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

L. Panella, USDA-Agricultural Research Service (ARS), Sugar Beet Res. Unit, Crops Res. Lab, 1701 Centre Ave., Ft. Collins, CO 80526-2083; and C. A. Strausbaugh, USDA-ARS NWISRL, 3793 N. 3600 E., Kimberly, ID 83341

Resistance to curly top of sugar beet in germplasm developed at USDA-ARS Ft. Collins, 2013.

Seventy-one sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Ft. Collins sugar beet program and three control lines were screened for resistance to *Beet curly top virus* (BCTV) in 2013. Commercial cultivars 'Monohikari' (susceptible), 'HM PM90' (resistant) and Betaseed line Beta G6040 (resistant) were included as controls. 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 alfalfa in 2012. The field was plowed in the fall and in the spring, on 19 Apr 13, it was fertilized (90 lb N and 110 lb P_2O_5/A), sprayed with Ethotron (2 pt/A) for weed control, and roller harrowed. Seed was planted (density of 142,560 seeds/A) on 20 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 fields were sprinkler irrigated and hand weeded as necessary. Plant populations were thinned to about 47,500 plants/A on 14 Jun. Plants were inoculated at the four- to six-leaf growth stage on 27 Jun with approximately six viruliferous beet leafhoppers per plant. The beet leafhoppers were redistributed twice a day (immediately after sunrise and just before sunset) for one week by dragging a tarp through the field to disrupt settled/feeding leafhoppers. The plants were sprayed with Lorsban 4E (1.5 pints/A) on 2 Jul to kill the beet leafhoppers. The plots were rated for foliar symptom development on 16 Jul using a scale of 0-9 (0 = healthy and 9 = dead), with the scale treated as a continuous variable (Plant Dis.:90:1539-1544). Data were analyzed in SAS (version 9.3) using the general linear models procedure (Proc GLM), and Fisher's protected least significant difference ($\alpha = 0.05$) was used for mean comparisons.

Development of curly top disease symptoms was uniform and no other disease problems were evident in the plot area. The disease pressure in the test was severe with good symptom development in the susceptible control. Beta G6040, HM P90, and Monohikari were rated at 4.2, 4.4, and 6.3, respectively. The field was confirmed to be predominantly infected with *Beet curly top virus* (BCTV) and *Beet severe curly top virus* (BSCTV), with minimal infection by *Beet mild curly top virus* (BMCTV), using species-specific PCR. Thirty-five entries tested were not significantly different from the resistant control (Beta G6040) based on visual symptoms but were significantly better than the susceptible control (Monohikari). Of those 35 entries, 15 were germplasm being evaluated for release based on a number of factors, including resistance to curly top. Decisions to release these germplasm to commercial plant breeders will be based on their total performance, including resistance to curly top. Among the 35 best performing entries were 20 selfed single plant families of the cross (07-FC1015-420/C833-5cms)/FC201. The top 3 of the resistant families based on severity scores will be grown from remnant seed, recombined, tested against other pathogens, and further developed for eventual release as enhanced germplasm to commercial breeders and other researchers.

Entry[x]	Description	Curly top rating[y]
46	0931aa & 9933aa x PI 142808 SBCN resistant	6.7 a
V4	**Monohikari (susceptible control)**	6.3 ab
4	FC712/MonoHy A4 - CMS equivalent	6.2 a-d
17	selfed families (07-FC1015-420) C833-5mmaaXFC201	6.2 a-c
7	FC1018 - 05-FC1018 = RZM-CR-% (C931 x FC709-2)F3	6.2 a-c
57	FC709-2	6.1 a-d
3	FC712/MonoHy A4	6.0 a-e
68	4933-14, CR933-14, PI 652892	5.9 a-f
15	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.9 a-f
43	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.8 a-h
6	(Best FC LSR x Best EL LSR) - mm seedballs Increased	5.8 a-h
67	5933, CR933, PI 652891	5.8 a-g
66	C931, 4931, PI 636340	5.8 a-g
53	20111030; 20091030PF	5.8 a-g
49	20091029PF; Blk best families of BGRC 45511 (LSR) x $Sucrose_{MM}$	5.7 b-h
14	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.7 b-h
39	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.6 b-k
23	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.6 b-k
21	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.6 b-k
61	20081001-38PF, -14MS Blk - LSR - SucroseMM x PI 535833 (Saturn)	5.6 b-j
56	C812-41 BI one S1 family from C890-2/3 (PI 593702)	5.6 b-j
37	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.6 b-j
54	03-FC1015 FC201 derivative - sel Rhizoc in 6R	5.6 b-i
38	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.6 b-i
60	20081001-13MS Blk selected - LSR fodder beet - SucroseMM x PI 535833	5.5 b-n
48	Lowest CLR family (BGRC45511 X $Sucrose_{MM}$)	5.5 b-m
47	0931aa & 9933aa x PI 232894 SBCN Res	5.5 b-l
34	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.5 b-l
58	Blk [(FC907 x FC709-2) and 9931 (Salinas)	5.5 b-k
55	03-FC1015H5 - CMS equivalent of 03-FC1015 - sel Rhizoc in 6R	5.5 b-k
18	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.5 b-k
2	FC607, LSR/CTR, easy bolting, O-type, 2X, mm, self-sterile	5.5 b-k
25	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.4 b-n
5	20051031; Rhzc sel of FC221	5.4 b-n
35	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.3 c-o
20	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.3 c-o
11	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.3 c-o
50	20091030PF; Increase 5 highest CLR families LSRMM w/Fargo	5.2 d-p
59	Blk [C790-15cms x FC1036]/[(FC907 x FC709-2) & 9931	5.1 e-q
51	FC302 = 03-FC1014-22 (half sib within FC201) - sel in 6R	5.1 e-q
41	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.1 e-q
10	C790-15cms x RZM-CR-% (FC712 x 9931)F3	5.1 e-q
64	R840 (Blk of RR740)	5.0 f-q
45	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q
44	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q
33	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q
31	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q

27	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q
24	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q
22	selfed families (07-FC1015-420) C833-5mmaaXFC201	5.0 f-q
40	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.9 g-q
19	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.9 g-q
8	C790-15cms x 05-FC1018 [RZM-CR-% (C931 x FC709-2)F3]	4.9 g-q
36	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.9 f-q
42	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.8 h-q
69	N412, CN12, PI 636338	4.8 g-q
26	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.7 j-q
9	FC1019 - 5-FC1019 = RZM-CR-% (FC712 x 9931)F3	4.7 j-q
62	Blk sel - F_3 LSRMM x RhzcR/LSR sel RhzcR - hs 10A-1775	4.7 i-q
52	FC302CMS; C833-H5 CMS x 03-FC1014-22(A,aa) - sel in 6R BC3	4.7 i-q
30	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.7 i-q
29	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.6 l-q
13	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.6 k-q
65	C869, PI 628754	4.5 n-q
12	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.5 m-q
V2	**HM PM90 (resistant control)**	4.4 o-q
63	20081013-07PF thru -47 PF Blk 7 sel families - hs 10A-1775	4.4 o-q
32	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.4 o-q
28	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.4 o-q
71	R740 Populations (Rz2)	4.3 pq
70	R740 Populations (Rz1 and Rz2)	4.3 pq
16	selfed families (07-FC1015-420) C833-5mmaaXFC201	4.2 q
1	**Beta G6040 (resistant control)**	4.2 q
Overall mean		5.2
P > *F*[z]		<0.0001
LSD		1.0

[x] All lines were *Beta vulgaris*. Three entries were check cultivars: Monohikari, HM PM90, and Beta G6040 (Bold).

[y] Curly top was rated using a scale of 0-9 (0 = healthy and 9 = dead), with disease index (DI) treated as a continuous variable.

[z] *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 value (LSD; $\alpha = 0.05$).