

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, 2017.

Forty-nine sugar beet (*Beta vulgaris* L.) germplasm lines produced by the USDA-ARS Ft. Collins sugar beet program and four commercial check cultivars [Beta G6040 (resistant), Detroit Dark Red (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 in barley in 2016. In the spring, the field was plowed and then fertilized (90 lb N and 110 lb P₂O₅/A) and roller harrowed on 11 Apr. The germplasm was planted (density of 142,560 seeds/A) on 15 May. The plots were two rows 10 ft long with 22-in. row spacing and arranged in a randomized complete block design with four replications. The field was sprinkler irrigated, cultivated, and hand weeded as necessary. Plant populations were thinned to about 47,500 plants/A on 9 Jun. Plants were inoculated at the four- to six-leaf growth stage on 14 Jun with approximately six viruliferous (contained the following BCTV strains: California/Logan and Severe) 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 28 Jun to kill the beet leafhoppers. Plots were rated for foliar symptom development on 6 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 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.

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. Based on the visual rating, none of the entries were as good as the resistant check CH6, except for the other resistant check, entry 2. However, five entries (10, 16, 21, 34, 46) were not significantly different from entry 2. These five entries will be retested and, if resistance is confirmed, they will be considered for incorporation into the USDA-ARS germplasm improvement program as sources of resistance to BCTV.

Entry ^z	Source ^y	Description	Curly top rating ^x
CH6	HM PM90	Resistant check	4.3 q
2	1996A008	Beta G6040 - Resistant Check	5.0 pq
10	20111030	Increase 5 highest CLR families 20071004HO-xs; LSRMM w/Fargo	5.1 po
34	20151019	20141011MS - B.I. hs LSR SucroseMM × PI 535833 (Saturn)	5.5 n-p
16	20131008HO	C869, PI 628754	5.6 m-p
46	20161026PF	20111019-x; BI LSR (Z325aa x [20011045MS (WB853 × SucroseMM)])	5.6 l-p
21	20141009	FC1741 Population (rz1rz1Rz2Rz2)	5.6 l-p
13	20121013PF	FC221-1; ({4918, 2915aa} × {FC902, FC607, FC709-2})	5.7 k-o
26	20141019PF	FC220-2; 20121037PF&MS; B.I. T1 (FC220-1 - inc. 20051030)	5.8 j-o
20	20141007	FC1740 Population (Rz1Rz1Rz2Rz2)	5.8 j-o
49	20161029PFHO	20121018HO-x & 20121018HO1; 03-FC1014-22 (hs sel FC201)	5.8 j-o
39	20161003PF	20111039MS/PF; BI Z325 × BGRC28938	5.8 i-o
44	20161024PF	20111019-x; BI LSR - (Z325aa x [20011045MS (WB853 × SucroseMM)])	5.8 i-n
9	20111028	20091028ms; 20071003H-74 - CLR family (BGRC 45511 X SucroseMM)	5.8 i-n
47	20161027PF	20101014HO-xs; BI of selfed families from 07-FC124-425	5.8 h-n
6	20101008	Best FC LSR x Best EL LSR	5.9 g-n
18	20141004	FC221 = {[4918aa x (FC902, FC607, Commerc)] F2; (2915 x FC709-2) reciprocal}	5.9 g-n
25	20141018	20121036; BI [(FC907 x FC709-2) & 9931 (Salinas)] × [C790-15cms x FC1036]	5.9 f-n
29	20141035	LSR BVM (biennial - France) × SucroseMM pop - PI 540596	6.0 e-n
24	20141016HO	20121023HO; Bulk increase of C812-41; FC1100 (Rz2)	6.0 e-n
30	20151014HO	20121019HO & HO1	6.0 e-n
3	1997A050	FC607, LSR/CTR, easy bolting, O-type, 2X, mm, self-sterile	6.2 d-n
8	20101012	C790-15cms x RZM-CR-% (FC712 × 9931) F3	6.2 d-n
48	20161028PF	20121014-x; B.I. of 8 half-sib families (Blk Inc of 05-FC1023m(iso)[2005A020])	6.2 d-n
43	20161023PF	20111018-x, BI (Z325 × [LSR Giant Poly (PI535826) × SucroseMM])	6.2 d-n
41	20161016PF	20141035; 20121055; 20081012PF-23, -29 - LSRsel Bvm (PI540596) × S%MM	6.2 d-m
22	20141011PF	20121053; SucroseMM x PI 535833 (Saturn) - 20121054 (other families)	6.2 d-l
23	20141011PF	20121053; SucroseMM x PI 535833 (Saturn) - 20121054 (other families)	6.2 d-l

12	20121012HO	03-FC1014-22 (half sib selection within FC201) - sel in 6R	6.2 d-l
7	20101010	C790-15cms x 05-FC1018 [RZM-CR-% (C931 × FC709-2) F3]	6.3 d-l
31	20151016	20111024-x, [(FC907×FC709-2) & 9931 (Salinas)]×[C790-15cmsxFC1036]	6.4 d-k
38	20151046PFHO	20101016HO1-xs/20101016HO-x; sel for CTR	6.4 d-k
33	20151018	20121056 - Bulk increase of F3 LSRMM × RhzcR/LSR	6.4 d-j
50	20161030PFHO	20121018HO-x & 20121018HO1; 03-FC1014-22 (hs sel FC201)	6.4 d-j
32	20151017	20121018HO-x	6.4 d-j
27	20141021PF	20121054; 20081001-38PF, SucroseMM x PI 535833 (Saturn)	6.4 d-j
17	20131011	20081016PF-54 -46 -34 -33 -31 -30; FC1037; Best LSR x CR011	6.4 d-j
40	20161004HO	20121018HO-119pf & 20121018HO-187pf/20121018HO-187pf	6.4 d-j
45	20161025PF	20111019-x; BI Z325aa x [20011045MS (WB853 × SucroseMM)]	6.4 d-j
35	20151020	20101013-xs; B.I. 20101013-24; 20101013-03; 20101013-71; 20101013-76	6.4 d-i
28	20141022PF	Bulk 0931 & 9933 x BCN Resistant, Iranian sugar beet landrace	6.5 d-h
11	20111031	20071003H2; LSR {(BGRC 45511) x Sucrose} × Z325aa	6.5 d-h
42	20161017	20141020; Increase F3 of CN12-446 x FC708 [SBCN × RhzcR/LSR]	6.6 c-g
1	19951017	FC727	6.6 c-g
4	20041010HO	FC712/MonoHy A4	6.6 c-f
5	20101004	FC708 Rhizoctonia Resistant, Leaf Spot Resistant O-type	6.6 c-e
36	20151036PF	20131009; bulk increase [20081012PF-10, LSR Bvm (PI540596) × S%MM]	6.7 b-d
37	20151044PFHO	20101015HO1-x/20131012MS; Selfed families of 20101015HO1-x/20101015HO-xs	6.8 b-d
19	20141005	FC715	6.8 b-d
14	20121017	20111030; 20091030PF; CLR families 20071004HO-xs	7.2 bc
15	20121034	FC709-2	7.2 bc
CH5	SV2012RR	Susceptible check	7.4 b
RBCH	Detroit Dark Red	Susceptible check	8.1 a
	$P > F^w$		<0.0001
	LSD		0.69

^z Four entries were commercial check cultivars (bold): 2 (resistant), CH5 (susceptible), CH6 (resistant), and RBCH (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. Within a column, means followed by the same letter did not differ significantly based on Fisher's protected least significant difference (LSD; $\alpha = 0.05$) value.