

Beet curly top resistance in USDA-ARS Kimberly sugar beet germplasm, 2013.

Fourteen sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Kimberly, ID sugar beet program were screened for resistance to *Beet curly top virus* (BCTV) in 2013, along with two commercial check cultivars, Monohikari (susceptible) and HM PM90 (resistant). 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, it was fertilized (90 lb N and 110 lb P₂O₅/A) on 19 Apr 13, sprayed with Ethotron (2 pt/A) for weed control, and roller harrowed. The germplasm 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 six 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 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 2 Jul to kill the beet leafhoppers. Plots were rated for foliar symptom development on 16 and 22 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 16 Jul disease rating, leaf samples were collected and evaluated by 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 if there were any unintended color shifts. To be considered positive, samples should be two or three times greater than the background number. 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 disease pressure in the test was considered severe since entry K944-19-17 died by the second rating. The susceptible check, Monohikari, had good symptom development and the highest ELISA value. Based only on ELISA, eight entries were not different from the resistant check. However, only the double haploid entries KDH04, KDH09, and KDH13 were not different from the resistant check (HM PM90) for all variables. KDH13 has been released as a curly top resistant genetic stock (PI663862) and whole genome shotgun sequenced. Its assembly (BvSeq-1) is available via the National Center for Biotechnology Information (NCBI) at <http://www.ncbi.nlm.nih.gov/bioproject/PRJNA176558>.

Entry ^z	Description	Curly top ratings ^y		
		16 Jul	22 Jul	ELISA ^x
Monohikari	Susceptible check.....	5.9 b-d	7.7 c-e	2.49 a
K944-19-9	Selected from C5944.....	6.1 b-d	7.9 b-d	2.37 a-b
K944-19-17	Selected from C5944.....	6.8 ab	9.0 a	2.22 a-c
K944-62	Selected from C5944.....	6.8 ab	8.5 a-c	2.13 a-d
K944-19-19	Selected from C5944.....	7.2 a	8.7 a-c	2.02 b-d
KEMS-8	Mutant –EMS treated C5944.....	5.5 c-e	7.2 de	2.10 a-d
K944-6-91	Selected from C5944.....	4.7 ef	6.7 e	1.95 b-e
K39-S1	Selected from PI608798.....	6.3 a-c	8.8 ab	1.79 c-f
K39-16	Selected from PI608798.....	6.4 a-c	8.2 a-d	1.78 c-f
KEMS-12	Mutant –EMS treated C5944.....	5.2 de	7.1 de	1.69 d-f
KEMS-9	Mutant –EMS treated C5944.....	6.0 b-d	7.8 cd	1.69 d-f
KEMS-6	Mutant –EMS treated C5944.....	6.4 a-c	8.0 a-d	1.67 d-f
KDH04	Doubled haploid (selected from C-762-17)	3.5 g	3.3 f	1.49 e-f
KDH13	Doubled haploid = PI663862	3.3 g	3.2 f	1.45 f
KDH09	Doubled haploid (selected from C-762-17)	3.1 g	3.2 f	1.39 f
HM PM90	Resistant check	4.0 fg	4.1 f	1.36 f
Overall mean	.....	5.4	6.8	1.85
<i>P</i> > <i>F</i> ^w	.....	<0.0001	<0.0001	<0.0001
LSD	.....	1.1	1.1	0.46

^z All lines were *Beta vulgaris*. The two commercial check cultivars were Monohikari and HM PM90 (Bold).

^y 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.

^x 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 0.36 ± 0.05.

^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.