BEET (*Beta vulgaris* L.)
SEA BEET (*Beta vulgaris* ssp. *maritima*)
SUGAR BEET (*Beta vulgaris* ssp. *vulgaris*)
Rhizoctonia crown and root rot; *Rhizoctonia solani*

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Evaluation of *Beta* PIs from the USDA-ARS, NPGS for Rhizoctonia crown and root rot resistance, 2013.

Thirty sea beet (*Beta vulgaris* subsp. *maritima* (L.) Arcang) accessions from the *Beta* collection of the USDA-ARS National Plant Germplasm System were screened for resistance to Rhizoctonia crown and root rot, at the USDA-ARS Fort Collins, CO Research Farm. The 2013 *Rhizoctonia* screening nursery was a randomized complete-block design with five replications in one-row plots (76 cm row spacing) 4 m long. The soil (Garrett loam, 0 to 1 % slope, pH 7.8) was fumigated with Telone® II in late October 2008, for control of soil-borne diseases (esp. rhizomania) and pests. Manure was applied 4 days later and the field was roller harrowed in Nov 2008. The field had been planted to sugarbeet in 2009 and summer fallowed until 2011 and 2012, when it was planted to Grazex BMR 737 (a sorghum/sudangrass hybrid). In 2013, the field was fertilized (70 lbs N acre^{-1} and 35 lbs P_2O_5 acre^{-1}) and bedded on 15 and 16 May. Sugar beet seed was planted on 28 May to moisture and furrow irrigated as needed. No herbicides were used this year. The field was hand weeded and thinned on 10 and 21 Jul. 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 25 Jul (at about the 8-12 leaf stage) at a rate of 6.11 g m^{-1} of row. A Gandy® electrically driven applicator was used to apply the inoculum and the field was cultivated afterwards to place soil onto the plant crowns. Beets were harvested on 23 Oct with a single row lifter (pulled and cleaned by hand), and each root was rated for rot on a scale of 0 (no disease) to 7 (dead plant with root completely rotted). Average disease severity per plot was determined (on a continuous scale between 0 and 7) to create a disease index (DI) for each entry. Analysis of variance was performed in SAS (Ver. 9.3) using Proc GLM for DI, % healthy roots (classes 0 and 1 combined) and % harvestable roots (classes 0 through 3). 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). Because a test of the residuals indicated the data were not normally distributed, a rank transformation was used and the rank of the entry in each replication was used in the ANOVA (The American Statistician, 35(3): 124-129). Analyses of variance (PROC MIXED) was performed on rank or DI, and Dunnett's one-tailed t-test ($p = 0.05$) was used to compare entries to the highly resistant control (FC705/1) and the most susceptible plant introduction accession (PI 604516).

Fort Collins was very wet in 2013. The nursery was planted to moisture and had a gentle rain after planting, which germinated the seed. A light rain after inoculation helped initiate the disease. Temperatures were warm until the beginning of September, when we had unseasonably heavy rainfall and flooding throughout Colorado. Research plots were not affected by the flooding but the week of rain lowered the temperature and slowed disease progression. The combination of wet weather and a sixteen day government furlough delayed harvest and evaluation of the nursery, but the disease pressure was severe and uniform. Screening a crop wild relative like sea beet is always difficult because the seed germinates and establishes poorly. Plots contained between 1 and 16 individual plants. An ANOVA test (PROC GLM) indicated highly significant differences among entries for DI, AP 0-1, and AP 0-3 (Data not shown) in the *Rhizoctonia* disease screening nursery this year. There was a good separation between resistant and susceptible entries, although the susceptible control was more resistant than expected. An ANOVA of the rank transformed data showed highly significant differences among entries' DIs. Results reported are based Dunnett's one-tailed t-test ($p = 0.05$) of the transformed data. The 12 entries below the lower line in the table (line below PI 604521) were not significantly different from the worst performing entry (PI 604516). Those entries between the lines, e.g., in the middle of the table (except entry PI 604534), were significantly more resistant than the worst performing entry and significantly more susceptible than the best performing entry (FC705/1). The 10 entries above the upper line in the table (line below PI 604520) and entry PI 604534 were not significantly different from the highly resistant control (FC705/1). Without the rank transformation of the data, only the first four entries (PI 604525, PI 604551, PI 604549, and PI 504189) were not significantly different from the highly resistant control (Dunnett's one-tailed t-test; $p = 0.05$). Those accessions that were not significantly less resistant than the resistant control will be retested and, if the resistance is confirmed, entered into the USDA-ARS Rhizoctonia root rot-resistance breeding program at Fort Collins, CO to develop sugar beet germplasm with increased resistance to Rhizoctonia root rot. These results will be accessible to interested parties through the USDA-ARS, NPGS GRIN database (http://www.ars-grin.gov/npgs/index.html).

ID	Subspecies[z]	Origin and Alternate ID	DI[y]	0-1[x]	0-3[x]	% 0-1	% 0-3
PI 590754	***vulgaris***	***FC705/1- Highly Resistant Control***	**1.2**	**85**	**100**	**70.0**	**90.0**
PI 590656	***vulgaris***	***FC703 - Resistant Control***	**1.5**	**68**	**97**	**55.4**	**83.7**
PI 599668	***vulgaris***	***FC709/2 - Highly Resistant Control***	**1.8**	**57**	**93**	**49.8**	**78.4**
PI 604525	*maritima*	IDBBNR 5935, Majorca, Spain	2.4	20	95	22.8	81.9
PI 604551	*maritima*	IDBBNR 9479, Veneto, Italy	2.5	16	86	23.5	73.6
PI 604549	*maritima*	IDBBNR 9462, Lazio, Italy	2.5	13	92	16.4	77.5
PI 504189	*maritima*	WB 508, IDBBNR 5670, Italy	2.5	19	93	22.8	83.0
Ames 4219	*maritima*	IDBBNR 5606, England, UK	2.6	4	90	7.7	75.7
PI 604535	*maritima*	IDBBNR 6952, Istria, Former Serbia and Montenegro	2.6	18	90	22.2	78.0
PI 604520	*maritima*	Acelga Palo Verde, IDBBNR 3628, Alicante, Spain	2.7	20	84	25.2	69.5
PI 604541	*maritima*	IDBBNR 7101, Aveiro, Portugal	2.7	23	83	28.3	68.4
PI 604529	*maritima*	IDBBNR 6096, Baleares, Spain	2.8	12	84	16.2	71.4
19941025	***vulgaris***	***Susceptible control (FC901/C817)***	**2.9**	**40**	**70**	**38.3**	**57.3**
PI 604527	*maritima*	IDBBNR 6072, Balearic Islands, Spain	2.9	11	80	16.6	66.4
PI 604524	*maritima*	IDBBNR 3851, Lisboa, Portugal	3.0	2	82	3.5	68.0
PI 604534	*maritima*	IDBBNR 6522, Noord Beveland, the Netherlands	3.0	14	82	17.4	73.2
PI 604547	*maritima*	IDBBNR 9172, Helgoland, Germany	3.0	13	78	18.6	62.9
PI 604523	*maritima*	IDBBNR 3742, Aetoloakarn, Greece	3.1	16	77	18.6	65.0
Ames 4265	*maritima*	IDBBNR 5652, Turkey	3.2	0	63	0.0	53.1
PI 546382	*maritima*	WB 201, IDBBNR 5660, Spain	3.4	4	77	5.3	64.6
PI 540702	*maritima*	WB 956, France	3.4	4	74	5.1	62.3
PI 604521	*maritima*	IDBBNR 3705	3.4	5	66	8.3	54.8
PI 518298	*maritima*	WB 620, IDBBNR 5792, England, UK	3.6	14	68	16.4	56.1
PI 604528	*maritima*	IDBBNR 6085, Baleares, Spain	3.6	4	70	7.6	57.7
PI 604526	*maritima*	IDBBNR 6069, Madeira Islands, Portugal	3.7	2	66	3.5	57.3
PI 599352	*maritima*	R720, Intercross of B.v.m. accessions	3.8	18	59	22.2	50.5
PI 604539	*maritima*	IDBBNR 7079, Vila do Bospo, Portugal	3.8	12	54	12.8	47.8
PI 518299	*maritima*	WB 621, IDBBNR 5793, England, UK	3.9	24	53	23.2	49.8
PI 604542	*maritima*	IDBBNR 7103, Morbihan, France	3.9	11	62	17.0	52.8
PI 604517	*maritima*	IDBBNR 3350, Chios, Greece	4.0	11	61	12.6	51.4
PI 604544	*maritima*	IDBBNR 7105, Morbihan, France	4.2	1	59	3.0	50.1
Ames 10841	*maritima*	IDBBNR 9528, India	4.9	0	39	0.0	32.0
PI 546398	*maritima*	WB 167, IDBBNR 5597, Israel	4.9	0	45	0.0	42.3
PI 604516	*maritima*	Seskla, IDBBNR 3339, Samos, Greece	5.6	3	23	4.4	25.6
		Trial Mean	**3.20**	**17**	**73**	**18.1**	**62.7**

[z] All entries that are *Beta vulgaris* subspecies *vulgaris* are the cultivated controls, those of *B. v.* ssp. *maritima* (sea beet) are wild.
[y] DI = Disease index on a scale of 0 (no damage) to 7 (plant death).
[x] Percent of healthy roots (disease classes 0 and 1 combined) and percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined); % indicates value after percentages were transformed to arcsine-square roots to normalize the data for analyzes.

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