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

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USDA-ARS germplasms evaluated for resistance to Rhizoctonia crown and root rot in Fort Collins, CO, 2014.

Thirty-six sugar beet (*Beta vulgaris* subsp. *vulgaris*) germplasms from the USDA-Agricultural Research Service pre-breeding program at Fort Collins, Colorado were screened for resistance to Rhizoctonia crown and root rot (RCRR) at the Colorado State University ARDEC facility in Fort Collins, CO. There were two highly resistant germplasms, one resistant germplasm, and one susceptible germplasm used as controls. The 2014 *Rhizoctonia* screening nursery was a randomized complete-block design with five replicates in one-row plots (76 cm row spacing) 3.7 m long. The soil is a Fort Collins loam (0 to 1% slope, pH 7.2). The field had been planted to hard red winter wheat in 2012, and Grazex BMR 737 (a sorghum/sudangrass hybrid) in 2013. In 2014, the field was fertilized (60 lbs N $acre^{-1}$ and 30 lbs P_2O_5 $acre^{-1}$) and bedded on the 22 May. Sugar beet seed was planted on 29 May to moisture and irrigated as needed with an overhead linear irrigation system. The herbicide Betamix (2 oz $acre^{-1}$ 8% phenmedipham, 8% desmedipham [v/v] and 84% inert ingredients) was applied on 12 and 19 Jun. The field was hand weeded and thinned on 28 Jun and 19 Jul. An inoculum of dry, ground, hulless-barley grain, infested with *Rhizoctonia solani* isolate R-9 (AG-2-2), was applied to the crown of the plants on 21 Jul (at the 8-12 leaf growth stage) at a rate of 6.01 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. Roots were harvested on 16 Sep 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, leaves necrotic with root completely rotted) (Plant Dis. Rep. 63:518–522). Average disease severity per plot (DI) was determined with the DI treated as a continuous variable for each replicate of each entry. Analyses of variance (PROC GLM) were performed on disease indices, percent of healthy roots (classes 0 and 1 combined) and percent of the 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). Additionally, an analyses of variance (PROC MIXED) was performed on DI, and Dunnett's one-tailed t-test ($p = 0.05$) adjusted for sample size was used to compare all entries to the highly resistant control (FC709-2) and the most susceptible germplasm (20121023HO) for DI.

At harvest there was moderate Rhizoctonia root rot and other diseases were not evident. There were significant differences among entries for all three variables (PROC GLM). The DI was 1.7 in the highly resistant control and 4.9 in the most susceptible entry. Those entries, for which DI<2.5 were not significantly different than the highly resistant control (Dunnett's one tailed t-test of DI, $p = 0.05$). Similarly all entries below 20131012PF in the table with a DI > 4.0 are not significantly more susceptible than the most susceptible entry (Dunnett's one tailed t-test for DI, $p = 0.05$). Those entries for which DI > 2.5 and DI < 4.0 showed a moderate resistance, more resistant than the most susceptible entry but significantly more susceptible than the highly resistant control. Based on their performance, entries will be released for resistance to RCRR or re-selected to improve their resistance to RCRR. All germplasms developed by the USDA-ARS pre-breeding program at Fort Collins are screened for RCRR before release; even if they have not been selected primarily for RCRR-resistance, this is useful information for other plant breeders wishing to incorporate released germplasm into their breeding programs.

ID	Description	DI[y]	%0-1[x]	%0-3[w]	AP0-1[v]	AP0-3[v]
PI 599668	*Highly Resistant Check FC709-2*	*1.7*	*56*	*94*	*45.5*	*83.5*
PI 590754H	*Highly Resistant Check FC705/1*	*1.9*	*52*	*90*	*46.3*	*78.2*
20121057	20081013-07PF - F_3 LSR x RhzcR/LSR (RhzcR-hs 10A-1775)	2.0	51	87	45.5	73.8
20121013PF	FC221-1	2.5	37	74	34.5	60.3
PI 590656	*Resistant Check FC703*	*2.8*	*30*	*72*	*30.2*	*61.4*
20041010HO	FC712/MonoHy A4	2.8	42	73	37.3	62.7
20131010H15	20111014 ({SP85657-01 x FC709-2} X EL53)F_2	2.9	39	62	35.7	55.1
20121012HO1	C833-H5 CMS x 03-FC1014-22(A,aa) - sel in 6R BC3	2.9	28	70	25.5	63.5
20101008	(Best FC LSR x Best EL LSR) - mm seedballs Increased	2.9	26	69	30.4	57.3
20121019HO	03-FC1015 FC201 derivative - sel Rhizoc in 6R	2.9	23	73	24.5	66.4
20101010	C790-15cms x 05-FC1018 [RZM-CR-% (C931 x FC709-2)F3]	3.1	26	62	26.8	58.4
20121019HO1	CMS equivalent - 03-FC1015 FC201 sel Rhizoc in 6R	3.1	27	62	27.2	52.4
20041010HO1	FC712/MonoHy A4 - CMS equivalent	3.1	29	57	28.7	49.4
20131010H14	20111013 (FC708CMS X EL 51)F_2	3.2	18	67	19.7	58.3
20131010H16	20111015 ({SP85657-01 x FC709-2} X EL51)F_2	3.2	23	65	28.4	54.4
20131010H09	20111011H3 (FC708CMS X EL51) X FC220-1	3.3	24	65	28.6	54.8
20131010H12	20111011H6 ({SP85657-01 x FC709-2} X FC708) X FC220-1	3.3	17	54	15.9	47.8
20121035PF	09-20071011Hmm&20071011H - [(FC907 x FC709-2) & 9931]	3.3	20	53	25.8	46.5
20101012	C790-15cms x RZM-CR-% (FC712 x 9931)F3	3.4	9	62	15.8	52.3
20111031	20071003H2; {(BGRC 45511) Bvm(Greece/annual) x Z325aa	3.4	22	47	24.8	42.6
20131010H10	20111011H4 ({SP85657-01 x FC709-2} X EL53) X FC220-1 -	3.5	26	47	27.2	40.5
20131009	*B. v.* ssp. *maritima* (PI 540596) (biennial - France) x Sucrose$_{MM}$	3.5	15	59	22.0	51.1
20131010H11	20111011H5 ({SP85657-01 x FC709-2} X EL51) X FC220-1 -	3.5	18	48	22.7	40.9
20111030	20091030PF; Inc. 5 highest CLR families 20071004HO-xs	3.7	14	47	21.3	42.9
19941025	*Susceptible Check - FC901/C817*	*3.7*	*18*	*54*	*19.6*	*47.8*
20121012HO	03-FC1014-22 (half sib selection within FC201) - sel in 6R	3.8	14	48	18.8	47.0
20131001pfHO	R1740 Population (Rz1Rz1Rz2Rz2)	3.8	19	45	22.8	44.1
20131010H17	20111016 ({SP85657-01 x FC709-2} X FC708)F_2	3.8	10	43	15.8	40.8
20111028	20071003H-74 - CLR family (BGRC 45511 X Suc$_{MM}$) sib line	4.0	13	47	16.4	42.9
20131012PF	07-FC1015-403 - Combine mod. CR, Rz1, CTR, mm, T-O, %S	4.0	21	39	23.9	35.4
20111029	Blk best families of BGRC 45511 (LSR) x Suc$_{MM}$	4.1	11	40	14.6	38.3
20131010H13	20111012 (FC708CMS x EL53)F_2	4.1	6	39	6.7	38.2
20061005HO	03-124 FC123 (FC301) derivative	4.1	15	46	16.5	36.7
2013A008	4933-14, CR933-14, PI 652892	4.2	21	47	21.0	43.7
2013A007	5933, CR933, PI 652891	4.3	23	40	24.4	36.2
20131002pfHO	R1741 Population (rz1rz1Rz2Rz2)	4.5	6	31	9.9	29.7
PI 636340	C931, 4931, PI 636340	4.5	7	30	11.8	26.9
20121054	LSR fodder beet - Sucrose$_{MM}$ x PI 535833 (Saturn)	4.7	4	21	7.6	24.2
20131010H08	20111011H2 (FC708CMS X EL 53) X FC220-1	4.8	8	30	10.4	29.6
20121023HO	C812-41 Inc. one S1 family from C890-2/3 (PI 593702)	4.9	4	21	6.9	21.3
	Trial Mean	*3.5*	*22*	*55*	*23.5*	*48.5*

[z]All entries that are *Beta vulgaris* subspecies *vulgaris* (including the control entries) are cultivated, those of *B. v.* ssp. *maritima* (sea beet) are wild.

[y]DI = Mean Disease Index, which is based on a scale of 0 (=healthy) to 7 (= plant dead) for individual roots to give a plot mean and averaged over five replicates.

[x]Mean Percent of healthy roots (disease classes 0 and 1 combined) averaged over five replicates.

[w]Mean Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined) averaged over five replicates.