

USDA-ARS Ft. Collins germplasm screened for resistance to Beet curly top, 2015.

Fifty sugar beet (*Beta vulgaris* L.) germplasm lines produced by the USDA-ARS Ft. Collins sugar beet program and two commercial check cultivars [SV2012RR (susceptible) and HM PM90 (resistant)] were screened for resistance to *Beet curly top virus* (BCTV). The curly top evaluation was conducted at the USDA-ARS North Farm in Kimberly, ID, which has Portneuf silt loam soil and had been in barley in 2014. The field was plowed in the Fall and fertilized in the Spring with 90 lb N and 110 lb P₂O₅/A then roller harrowed on 9 Apr. The germplasm was planted (density of 142,560 seeds/A) on 27 May. The plots were two rows 10 ft long with 22-in row spacing arranged in a randomized complete block design with three replications. The fields were sprinkler irrigated, cultivated, and hand weeded as necessary. Plant populations were thinned to about 47,500 plants/A on 20 Jun. Plants were inoculated at the four- to six-leaf growth stage on 24 Jun with approximately six viruliferous (contained at least the following BCTV strains: Cal/Logan, CO, Severe, and Worland) beet leafhoppers per plant. The beet leafhoppers were redistributed three times a day during the first two days and then twice a day for five more days by dragging a tarp through the field. The plants were sprayed with Lorsban 4E (1.5 pints/A) on 7 Jul to kill the beet leafhoppers. Plots were rated for foliar symptom development on 13 and 20 Jul using a disease index scale (DI) of 0 to 9 (0 = healthy and 9 = dead), with the scale treated as a continuous variable (Plant Dis 2006 90:1539-1544). Values from the final and more severe rating are presented. Data were analyzed in SAS using the general linear models procedure (Proc GLM), and Fisher's protected least significant difference (LSD; $\alpha = 0.05$) was used for mean comparisons. Additionally, an analysis 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 resistant control (HM PM90) and the most susceptible germplasm (20121034) for DI.

Curly top symptom development was uniform and no other disease problems were evident in the plot area. Disease pressure was moderate, and the resistant and susceptible checks performed as expected for the final visual rating. The DI was 4.0 in the resistant control, 7.4 in the susceptible control, and 7.9 in the most susceptible entry. Those entries for which DI < 5.5 were not significantly different than the resistant control (HM PM90) (Dunnett's one tailed t-test, $p = 0.05$). Similarly all entries for which DI > 6.2, were not significantly different than the most susceptible entry (20121034) (Dunnett's one tailed t-test, $p = 0.05$). Those entries for which DI > 5.4 and DI < 6.4 showed a moderate resistance, significantly more resistant than the most susceptible entry, but significantly more susceptible than the resistant control. Based on their performance, entries will be released for resistance to BCTV or re-selected to improve their resistance to BCTV. All germplasms developed by the USDA-ARS pre-breeding program at Fort Collins are screened for BCTV before release; even if they have not been selected primarily for BCTV-resistance, because this is useful information for other plant breeders wishing to incorporate released germplasm into their breeding programs.

Entry ^z	Description	Subspecies ^y	Curly Top Rating ^x
HM PM90	Resistant check	vulgaris	4.0 a^w
1996A008	Beta G6040 - Resistant Check	vulgaris	4.1 a
20061005HO1	03-124 CMS equivalent	vulgaris	4.7 a
20121013PF	FC221-1; ({4918, 2915aa} x {FC902, FC607, FC709-2})	vulgaris	5.2 a
20121012HO	FC302 = 03-FC1014-22 - sel in 6R	vulgaris	5.3 a
2013A009	N412, CN12, PI 636338	vulgaris	5.3 a
20141009	FC1741 Population (rz1rz1Rz2Rz2)	vulgaris	5.3 a
20061005HO	03-124 FC123 derivative	vulgaris	5.4 a
20131009	LSR B. v. ssp. maritima x SucroseMM pop	vulgaris	5.4 a
20141003	FC301, PI 634210	vulgaris	5.4 a
20141016HO	20121023HO; Bulk increase of C812-41	vulgaris	5.4 a
2012A035	R840 (Blk of R740)	vulgaris	5.5
20131008HO	C869, PI 628754	vulgaris	5.6
20141007	FC1740 Population (Rz1Rz1Rz2Rz2)	vulgaris	5.7
20101010	C790-15cms x 05-FC1018 [RZM-CR-% (C931 x FC709-2)F3]	vulgaris	5.8
20101012	C790-15cms x RZM-CR-% (FC712 x 9931)F3	vulgaris	5.8
20141015HO1	03-FC1015H5 - CMS equivalent of 03-FC1015	vulgaris	5.8
20141004	FC221, PI 651016	vulgaris	5.9

Entry ^z	Description	Subspecies ^y	Curly Top Rating ^x
20141015HO	03-FC1015 FC201 derivative	vulgaris	6.0
2013A008	4933-14, CR933-14, PI 652892	vulgaris	6.1
20141019PF	FC220-2	vulgaris	6.1
2013A007	5933, CR933, PI 652891	vulgaris	6.2
20111028	20091028ms; CLR family (BGRC 45511 X SucroseMM)	vulgaris	6.4 b
20141010	FC201, PI 634018	vulgaris	6.4 b
20131011	(Best FC LSR x Best EL LSR) x CR011	vulgaris	6.5 b
20141018	20121036; FC907, 709-2, 9931,C790-15cms, FC1036]	vulgaris	6.5 b
20101004	FC708, PI 590845	vulgaris	6.6 b
20111031	20071003H2; LSR {(BGRC 45511) x Sucrose} x Z325aa	vulgaris	6.6 b
20131010H08	(FC708CMS X EL 53) X FC220-1	vulgaris	6.6 b
20131010H11	({SP85657-01 x FC709-2} X EL51) X FC220-1	vulgaris	6.6 b
20131010H13	(FC708CMS x EL53)F2	vulgaris	6.6 b
20131012PF	07-FC1015-403	vulgaris	6.6 b
20081010	FC717, PI 574628	vulgaris	6.7 b
1997A050	FC607, PI 590837	vulgaris	6.8 b
20131010H09	(FC708CMS X EL51) X FC220-1	vulgaris	6.8 b
20141005	FC715, PI 574625	vulgaris	6.9 b
20131006	FC305;PI 671963	vulgaris	6.9 b
20131010H15	({SP85657-01 x FC709-2} X EL53)F2	vulgaris	6.9 b
20131010H12	({SP85657-01 x FC709-2} X FC708) X FC220-1	vulgaris	7.0 b
2013A006	C931, 4931, PI 636340	vulgaris	7.0 b
19951017	FC727, PI 599669	vulgaris	7.1 b
20131010H17	({SP85657-01 x FC709-2} X FC708)F2	vulgaris	7.1 b
20101008	(Best FC LSR x Best EL LSR) - mm seedballs Increased	vulgaris	7.3 b
20131010H10	({SP85657-01 x FC709-2} X EL53) X FC220-1	vulgaris	7.4 b
20141011PF	SucroseMM x PI 535833	vulgaris	7.4 b
20141021PF	20121054; SucroseMM x PI 535833	vulgaris	7.4 b
SV2012RR	Susceptible check	vulgaris	7.4 b
20041010HO	FC712/MonoHy A4	vulgaris	7.5 b
20121017	20111030; 20091030PF; LSRMM w/Fargo	vulgaris	7.5 b
20131010H14	(FC708CMS X EL 51)F2	vulgaris	7.7 b
20131010H16	({SP85657-01 x FC709-2} X EL51)F2	vulgaris	7.8 b
20121034	FC709-2, PI 599668	vulgaris	7.9 b
Overall mean			6.34

^z Two entries were commercial check cultivars: SV2012RR (susceptible) and HM PM90 (resistant).

^y All lines were *Beta vulgaris*. Subspecies *vulgaris* are cultivated beet and subspecies *maritima* are sea beet, the wild progenitor.

^x Curly top ratings = curly top was rated using a scale of 0 to 9 (0 = healthy and 9 = dead), with disease index (DI) treated as a continuous variable. Rating was taken on 20 Jul, the final and most severe rating.

^w Those entries followed by an 'a' are not significantly different from the resistant check (HM PM90) and those entries followed by a 'b' are not significantly different from the most susceptible entry (20121034).