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

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

Beet curly top resistance in USDA-ARS Ft. Collins Germplasm, 2012.

Seventeen sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Ft. Collins sugar beet program were screened for resistance to *Beet severe curly top virus* (BSCTV) and closely related *Curtovirus* species in 2012. Commercial cultivars Monohikari (susceptible) and HM PM90 (resistant) and Betaseed, Inc. germplasm line 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 2011. The field was plowed in the fall and in the spring, it was fertilized (90 lb N and 110 lb P_2O_5/A) on 16 Apr 12, sprayed with Ethotron (2 pt/A) for weed control, and roller harrowed. The germplasm was planted (density of 142,560 seeds/A) on 21 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 19 Jun. Plants were inoculated at the four to six leaf growth stage on 22 Jun with 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 4 Jul to kill the beet leafhoppers. The plots were rated for foliar symptom development on 10 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). Leaf samples were also pulled at the time of disease rating and evaluated in an enzyme-linked immunosorbent assay (ELISA) as described previously (Plant Dis. 94:972-976). As a negative background control, blank wells filled only with reagents were used to determine any color shift in the wells based on how long the ELISA assay ran. Therefore, a well should be at least two or three times the background number to be considered positive. Data were analyzed using the general linear models procedure (Proc GLM-SAS), and Fisher's protected least significant difference ($\alpha = 0.05$) was used for mean comparisons.

Curly top symptom development was uniform and no other disease problems were evident in the plot area. The disease pressure in the test was severe with good symptom development in the susceptible control. Five germplasm tested were not significantly different from the most resistant control (HM PM90) based on visual symptoms, and five were not significantly different from the most resistant control based on ELISA. Three lines – 20101011 (PI 658060, FC1019), 20101010, and 20111029 – were not significantly different from the most resistant control based on both criteria. This indicates that these lines had true resistance to the virus and not just tolerance. The resistant controls were not completely immune because they had symptoms and an ELISA value that was six times higher than the negative background controls. Thus, there is still room for improving resistance to the curly top virus species.

Entry[w]	Seed source	Description	CT rating[x]	ELISA[y]
V2	.....	*HM PM90 (resistant control)*	4.19 i	0.75 c-e
11	20101011	PI 658060, FC1019	4.34 hi	0.55 e
10	20101010	C790-15cms x FC1018 [RZM-CR-% (C931 x FC709-2)F3]	4.56 f-i	1.17 b-e
5	2009A020	FC1036, PI 665054	4.88 d-i	1.62 ab
17	20111029	5 LSR families - ½ sib sel BGRC 45511 (LSR) x Suc_{MM} pop.....	4.88 d-i	1.26 b-e
14	20111025	PI 665055, FC1037	4.91 d-i	1.69 ab
1	*1996A008*	*Beta G6040 (resistant control)*	4.97 c-h	0.69 de
2	20101004	PI 590845, FC708	5.06 c-h	1.04 b-e
13	20111023MS	Bulk Increase of 20081015 - Best FC & EL LSRmm	5.13 c-g	1.68 ab
15	20111027	PI 665053, FC1028	5.22 c-f	1.13 b-e
8	20101008	(Best FC LSR x Best EL LSR) - mm seedballs increased	5.28 b-f	1.48 a-c
12	20101012	C790-15cms x RZM-CR-% (FC712 x 9931)F_3	5.41 a-e	1.40 b-d
18	20111030	5 highest CLR families 20071004HO-xs; LSR_{MM} w/Fargo	5.47 a-d	1.18 b-e
6	20091011PF	Rhzc sel FC221 RhzcR, RhzmR, MM, CTR, LSR	5.50 a-d	1.56 ab
7	20091029PF	5 LSR families - ½ sib sel BGRC 45511 (LSR) x Suc_{MM} pop	5.50 a-d	1.40 b-d
16	20111028	20071003H-74 - Lowest CL family (BGRC 45511 x Suc_{MM}) ..	5.56 a-d	1.33 b-d
9	20101009	PI 658059, FC1018	5.69 a-c	1.58 ab
4	20041010HO1	FC712/MonoHy A4 - CMS equivalent	6.00 ab	1.58 ab
V4	.....	*Monohikari (susceptible control)*	6.06 a	2.16 a
3	20041010HO	FC712/MonoHy A4	6.12 a	1.63 ab
Overall mean	.....	.....	5.14	1.30
P > F[z]	.....	.....	<0.0001	0.0097
LSD	.....	.....	0.74	0.74

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

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

[y] ELISA = the enzyme-linked immunosorbent assay (ELISA) values recorded at OD 405 nm. The 12 negative background checks (4 per plate) for the ELISA assay averaged 0.12 ± 0.01 and the positive checks averaged 2.85 ± 0.27.

[z] *P* > F was the probability associated with the F value. LSD = Fisher's protected least significant difference value ($\alpha = 0.05$). Within a column, means followed by the same letter did not differ significantly based on Fisher's protected LSD.