

BEET (*Beta vulgaris*)  
 BEET, WILD (*Beta vulgaris* ssp. *maritima*)  
 SUGAR BEET (*Beta vulgaris* ssp. *vulgaris*)  
 Rhizoctonia root rot; *Rhizoctonia solani*

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**Rhizoctonia root rot resistance of *Beta* PIs from the USDA-ARS NPGS, 2007.**

Thirty-two plant introductions (PIs) from the USDA-ARS National Plant Germplasm System (NPGS) (including garden beet, sugar beet, leaf beet, fodder beet, and wild beet) were evaluated for resistance to *Rhizoctonia* root rot. The trial was a randomized complete-block design with five replications in one-row plots (76 cm row spacing) 4 m long at the ARS Fort Collins Research Farm, CO. The field had been summer fallowed in 2004, 2005, 2006, and planted to barley in 2003. The soil (Garrett loam, 0 to 1 % slope, pH 7.8) was deep ripped in Nov 2006, and disked, roller harrowed and leveled in May prior to bedding and planting. The field was fumigated Apr 2006 with Telone II™<sup>1</sup> (18 gallons/acre) for control of potentially confounding soil-borne diseases (esp. rhizomania) and insects. Seed was planted on 22 May, and furrow irrigated as needed. The first irrigation, on 6 Jun, germinated the seed. The plant population was thinned to 20-25 cm spacing by hand in late June. Inoculation with dry, ground, barley grain inoculum of *Rhizoctonia solani* isolate R-9 (AG-2-2) was applied to the crown of the plants on 1 Aug at a rate of 5.1 g/m row and again (due to heavy rainfall after initial inoculation) on 10 Aug at a rate of 2.4 g/m. A Gandy™ electrically driven applicator with Hawkins Ditchers™ attached was used to apply the inoculum and place soil onto the plant crowns. Beets were harvested 3 Oct, with a single row lifter (pulled and cleaned by hand) and each root was rated for rot on a scale of 0 (no damage) to 7 (dead plant with root completely rotted). Average disease severity was determined to create a disease index for each PI. Analyses of variance (PROC GLM) were performed on disease indices (DI), % healthy roots (classes 0 and 1 combined) and % roots in classes 0 through 3 (harvestable roots). Data in classes 0-1 and 0-3 were transformed using arcsine square root to normalize the data for analyses (AP 0-1 and AP 0-3, respectively). The LSD values in this trial were calculated with three missing plots using five as the number of replications. Means of entries in all three tests were statistically significant ( $P < 0.0001$ ).

There were six screening tests in the 2007 nursery, including plant introductions, experimental breeding material, and commercially cultivated varieties. Controls were included in all tests. The disease started slowly but, by the end of September, *Rhizoctonia* root rot reached severe levels in most of the nursery. The average DI across the six tests in the 2007 nursery for highly resistant FC705-1, resistant FC703, and susceptible FC901/C817 controls were 1.8, 2.6, and 4.6, respectively. Percentages of healthy roots (those in disease classes 0 to 1) were 46.4, 35.8, and 12.6% for these controls, respectively. The percentages of harvestable roots (those in disease classes 0 through 3) were 77.5, 62.2, and 30.0% for these controls, respectively. The DI range for all of the lines evaluated in the nursery was 6.7 to 1.3. In all of the tests in 2007, there were highly significant differences among the entries for DI, percent healthy roots, and percent harvestable roots. Four of the PIs had a significantly lower DI than the susceptible check, PI 552534, PI 504261, PI 552533, and PI 546420, and three of these were not significantly different from the highly resistant check. PI 546420 was significantly higher (more susceptible) than the highly resistant check. It is interesting that two of the PIs, which showed resistance to *Rhizoctonia* root rot, were developed by the USDA-ARS prebreeding program in Fargo, ND. PI 552533 (F1013) was developed from a Turkish accession (PI 169025) and PI 552534 (F1014) was developed from a Russian accession (PI 355959) (Crop Science, 40:867-868). These germplasms may provide novel sources of resistance to *R. solani*.

Seed Source	Subspecies	Donor's ID	DI*	% 0-1	% 0-3	AP 0-1	AP 0-3
Ames 8447.....	<i>maritima</i>	Thurles I, Ireland.....	5.9	11	19	12.4	17.2
PI 504198.....	<i>maritima</i>	Wild Beet, Italy.....	5.3	6	31	10.0	32.5
PI 504234.....	<i>maritima</i>	Wild Beet, Italy.....	3.8	35	42	32.4	39.9
PI 504259.....	<i>maritima</i>	Wild Beet, Italy.....	3.9	46	52	42.2	49.3
PI 504261.....	<i>maritima</i>	Wild Beet, Italy.....	3.0	49	57	42.0	49.4
PI 518309.....	<i>maritima</i>	IDBBNR 5803, England.....	4.9	16	26	18.3	24.7
PI 518440.....	<i>maritima</i>	IDBBNR 5934, England.....	5.9	6	9	9.1	13.7
PI 540560.....	<i>maritima</i>	WB 811, France.....	5.8	8	18	12.7	22.1
PI 540569.....	<i>maritima</i>	WB 823, France.....	6.3	5	5	6.0	6.0
PI 540572.....	<i>maritima</i>	WB 826, France.....	6.0	0	7	0.0	7.1
PI 540576.....	<i>maritima</i>	WB 830, France.....	6.5	6	6	6.5	6.5
PI 540612.....	<i>maritima</i>	WB 866, France.....	6.5	2	7	3.7	9.5
PI 546411.....	<i>maritima</i>	IDBBNR 5605, England.....	3.6	42	49	40.5	44.3
PI 546420.....	<i>maritima</i>	IDBBNR 5614, Greece.....	3.2	37	66	36.8	55.8
PI 546510.....	<i>maritima</i>	IDBBNR 9677, Greece.....	6.0	4	18	7.0	21.9
PI 546527.....	<i>maritima</i>	IDBBNR 9694, Sicily, Italy.....	5.5	22	25	24.4	26.7
PI 562595.....	<i>maritima</i>	IDBBNR 9745, Matruh, Egypt.....	6.7	6	6	7.0	7.0
W6 21681.....	<i>maritima</i>	G062, Greece.....	5.9	11	14	9.8	13.7
PI 552533.....	<i>vulgaris</i>	F1013, North Dakota, US.....	3.1	27	60	25.1	51.0
PI 552534.....	<i>vulgaris</i>	F1014, North Dakota, US.....	2.5	60	62	50.8	52.3
PI 555454.....	<i>vulgaris</i>	F1011, North Dakota, US.....	5.0	7	24	9.7	28.4
PI 560133.....	<i>vulgaris</i>	C766-62, California, US.....	4.1	26	38	28.8	38.0
PI 560134.....	<i>vulgaris</i>	C312, California, US.....	5.8	5	10	6.0	14.6
PI 564243.....	<i>vulgaris</i>	C50, California, US.....	5.8	5	10	8.3	13.9
PI 565281.....	<i>vulgaris</i>	C49/2, California, US.....	5.1	9	14	11.1	17.3
PI 565282.....	<i>vulgaris</i>	C54/2, California, US.....	4.6	6	21	8.8	24.6
PI 565286.....	<i>vulgaris</i>	B883, California, US.....	4.1	46	49	42.5	44.2
PI 590582.....	<i>vulgaris</i>	US 056/2, Utah, US.....	5.1	8	20	10.3	20.1

Seed Source	Subspecies	Donor's ID	DI*	% 0-1	% 0-3	AP 0-1	AP 0-3
PI 590583.....	<i>vulgaris</i>	US 035, Utah, US.....	4.8	8	20	10.2	20.1
PI 612768.....	<i>vulgaris</i>	AT3933-5, Utah, US.....	3.4	11	52	17.1	46.0
PI 5907543.....	<i>vulgaris</i>	FC705/1 - 'Highly Resistant Check.....	1.6	70	92	59.9	79.6
PI 590656.....	<i>vulgaris</i>	FC703 - 'Resistant Check.....	2.4	43	79	41.1	68.2
19941025.....	<i>vulgaris</i>	FC901/C817 - 'Susceptible Check.....	4.9	4	16	7.0	23.1
		<b>LSD (P=0.05)</b> .....	<b>1.5</b>			<b>21.6</b>	<b>25.7</b>
		<b>Trial Mean **</b> .....	<b>4.6</b>	<b>21</b>	<b>33</b>	<b>21.3</b>	<b>31.8</b>

\* DI = Disease index on a scale of 0 (no damage) to 7 (plant death), % 0-1 = % roots in class 0 and 1 combined, % 0-3 = % roots in class 0 to 3 combined, AP is the arcsine-square root transformation of percentages of roots in classes 0-1 and 0-3 to normalize the data for analyses.

\*\* Because of varied rates of germination among the wild beet accessions, the number of roots per plot that were rated, ranged from 0 to 19, with an average of 8.0.

<sup>1</sup> Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.