

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

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#### **Beet curly top resistance in USDA-ARS Plant Introduction Lines, 2014.**

Twenty-four sugar beet (*Beta vulgaris* L.) Plant Introduction (PI) Lines from the USDA-ARS National Plant Germplasm System (NPGS), three commercial check cultivars [SV2012RR (susceptible), Monohikari (susceptible), and HM PM90 (resistant)], and one commercial check breeding line (Beta G6040) 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 2013. The field was plowed in the fall and in the spring, it was fertilized (90 lb N and 110 lb P<sub>2</sub>O<sub>5</sub>/A), sprayed with Ethotron (2 pt/A) for weed control, and roller harrowed on 11 Apr. The germplasm was planted (density of 142,560 seeds/A) on 19 May. The plots were two rows 10 ft long with 22-in row spacing and arranged in a randomized complete block design with three 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 23 Jun with approximately six viruliferous (contained three BCTV strains: Cal/Logan, 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 16 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). During the disease rating, leaf samples were collected and evaluated by enzyme-linked immunosorbent assay (ELISA) as described previously (Plant Dis. 94:972-976). 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 both the visual rating and ELISA. Based on these same variables, there were two PI accessions (entries 1 and 29) that ranked above the resistant checks, but were not significantly different from the resistant checks. Three other lines (entries 26, 27, and 28) had visual ratings that did not differ from the resistant checks, but were more intermediate for ELISA. Four of these top performing entries (26 to 29) were a series of lines from Logan, UT that were deposited into the NPGS in 1983 by Clair Theurer. The SLC 133 line (entry 1) with good resistance to BCTV was developed in the mid 1950's as one of the original sources on monogerm and used as a tester for combining ability. These germplasm will be retested and, if resistance is confirmed, they may be incorporated into the USDA-ARS germplasm improvement program as sources of resistance to BCTV. These results and germplasm will be accessible to interested parties through the USDA-ARS, NPGS GRIN database (<http://www.ars-grin.gov/npgs/index.html>).

Entry <sup>z</sup>	Description	Subspecies <sup>y</sup>	CT ratings <sup>x</sup>	ELISA <sup>w</sup>
1	Ames 2662, IDBBNR 4804, SLC 133, United States	<i>vulgaris</i>	4.33 hi	0.44 k
29	PI 633940, AT3994-8, United States; 1983 from J.C. Theurer in Utah	<i>vulgaris</i>	3.77 i	0.53 jk
HM PM90	Resistant check	<i>vulgaris</i>	4.08 hi	0.63 i-k
Beta G6040	Resistant check	<i>vulgaris</i>	4.42 hi	0.63 i-k
22	PI 604551, IDBBNR 9479; collected in Veneto, Italy	<i>maritima</i>	6.59 c-f	0.83 h-j
21	PI 604549, IDBBNR 9462; Torrimipetra to Focene Italy, at airport, Lazio	<i>maritima</i>	7.83 ab	0.89 g-j
28	PI 633939, AT3994-7, United States; 1983 from J.C. Theurer in Utah	<i>vulgaris</i>	3.96 i	0.91 g-j
30	PI 663876, United States, C23BM is 100% accessions of North Atlantic Coast	<i>maritima</i>	6.29 e-g	0.91 g-j
26	PI 612768, AT3993-5, United States; 1983 from J.C. Theurer in Utah	<i>vulgaris</i>	3.93 i	0.99 f-i
17	PI 546443, WB 311, IDBBNR 5624; collected 1979 in Mitilini, Greece	<i>maritima</i>	7.50 a-d	0.99 f-i
27	PI 633936, AT3993-7, United States; 1983 from J.C. Theurer in Utah	<i>vulgaris</i>	4.38 hi	1.02 e-h
14	PI 507848, IDBBNR 5565, Hungary; donated Res. Center For Agrobotany	<i>vulgaris</i>	7.42 a-e	1.03 d-h
13	PI 372275, 203/1, Poland; donated Instytut Hodowli I Aklimatyzacji Roslin	<i>vulgaris</i>	6.23 fg	1.15 c-h
25	PI 608804, 405, United States; 4X Janasz variety/4X NB1 inbred	<i>vulgaris</i>	5.19 gh	1.16 b-h
23	PI 604552, IDBBNR 9480; collected in Friuli-Venezia, Italy	<i>maritima</i>	7.00 a-f	1.25 b-g
19	PI 590614, DESPREZ Z, French cultivar from F. Desprez in 1963	<i>vulgaris</i>	6.98 b-f	1.27 b-g
20	PI 590616, ELITE DESPREZ TYPE R, French cultivar from F. Desprez, 1963	<i>vulgaris</i>	6.62 c-f	1.29 b-f
12	PI 181716, IDBBNR 5358; collected 1948 in Lebanon	<i>vulgaris</i>	6.33 d-g	1.30 b-f
SV2012RR	Susceptible check	<i>vulgaris</i>	6.69 b-f	1.33 b-f
16	PI 535825, CYKLOP, Poland; donated Instytut Hodowli I Aklimatyzacji Roslin	<i>vulgaris</i>	6.79 b-f	1.34 b-f
4	W6 17116, EL 43, United States; F <sub>2</sub> from BC <sub>1</sub> to SP6822-0 with FC 702/2	<i>vulgaris</i>	7.04 a-f	1.37 b-f
3	W6 17112, EL38, United States; Monogerm, type O, open-pollinated line	<i>vulgaris</i>	6.46 c-f	1.38 b-e
Monohikari	Susceptible check	<i>vulgaris</i>	6.75 b-f	1.40 b-e
10	PI 120705, IDBBNR 5192; collected 15-Oct-1936 in Turkey	<i>vulgaris</i>	8.17 a	1.41 b-d
24	PI 604553, IDBBNR 10024; collected in China, donated BAZ - Genebank	<i>maritima</i>	6.58 c-f	1.42 bc
18	PI 590613, ELITE TM, French breeding material from F. Desprez in 1989	<i>vulgaris</i>	7.62 a-c	1.44 a-c
15	PI 535823, ALBUS, Poland; donated Instytut Hodowli I Aklimatyzacji Roslin	<i>vulgaris</i>	7.13 a-f	1.53 ab
11	PI 175598, KOCABA; collected 20-Sep-1948 in Turkey	<i>vulgaris</i>	7.46 a-e	1.81 a
Overall mean			6.20	1.13
$P > F^v$			<0.0001	<0.0001
LSD			1.17	0.38

<sup>z</sup> Four entries were commercial check cultivars or breeding line (bold): SV2012RR (susceptible), Monohikari (susceptible), Beta G6040 (resistant), and HM PM90 (resistant).

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

<sup>x</sup> 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.

<sup>w</sup> ELISA = the enzyme-linked immunosorbent assay (ELISA) values recorded at OD 405 nm. The 8 negative background checks (4 per plate) for the ELISA assay averaged  $0.19 \pm 0.02$ .

<sup>v</sup>  $P > F$  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.