SUGAR BEET (*Beta vulgaris* ssp. *vulgaris*)
   Beet curly top; *Beet curly top virus*

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Beet curly top resistance in USDA-ARS Ft. Collins germplasm, 2020.

Thirty sugar beet (*Beta vulgaris* L.) germplasm lines produced by the USDA-ARS Ft. Collins sugar beet program and three commercial check cultivars [Early Wonder (susceptible), HM PM90 (resistant), and SV2012RR (susceptible)] 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 cropped to barley in 2019. The field was plowed and then fertilized (110 lb N/A and 120 lb P_2O_5/A) and roller harrowed on 27 Mar. The germplasm was planted (density of 51,840 seeds/A) on 18 May. The plots were two rows 10-ft long with 22-in. row spacing and treatments were arranged in a randomized complete block design with six replications. The field was sprinkler irrigated, cultivated, and hand weeded as necessary. Plant populations were thinned to about 23,760 plants/A on 17 Jun. Plants were inoculated at the four- to six-leaf growth stage on 23 Jun with approximately six viruliferous (containing the following BCTV strains: California/Logan and Severe) beet leafhoppers (*Circulifer tenellus* Baker) 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 Jul using a scale of 0 to 9 (0 = healthy and 9 = dead), with the scale treated as a continuous variable (Plant Dis. 90:1539-1544). Data were rank transformed and analyzed in SAS using the general linear model procedure (Proc GLM), and Fisher's protected least significant difference (LSD; $P = 0.05$) was used for mean comparisons. The non-transformed means are presented in the table.

Curly top symptom development was uniform and no other disease problems were evident in the plot area. The resistant and susceptible checks performed as expected for the visual ratings. Statistically, 22 of the entries contained at least some minor resistance since their visual ratings were significantly lower than those for both susceptible checks. However, only four entries 1,7,14, and 20 were not significantly different from the resistant check. These four entries along with entries with similar levels of resistance will be retested and, if resistance is confirmed, these lines will be considered for incorporation into the USDA-ARS germplasm improvement program as a source of resistance to BCTV.

Entry[z]	Source[y]	Description	Curly top rating[x]
CH6[*]	HM PM90	Resistant check, sugar beet cultivar	5.1 q
1	1996A008	Beta 3G6040 - Resistant Check	5.4 pq
7	20101011	FC1019 (PI 658060), Rz1, Rhizoc, LS, Aphan, CT	5.8 o-q
14	20161028PF	20121014-x; B.I. of 8 half-sib families (Blk Inc of 05-FC1023m(iso)[2005A020], half sibs of FC301 LSR, CTR, RhzmR)	6.0 n-q
20	20171023HO1	20141016HO & 20141016HO1; 20121023HO & HO1; Bulk increase of C812-41= mm, T-O, CTR, Rz?,Sf from Salinas; FC1100 (Rz2)	6.0 m-q
16	20171020	FC1742 Bulk incr. of rz1rz1rz2rz2 MAS from R740	6.0 m-p
9	20141010	FC201 CT, LS, Aphan, Rhizoc, Rz1 (PI 634018)	6.2 l-o
8	20121040	Bulk increase of rhizoctonia selections from FC1019	6.2 k-o
17	20171021	FC1743 Bulk incr. of Rz1Rz1/rz2rz2 MAS from R740	6.2 k-o
24	20181025HO1	20151046HO1; selected in Kimberly for CT resistance; 20101016HO1-xs/20101016HO-x; selfed families (07-FC1015-420CMS) 2007A092	6.3 j-o
19	20171023HO	Bulk increase of O-type/CMS pair - C812-41 = mm, T-O, CTR, Sf from Salinas; FC1100 (homozygous Rz2); 20121023HO	6.3 i-n
25	20181026	20151017; Bulk increase from Rhizoc selections from 201201018HO-x	6.3 i-n
28	20191008	Bulk increase of resistant check 1996A008 Beta 3G6040	6.4 h-m
27	20191001	Bulk increase of 20181017 – 2 cycles of selection for Fusarium resistance at Sterling	6.4 g-l
5	20101004	FC708 Rhizoctonia Resistant, mm 2n O-type (PI 590845)	6.5 f-k
29	20191009	Bulk increase of 20131009 [20081012PF-10, -18 Blk selected - LSR Bvm (PI540596 biennial - France) x S%MM pop - blkF2 LSR=2.5]	6.5 f-k
18	20171022	201510346 Bulk Increase for testing and release of ½ sib LSR fam; Bvm (PI 540596) (biennial-France)/SucroseMM pop	6.5 e-i
21	20181014	*Sclerotium rolffsii* resistant population	6.6 e-j
22	20181017	201610140; Bulk incr. 2 Fusarium sels. (Sterling, 2016) and 20131010H14 (Sterling,2015)	6.6 e-i
23	20181025HO	20151046HO; selected in Kimberly for CT resistance; 20101016HO1-xs/20101016HO-x; selfed families (07-FC1015-420) 2007A091	6.6 e-h
15	20161042H	PI&ARS (bi 20101009) To Produce Hybrid seed of FC708CMS x FC1018	6.6 e-g
6	20101009	FC1018 - F3 sel for CLS resistance, Rzm resistance, size, shape and sucrose (PI658059)	6.6 e-g
3	1997A050	FC607, LSR/CTR, easy bolting, O-type, 2X, mm, self-sterile (PI 590837)	6.6 e-g
2	19951017	FC727 Strong Rhizoc resistance and moderate CLS resistance (PI 599669)	6.7 c-f
10	20141035PF	Bulk increase of this LSR population (20081012PF-23, -29 Blk selected - LSR Bvm (PI540596 biennial - France) x S%MM pop - blkF2; LSR=2.0)	6.8 c-f
4	20041010HO	FC712 (PI 5490766)/MonoHy A4 MM LS Rhiz SS Rr	6.8 c-e
12	20151044PFHO	20101015HO1-x/20131012MS; Selfed families of 20101015HO1-x/20101015HO-x	6.8 b-e
11	20151036MS	20131009; bulk increase [20081012PF-10, -18 Bulk selected - LSR Bvm (PI540596 biennial - France) x S%MM pop - blkF2 LSR=2.5]	6.8 b-e
30	20191010	bi of 20111029 - Bulk incr. of best performing LSR families (tested in EL MI, 2008) of BGRC 45511 (LSR) x SucroseMM pop 20071003H-2,-19,-67 -78	6.9 d-g
CH5[*]	SV2012RR	Susceptible check, sugar beet cultivar	6.9 a-d
13	20161016PF	20141035; 20121055; 20081012PF-23, -29 - LSRsel Bvm (PI540596 biennial - France) x S%MM pop - sib families to 20131009	6.9 a-c
26	20181028	B.v. vulgaris Poland REKORD POLY 2010i PI 535827 2010I SD	7.2 ab
RB[*]	Early Wonder	Susceptible check, red beet cultivar	7.6 a
P > F[w]			<0.0001

[z] Three entries with asterisk were commercial check cultivars: CH5 (susceptible), CH6 (resistant), and RB (susceptible).

[y] All lines were *Beta vulgaris* subspecies *vulgaris* (cultivated beet).

[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.

[w] P > F was the probability associated with the F value when using rank transformed data. Within a column, means followed by the same letter did not differ significantly based on Fisher's protected least significant difference (LSD; α = 0.05) value. The non-transformed mean values are presented.