MIXTURES OF RHIZOCTONIA-RESISTANT AND SUSCEPTIBLE SUGARBEET VARIETIES GROWN IN MODERATE DISEASE AND DISEASE-FREE CONDITIONS

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Rhizoctonia root and crown rot of sugarbeet caused by the soilborne fungus *Rhizoctonia solani* AG 2-2 (= *R. solani*) is increasing in prevalence and severity in Minnesota and North Dakota. An important contributing factor is an increase in production of soybean and edible bean crops in rotation with sugarbeet, often the year prior to sugarbeet. Sugarbeet, soybean, and edible beans are susceptible to *R. solani* AG 2-2 IIIB and IV (1). As bean production continues over the years, inoculum levels of *R. solani* gradually increase in soil. Although sugarbeet varieties with resistance to *R. solani* are available, they generally are not sown because disease occurrence is hard to predict and susceptible varieties have higher yield potential than resistant varieties when disease pressure is low or absent.

Sowing seed mixtures of varieties differing in resistance to several foliar pathogens is a well-established practice (3). Inclusion of resistant germplasm in a seed mixture reduces disease severity, secondary inoculum densities, and spread of disease from plant to plant, which increases yield and quality of the crop. In Michigan, Halloin and Johnson (2) reduced Rhizoctonia root and crown rot by mixing a susceptible sugarbeet variety (RH3) with a highly resistant, but lower-yielding variety (E17). Mixtures containing 17 to 33% of the resistant variety resulted in optimal yields in a field trial naturally infested with *R. solani*; yields were comparable to the susceptible variety in the absence of disease. Seed mixtures that include a *Rhizoctonia*-resistant variety are recommended and being adopted by sugarbeet growers in Michigan who have severely infested fields. *Rhizoctonia*-resistant varieties approved for Minnesota and North Dakota are different than those grown in Michigan, so evaluation of local variety mixtures under moderate disease pressure is needed.

OBJECTIVE

Our objective was to evaluate and compare sugarbeet seed mixtures of a *Rhizoctonia*-resistant and a susceptible variety sown in *Rhizoctonia*-free and infested plots for maximum disease control and sugarbeet yield and quality.

MATERIALS AND METHODS

Two varieties of Betaseed Pro50™ (diameter 8.75-10/64) were used: 1301R (resistant to *Rhizoctonia*) and 1305R (susceptible). Five seed mixtures were prepared that contained 0, 17, 33, 50, and 100% of the resistant variety (based on number of seed). Seed mixtures were sown May 18, 2006 in *Rhizoctonia*-free plots located at the University of Minnesota, Northwest Research and Outreach Center, Crookston. Plots had been fertilized so the nitrogen level was 130 lb/A; 78 lb/A P_2O_5 also were added. Seed was sown 2.6 inches apart in rows 30 ft long and 22 inches apart. To test accuracy of mixing seed, six samples of the 50% mixture were collected from the planter by spinning the drive wheels and catching seed below the shoe. Varieties were identified by color of seed; there were 520 seed of the resistant variety (50.3%) and 513 seed of the susceptible variety (49.7%). Plots (six rows per seed treatment) were arranged in a randomized block design with four replicates. The same trial was sown in an adjacent location for inoculation with *R. solani* in mid July.

A pre-emergence application of Roundup (1 qt/A) was made on May 24 and Select Max + MSO (12 fl oz + 1 pt/A, respectively) were applied on June 1. Microrates of Betamix + UpBeet + Stinger + Select Max + MSO (0.5-0.7 pt + 0.125 oz + 35 ml + 90-120 ml + 1-1.5 pt/A, respectively) were applied on June 5, 12, 23, and 30. Fungicide applications for control of Cercospora leaf spot were made on August 22 (Eminent, 13 fl oz/A) and September 1 (Headline, 9 fl oz/A) with a tractor-mounted sprayer with TeeJet 8002 flat fan nozzles (100 psi).

Stand counts were done on the center two rows of each plot at 12, 14, 19, and 25 days after planting. Plants were thinned to a 6.5-inch spacing on June 1 and cultivated on July 5. On July 13, the center four rows of each plot in one trial were inoculated by spreading 8 g of barley grain infested with *R. solani* AG 2-2 IIIB along each 30 ft row (four rows per plot). Plots were immediately deep-cultivated to throw soil into the sugarbeet crown and cover inoculum of *R. solani* (the non-inoculated trial was not cultivated). Plots were harvested on September 27. Roots (40 per plot) were rated for Rhizoctonia root and crown rot (0-7 scale, 0 = healthy and 7 = root completely rotted and foliage dead). Two samples of 10 roots were randomly selected from each plot and analyzed for sugar and quality by the American Crystal Sugar Company Quality Laboratory, East Grand Forks, MN.

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

RESULTS

Seedling stand counts were done in both trials (before one of the trials was inoculated on July 13). Stand data from both trials were similar, so they were combined (Figure 1). At 12 days after planting, stand was statistically highest for seed treatments composed of 100 and 50% of the resistant variety, lowest with 17 and 0% seed of the resistant variety, and intermediate with 33% of the resistant variety (Figure 1). From 14 through 25 days after planting, stand remained significantly highest for the seed treatment composed of 100% of the resistant variety, lowest with 17 and 0% of the resistant variety, and intermediate with 50 and 33% of the resistant variety (Figure 1). After thinning, stands were the same for all seed mixtures and numbers of plants per 60-feet row averaged 104, 105, 106, 104, and 107 for seed mixtures of 0, 17, 33, 50, and 100% of the resistant variety, respectively.

In the *Rhizoctonia*-free (non-inoculated) trial, there was a low level of Rhizoctonia root and crown rot regardless of seed mixture (Table 1), which indicated low levels of natural inoculum of the fungus. All sugarbeet seed mixtures also resulted in statistically equal numbers of harvestable roots, yield and quality, and gross economic return (Table 1).

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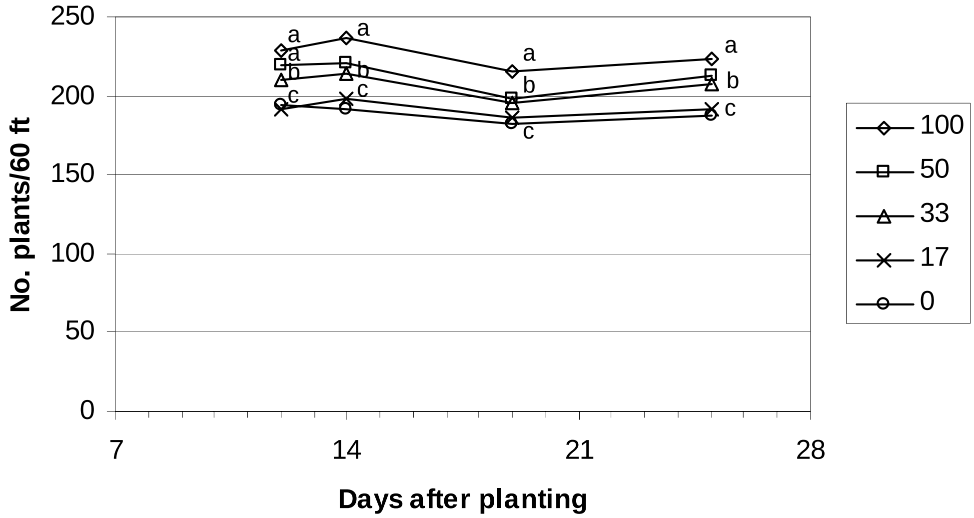

Figure 1. Number of sugarbeet seedlings when seed mixtures of a *Rhizoctonia*-resistant (Beta 1301R) and susceptible (Beta 1305R) variety were sown on May 18, 2006. Seed mixtures included 0, 17, 33, 50, and 100% of the resistant variety. Stand data were collected under *Rhizoctonia*-free conditions (before inoculation with *R. solani*) and each value is averaged across eight replicates (two trials). For each date, values marked with a different letter are significantly different, *P* = 0.05.

Table 1. Rhizoctonia root and crown rot ratings and harvest data of sugarbeet sown May 18, 2006 with mixtures of a *Rhizoctonia*-resistant (Beta 1301R) and susceptible (Beta 1305R) variety in a *Rhizoctonia*-free location at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

% Resistant variety in seed mixture	RRCR (0-7)[Y]	No. root harvested / 60-ft row	Yield (tons /A)	Sucrose %	Sucrose lb/ton	Sucrose lb recov/A	Gross return ($/A)
0	1.2	101	27.2	16.4	298	8084	894
17	1.2	99	27.0	15.9	286	7725	813
33	1.2	101	27.3	16.1	290	7904	846
50	1.2	100	27.3	16.0	287	7804	822
100	1.2	103	26.6	16.2	292	7731	832
LSD (*P* =.05)[Z]	NS	NS	NS	NS	NS	NS	NS

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

[Z] LSD = Least significant difference, *P* = 0.05; NS = not significantly different.

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Table 2. Rhizoctonia root and crown rot ratings and harvest data of sugarbeet sown May 18, 2006 with mixtures of a *Rhizoctonia*-resistant (Beta 1301R) and susceptible (Beta 1305R) variety in plots inoculated with *R. solani* AG 2-2 IIIB on July 13. The trial was located at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

% Resistant variety in seed mixture	RRCR (0-7)[XY]	No. roots harvested/ 60-ft row	Yield (ton /A)	Sucrose			Gross return ($/A)
				%	lb/ton	lb recov./ A	
0	3.0 a	79	20.4	15.7	285	5785	601
17	3.0 a	87	22.2	15.1	269	5798	535
33	2.8 a b	87	23.9	15.1	270	6314	593
50	2.7 b	84	21.5	15.5	278	5941	595
100	2.4 c	101	26.1	15.0	268	6971	666
LSD (*P* = .05)[Z]	0.3	NS	NS	NS	NS	NS	NS

X *R. solani* AG 2-2 was grown on sterile barley grain for 3 weeks and air-dried; 8 grams of barley-grain inoculum were spread along a 30-ft row (four rows per plot, four replicates per seed mixture). Plots then were cultivated to throw soil into sugarbeet crowns.

Y Rhizoctonia root and crown rot rating (0-7 scale, 0 = root healthy, 7 = root 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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In the inoculated trial, variety mixtures were significantly different for Rhizoctonia root and crown rot ratings (Table 2). As percent seed of the resistant variety increased, there was a decrease in disease. Ratings were highest for the seed mixture containing 0 and 17% seed of the resistant variety, intermediate with 33 and 50% seed of the resistant variety, and lowest with 100% seed of the resistant variety. Numbers of harvestable roots, yield and quality, and gross return were not significantly different (*P* = 0.05) among seed mixtures. Variety mixtures with higher proportions of susceptible than resistant seed, however, tended to have highest percent sucrose and pounds of sucrose per ton. On the other hand, mixtures with higher proportions of resistant than susceptible seed tended to result in more roots, and higher yields (tons of roots) and pounds of recoverable sucrose per acre. Gross return was highest for the 100% resistant variety.

DISCUSSION

Mixing seed of a *Rhizoctonia*-resistant and susceptible variety in various proportions improved stand establishment when 33% or more of the mixture was composed of the resistant variety. Although improvement in stand establishment occurred under "*Rhizoctonia*-free" conditions, the increase can not be explained by known varietal emergence data. Emergence in 2005 American Crystal Sugar Company variety evaluations across all factory districts was 65 and 70% for Beta 1301R and Beta 1305R, respectively (4). Emergence in our trial averaged 86 and 70% for Beta 1301R and Beta1305R, respectively. There was low level of natural inoculum of *R. solani* in the soil, so seed mixtures containing the resistant variety had less seed rot or pre-emergence damping-off. Since this trial was over-seeded at a 2.6-inch spacing any benefits from better stand establishment with the resistant variety was lost when plots were thinned to uniform stands. Stand establishment may have affected harvest data if the trial been planted to stand.

Although mixing seed of a resistant and a susceptible variety resulted in significantly lower root rot ratings, sugarbeet yield and quality were not significantly improved. The amount of disease pressure may have been too low to result in a benefit with the resistant variety. Plots were inoculated on July 13, which normally would allow ample time for disease development during the season. A lack of appreciable rainfall until 12 days after inoculation (0.78 inches) not only delayed, but reduced disease development and severity. Soil conditions were fairly dry for the remainder of the season so the environment was unfavorable for disease. This is evidenced by the relatively low root and crown rot ratings at harvest, which averaged 1.2 and 2.8 (0-7 scale) in the non-inoculated and inoculated trials, respectively. This low level of disease, however, affected harvest data - root yield was 4.3 tons per acre less and sugar was 0.8% lower in the *Rhizoctonia*-inoculated trial (Table 2) than in the non-inoculated trial (Table 1).

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