Corn - Red River Valley: Disease ratings, isolation of *Rhizoctonia solani* from roots, and yields of corn sown May 17, 2007 in plots previously inoculated (same day) with *R. solani* AG 2-2 IV, *R. solani* AG 2-2 IIIB, or not inoculated at the University of Minnesota, Northwest Research and Outreach Center, Crookston (Red River Valley).

Main treatment[V]	Root rot rating[W]	% Plants with *R. solani*[X]	Yield (bu/A)[Y]
Inoculum			
Non-inoculated (control)	1.5	11	173
R. solani AG 2-2 IV	1.8	17	170
R. solani AG 2-2 IIIB	2.1	20	166
LSD (P = 0.05)[Z]	NS	NS	NS
Corn variety			
Proseed GVRP80	1.8	25	159 b
DKC 35-51	1.7	12	169 b
DKC 41-57	1.8	15	170 ab
DKC 35-18	1.9	17	172 ab
DKC 33-11	1.8	15	164 b
DKC 42-91	1.6	12	183 a
Pioneer 39D81	1.9	19	171 ab
LSD (P = 0.05)[Z]	NS	NS	13.5

V *R. solani* AG 2-2 IV and *R. solani* AG 2-2 IIIB were grown on sterile barley grains for 3 weeks and air-dried. Plots were inoculated on May 17, 2007 by sprinkling infested barley grains onto the soil surface (26.4 oz per 2,310 ft^2; the control was not inoculated) and incorporated with a Melroe multiweeder. Plots were arranged in a randomized block design with four replicates. Corn varieties were sown May 17, 2007 as subplots (6 rows, 22 inches apart and 30 feet long) within each soil inoculum main plot.

W Corn plants were dug from plots on September 12 and 13, 2007; roots were washed and rated with a 1-5 scale where 1 = less than 2% root surface with lesions and 5 = roots completely rotted and plant dead (6). Each value for effect of inoculum is an average of 560 plants. Each value for corn variety is an average of 240 plants.

X Segments of roots (three, ~1-inch long per plant) were excised after disease assessment, surface-treated with bleach, and cultured on a semi-selective medium for isolation of *R. solani*.

Y Plots were harvested October 12, 2007; yields were adjusted to 15.5% moisture and calculated based on 56 pounds per bushel.

Z LSD = Least significant difference, P = 0.05; for each column, values followed by the same letter are not significantly different; NS = not significantly different.

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Table 3. Corn – Southern Minnesota: Disease ratings, isolation of *Rhizoctonia solani* from roots, and yields of corn planted on May 15, 2007 and May 22, 2008 in plots previously inoculated (same day) with *R. solani* AG 2-2 IV, *R. solani* AG 2-2 IIIB, or not inoculated at Gluek in southern Minnesota.

	Root rot rating[W]		% Plants with *R. solani*[X]		Yield (bu/A)[Y]	
Main treatment[V]	2007	2008	2007	2008	2007	2008
Inoculum						
Non-inoculated (control)	2.2	1.9	6	2	145	144
R. solani AG 2-2 IV	2.3	1.8	4	3	152	145
R. solani AG 2-2 IIIB	2.4	2.0	19	4	138	136
LSD (P = 0.05)[Z]	NS	NS	5	NS	NS	NS
Corn Variety						
DKC 38-92	2.6 a	2.3 a	10	4	139	140
DKC 41-64 (43-31)	2.4 ab	2.1 a	14	3	129	159
DKC 41-57	2.2 cd	1.8 b	18	3	142	135
DKC 48-52 (48-46)	2.4 bc	1.8 b	8	7	161	134
DKC 42-95	2.2 d	1.7 b	4	1	151	132
DKC 42-91	2.1 d	1.7 b	4	3	148	149
LSD (P = 0.05)[Z]	0.17	0.21	NS	NS	NS	NS

V *R. solani* AG 2-2 IV and *R. solani* AG 2-2 IIIB were grown on sterile barley grains for 3 weeks and air-dried. Plots were inoculated on May 15, 2007 and May 22, 2008 by sprinkling infested barley grains onto the soil surface (26.4 oz per 2,310 ft^2; the control was not inoculated) and incorporated. Plots were arranged in a randomized block design with four replicates. Corn varieties were sown May 15, 2007 and May 22, 2008 as subplots (6 rows, 22 inches apart and 35 feet long) within each soil inoculum main plot.

W Corn plants were dug from plots on October 3, 2007 and September 10, 2008; roots were washed and rated with a 1-5 scale where 1 = less than 2% root surface with lesions and 5 = roots completely rotted and plant dead (6). Each value for effect of inoculum is an average of 480 plants. Each value for corn variety is an average of 240 plants.

X Segments of roots (three, ~1-inch long per plant) were excised after disease assessment, surface-treated with bleach, and cultured on a semi-selective medium for isolation of *R. solani*.

Y Plots were harvested October 3, 2007 and October 22, 2008; yields were adjusted to 15.5% moisture and calculated based on 56 pounds per bushel.

Z LSD = Least significant difference, P = 0.05; for each column, values followed by the same letter are not significantly different; NS = not significantly different.

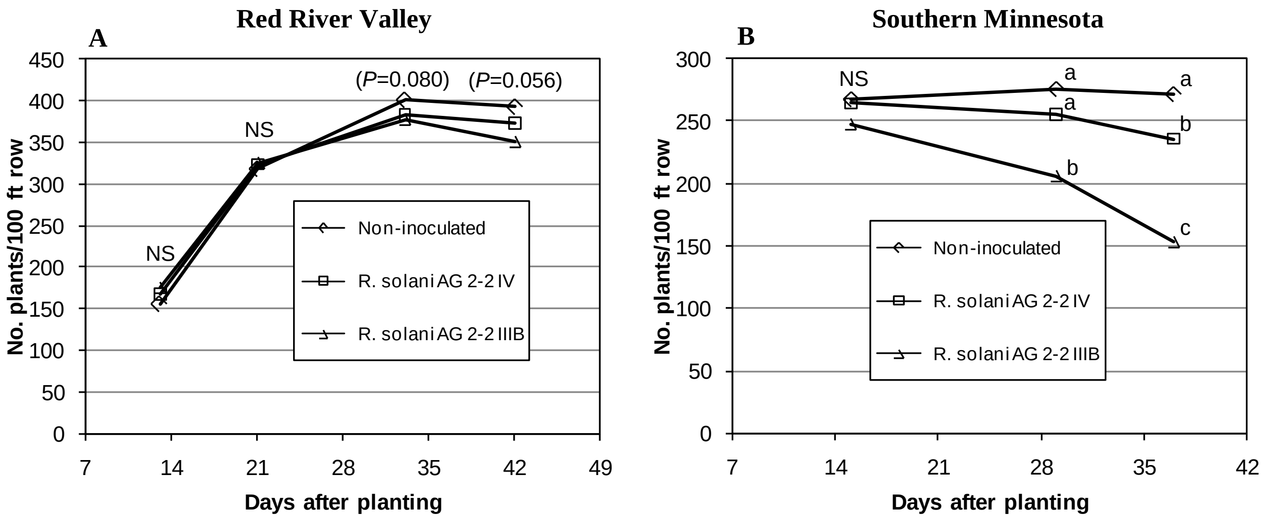

Figure 1. Sugarbeet stand in field trials at **A.**) Crookston, MN (sown May 13, 2008) and **B.**) Gluek, MN (sown May 14, 2008) that had been inoculated with *Rhizoctonia solani* AG 2-2 IV, *R. solani* AG 2-2 IIIB, or not inoculated and planted to corn (six varieties at Gluek and seven at Crookston representing different variety traits) the previous year.

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Sugarbeet disease assessment and yield: For both locations, there were no significant interactions between soil inoculum and previous corn variety, so these main treatments will be presented separately.

Red River Valley. In 2008, sugarbeet seedling stands were statistically the same following 2007 plots that had been inoculated with *R. solani* AG 2-2 IIIB, AG 2-2 IV, or not inoculated and then sown to corn (Fig. 1A). At 6 weeks after planting sugarbeet, there was a trend for decreasing stand in plots previously inoculated with *R. solani* AG 2-2 IIIB, but stands were not quite significantly different (P = 0.056) among the inoculum treatments.

At harvest in 2008, ratings for RCRR were statistically the same, regardless of soil inoculation in 2007, but tended to be equal and somewhat higher in plots inoculated with *R. solani* AG 2-2 IIIB and AG 2-2 IV compared to the non-inoculated control (Table 4). There were no differences for number of sugarbeet roots harvested, root yield, or sucrose yield following soil inoculation with *R. solani* AG 2-2 IIIB, AG 2-2 IV, or the non-inoculated control the previous growing season (Table 4).

The corn variety sown in 2007 had no significant effect on sugarbeet in 2008 for RCRR, number of harvested roots, or sucrose (Table 4). Yield of sugarbeet, however, was significantly higher following Proseed GVRP80 and DKC 35-51 compared with other varieties.

Southern Minnesota. In 2008, by 2 weeks after planting, sugarbeet reached equally high and maximum stands in plots inoculated with *R. solani* AG 2-2 IIIB, AG 2-2 IV, or not inoculated in 2007 (Fig. 1B). Over the next 3 weeks, plants began to die in plots previously inoculated with *R. solani* AG 2-2 IIIB and AG 2-2 IV so that by 5 weeks after planting, seedling stands were lowest in plots inoculated with *R. solani* AG 2-2 IIIB, intermediate in plots inoculated with AG 2-2 IV, and highest in non-inoculated plots (Figure 1B).

At harvest in 2008, plots inoculated in 2007 with *R. solani* AG 2-2 IIIB had more severe RCRR than those inoculated with AG 2-2 IV and the non-inoculated control and also were lower for number of harvested roots, root yield, and sucrose (Table 5). Plots inoculated in 2007 with AG 2-2 IV were significantly lower than the non-inoculated control for root yield and recoverable sucrose/A but were equal to the non-inoculated control for number of harvested roots, RCRR, percent sugar and pounds of sugar per ton (Table 5).

The corn variety sown in 2007 had no significant effect on sugarbeet in 2008 for RCRR or any harvest parameters (Table 5).

Table 4. Sugarbeet – Red River Valley: Number of harvested roots, root rot ratings, yield, and quality of sugarbeet sown May 14, 2008 in plots previously inoculated with *Rhizoctonia solani* AG 2-2 IV, *R. solani* AG 2-2 IIIB, or not inoculated and planted (same day) to corn varieties on May 17, 2007 at the University of Minnesota, Northwest Research and Outreach Center, Crookston (Red River Valley).

Main treatments [X]		No. roots Harvested/ 60 ft row	RCRR 0-7 [Y]	Yield (Ton/A)	Sucrose %	Sucrose lb/T	Sucrose lb recov/A
Inoculum							
Non-inoculated (control)		81	2.8	25.8	16.1	301	7757
R. solani AG 2-2 IV		73	3.4	23.6	15.7	292	6893
R. solani AG 2-2 IIIB		74	3.4	24.1	16.1	301	7241
LSD (P = 0.05) [Z]		NS	NS	NS	NS	NS	NS
Previous Corn Variety	Genetics						
Proseed GVRP80	RR, feed	80	3.1	26.4 a	15.8	294	7732
DKC 35-51	RR+Bt, feed	77	3.0	26.1 ab	15.9	297	7777
DKC 41-57	RR+Bt+CRW, feed	77	3.1	23.8 c	16.0	300	7145
DKC 35-18	RR, ethanol	71	3.3	23.5 c	16.0	299	7011
DKC 33-11	RR+Bt, ethanol	78	3.2	24.2 bc	16.0	299	7267
DKC 42-91	RR+Bt+CRW, ethanol	74	3.3	23.6 c	16.1	300	7093
Pioneer 39D81	Conventional	76	3.3	24.0 c	15.8	295	7053
LSD (P = 0.05) [Z]		NS	NS	2.08	NS	NS	NS

X Inoculum of *R. solani* AG 2-2 was grown on sterile barley grain; plots were inoculated on May 17, 2007 by sprinkling infested barley grains onto the soil surface (26.4 oz per 2,310 ft^2; the control was not inoculated) and incorporating with a Melroe multiweeder. Plots were arranged in a randomized block design with four replicates. Corn varieties were sown May 17, 2007 as subplots (6 rows, 22 inches apart and 30 feet long) within each soil inoculum main plot. Sugarbeet plots were harvested October 2, 2008.

Y Rhizoctonia crown and root rot rating (0-7 scale, 0 = root healthy, 7 = root completely rotted and foliage dead).

Z LSD = Least significant difference, P = 0.05; for each column, numbers followed by the same letter are not significantly different; NS = not significantly different.

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Table 5. Sugarbeet – Southern Minnesota: Number of harvested roots, root rot ratings, yield, and quality of sugarbeet sown May 21, 2008 in plots previously inoculated with *Rhizoctonia solani* AG 2-2 IV, *R. solani* AG 2-2 IIIB, or not inoculated and planted to corn varieties on May 15, 2007 at Gluek in southern Minnesota.

Main treatments [X]		No. roots Harvested/ 60 ft row	RCRR 0-7 [Y]	Yield (Ton/A)	Sucrose %	Sucrose lb/T	Sucrose lb recov/A
Inoculum							
Non-inoculated (control)		92 a	2.5 a	23.7 a	17.5 a	296 a	6994 a
R. solani AG 2-2 IV		82 a	2.9 a	21.1 b	16.9 a	284 a	6002 b
R. solani AG 2-2 IIIB		30 b	6.2 b	14.8 c	14.5 b	226 b	3385 c
LSD (P = 0.05) [Z]		14	0.6	2.2	0.9	20	649
Previous Corn Variety	Genetics						
DKC 38-92	RR, feed	64	4.0	19.1	16.4	271	5329
DKC 41-64	RR+Bt, feed	69	3.9	20.2	16.2	267	5525
DKC 41-57	RR+Bt+CRW, feed	67	3.8	20.2	16.4	270	5554
DKC 48-52	RR, ethanol	71	3.8	19.3	16.1	264	5284
DKC 42-95	RR+Bt, ethanol	67	3.8	20.3	16.3	270	5556
DKC 42-91	RR+Bt+CRW, ethanol	72	3.7	20.1	16.4	271	5515
LSD (P = 0.05) [Z]		NS	NS	NS	NS	NS	NS

X Inoculum of *R. solani* AG 2-2 was grown on sterile barley grain; plots were inoculated on May 15, 2007 by sprinkling infested barley grains onto the soil surface (26.4 oz per 2,310 ft^2; the control was not inoculated) and incorporating. Plots were arranged in a randomized block design with four replicates. Corn varieties were sown May 15, 2007 as subplots (6 rows, 22 inches apart and 35 feet long) within each soil inoculum main plot. Sugarbeet plots were harvested October 15, 2008.

Y Rhizoctonia crown and root rot rating (0-7 scale, 0 = root healthy, 7 = root completely rotted and foliage dead).

Z LSD = Least significant difference, P = 0.05; for each column, numbers followed by the same letter are not significantly different; NS = not significantly different.

DISCUSSION

At both locations and in both years *R. solani* AG 2-2 IV and AG 2-2 IIIB caused no aboveground symptoms on corn and did not affect yields compared to a non-inoculated control, which confirms results of previous trials in the RRV (7,8,9). The significantly higher isolation of *R. solani* from roots in plots inoculated with *R. solani* AG 2-2 IIIB than in plots inoculated with AG 2-2 IV and the non-inoculated control in the 2007 trial at Gluek also confirms results of previous trials at Crookston (8,9). There were no differences, however, in isolation of *R. solani* from corn in plots inoculated with *R. solani* and the non-inoculated control in the 2007 trial at Crookston or the 2008 trial at Gluek. It is unknown why these inconsistencies occurred but could be related to late planting date and weather conditions that affect infection of roots by *R. solani*. Recovery of the fungus from corn roots also is very difficult because of numerous competitive microbes in soil.

Soil inoculation with *R. solani* AG 2-2 IIIB prior to growing corn in 2007 had a tremendous effect on the following (2008) sugarbeet crop at Gluek, but not at Crookston. Results at Gluek confirm previous trial results in Crookston (8,9) where growing corn in soil inoculated with *R. solani* AG 2-2 IIIB resulted in high levels of RCRR in a following sugarbeet crop compared with soil inoculated with *R. solani* AG 2-2 IV or not inoculated. The lack of significant disease on sugarbeet at Crookston following soil inoculation with *R. solani* AG 2-2 IIIB and growing corn is contrary to previous trial results. Ironically, isolation of *R. solani* from corn roots in plots inoculated with *R. solani* AG 2-2 IIIB in the 2007 trials at Crookston and Gluek were similar and averaged 20 and 19%, respectively. The low ratings of RCRR on sugarbeet in 2008 at Crookston compared to Gluek may be attributable to an earlier planting date in Crookston (May 14) than at Gluek (May 21) and to differences in environmental conditions affecting survival of the fungus, infection, and/or disease development.

Severe RCRR in sugarbeet following corn inoculated with *R. solani* AG 2-2 IIIB compared to AG 2-2 IV may not be solely due to the differences in their ability to infect corn roots. Perhaps, *R. solani* AG 2-2 IIIB has a greater ability to survive the winter (on corn root stubble or in soil) compared to AG 2-2 IV. In addition, *R. solani* AG 2-2 IIIB grows at warmer temperatures (up to 95° F) than AG 2-2 IV, which may give it the ability to infect sugarbeet and favor disease development over a wider range of soil temperatures.

The effects of corn variety on root rot ratings, percent recovery of *R. solani*, and corn yields were variable among both locations and years and showed no conclusive trends. Overall, 2007 results followed previous reports where no aboveground symptoms or yield losses in *Rhizoctonia*-inoculated plots occurred on corn compared to the non-inoculated control. In contrast, Sumner (5) reported that all varieties of dent corn evaluated in the southeastern USA were susceptible to *R. solani* AG 2-2 IIIB. Previous corn variety had no effect on 2008 sugarbeet stand, root rot ratings, or sugar yield, but did affect sugarbeet yield at Gluek.

CONCLUSIONS

1. *R. solani* AG 2-2 IIIB can infect corn roots without causing aboveground symptoms or yield loss.
2. *R. solani* AG 2-2 IIIB can maintain high soil inoculum levels during a corn rotation crop, which may result in disease on a following sugarbeet crop.
3. When high inoculum levels of *R. solani* AG 2-2 IIIB occur, caution should be taken in growing corn in rotation with sugarbeet.

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