

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

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Beet curly top resistance of released germplasm from the USDA-ARS Program at Fort Collins, CO, 2009.

Seventy sugar beet (*Beta vulgaris* L.) germplasms released from the USDA-ARS Breeding Program in Fort Collins, Colorado over the last 40 years and 27 experimental germplasm were screened for resistance to *Beet severe curly top virus* (BSCTV) in 2009. The curly top evaluation was conducted at the USDA-ARS North Farm in Kimberly, ID which had been in beans in 2008. The field was plowed in the fall, fertilized (75 lb N/A and 75 lb P₂O₅/A) on 22 Apr 09, sprayed with Ethotron (2 pt/A), and roller harrowed. The germplasm was planted (density of about 143,000 seeds/A) on 18 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. A resistant breeding line from Betaseed, Inc., G6040, was included as a resistant check. 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 23 Jun with six viruliferous beet leafhoppers per plant. The beet leafhoppers were moved twice a day (right after sunrise and just before sunset) for one week 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. The plots were rated for foliar symptom development using a scale of 0-9 (0 = healthy and 9 = dead; Mumford 1974), with disease index (DI) treated as a continuous variable. Data were analyzed using the general linear models procedure (Proc GLM-SAS), and Fisher's protected least significant difference was used for mean comparisons.

Disease development was uniform and severe. Other disease problems were not evident in the plot area. Only 14 germplasm (some of the FC600 series, FC403CMS, and some experimental germplasms) were not significantly different from G6040 (resistant control). Very little of the germplasm tested was selected specifically for resistance to beet curly top, except for FC600 lines. They were developed to combine resistance to BSCTV with resistance to *Cercospora beticola*. Nonetheless, it is important for germplasm to be screened against as many diseases as possible, because plant breeders want as much information for a germplasm as is available. Many of the germplasms under development were from a collaborative breeding project with the USDA-ARS sugar beet breeding program at Salinas, CA, and much of the germplasm from this source has good resistance to beet curly top. Two of the lines that did well were experimental hybrids in which the female parent (C790-15cms and C833-tcms) was a Salinas germplasm with good resistance to beet curly top. Some of the more recently released lines from the FC700 series also did well, although significantly worse than the resistant check. Both FC721 and FC723 were developed to combine resistance to Rhizoctonia root and crown rot with resistance to beet curly top, and both were significantly better than the worse performing germplasm (DI = 9.0). The FC400 lines, which did well, were released historically as parental lines for performance under Spanish growing conditions and both FC403CMS and FC401 did well.

Source	PI no. ^z	Designation/Description	DF ^y
19751073H	PI590664	FC701-4 (4X)	9.0 a
19751079H	W6 17137	FC701-5	9.0 a
19681009-0	PI590662	FC702	9.0 a
19721018	PI590658	FC702-4	9.0 a
19721057	W6 17138	FC702-5	9.0 a
19751075H	PI590657	FC703 (4X)	9.0 a
19851054HO		FC502/3	9.0 a
19751093		FC701-3	9.0 a
19951035		FC714	9.0 a
19771067HO	PI590823	FC504	8.3 ab
19931024	PI590661	FC701	8.3 ab
19851044HO	W6 17125	FC505	8.3 ab
19861039	PI590766	FC712	8.3 ab
19961010HO1	PI636337	FC722CMS	8.0 a-c
19741078H	W6 17136	FC701-2	8.0 a-c
19921028HO	PI590845	FC708 (re-indexed)	8.0 a-c
20021011H	PI599668	FC709-2	8.0 a-c
19911026HO1	PI574626	FC715 CMS	8.0 a-c
20061009	PI594910	FC721	7.8 b-d
19961014	PI632251	FC724	7.8 b-d
20041010HO		FC712/MonoHyA4	7.8 b-d
19961013HO	PI558505	FC506	7.7 b-e
19791070H	PI590722	FC703-4	7.7 b-e
19851032H/ [^]			
20081008	PI590754	FC705-1	7.7 b-e
19921028HO1	PI590846	FC708CMS (re-indexed)	7.7 b-e
19991018	PI518643	FC709	7.7 b-e
20041007	PI599668	FC709-2	7.7 b-e
19971017	PI633733	FC710 (4X)	7.7 b-e
19821087	PI590729	FC711	7.7 b-e
20051019	PI607379	FC712 (4X)	7.7 b-e
19911032	PI574629	FC718	7.7 b-e
19961010HO	PI636336	FC722	7.7 b-e
19921019		FC729 – FC712/A4, 3 cycles Rhizoc, MM	7.7 b-e
20001019	PI590660	FC705	7.5 b-f
19851044HO1	W6 17126	FC505CMS	7.3 b-g
19961013HO1	PI610295	FC506CMS	7.3 b-g
19991017	PI590656	FC703	7.2 c-h
19831085HO1	PI590846	FC708CMS	7.2 c-h
19941024	PI542971	FC710	7.2 c-h
19911037	PI574627	FC719	7.2 c-h
19921025	PI591336	FC728	7.2 c-h
19921021		FC703-5	7.2 c-h
19991016		FC702/2	7.2 c-h
20071013	PI651015	FC220	7.0 c-i
20001021	PI590702	FC707	7.0 c-i
19921020	PI506238	FC707 (4X)	7.0 c-i
19971019	PI574627	FC716	7.0 c-i
1986A046	PI590767	FC606 (4X)	7.0 c-i
20021017	PI591335	FC726	7.0 c-i
20011022	PI590663	FC701-4	6.8 d-j
20001020	PI590701	FC706	6.8 d-j
19921022	PI590755	FC702-7	6.8 d-j
20041002	PI599668	FC709-2	6.8 d-j
20061007		FC220-1 sel - inc. 20051030	6.8 d-j
20061013		(Best FC LSR x Best EL LSR) - mm seedballs Increased	6.8 d-j
20071001		Z325 - Salinas high sucrose with disease resistance	6.8 d-j
20041010HO1		FC712/MonoHyA4	6.8 d-j
20061010HO		03-FC1015 FC201 sib - sel R	6.8 d-j
20061010HO1		CMS equivalent	6.8 d-j

Source	PI no. ^z	Designation/Description	DI ^y
19941027		Leaf Spot Susceptible synthetic check	6.8 d-j
20051022	PI634210	FC301	6.7 e-k
20001017	PI636335	FC720	6.7 e-k
20051021	PI63018	FC201	6.5 f-k
1997A050	PI590837	FC607	6.5 f-k
20001018	PI590659	FC704	6.5 f-k
20051018 ^x			
20081010	PI574628	FC717	6.5 f-k
19931005HO1	PI594911	FC721CMS	6.5 f-k
19951016HO1	PI639918	FC723CMS	6.5 f-k
19951017	PI599669	FC727	6.5 f-k
20071014	PI651016	FC221	6.3 g-l
19911042HO	PI558514	FC402	6.3 g-l
1978A044	PI590843	FC606	6.3 g-l
20031007	PI594910	FC721	6.3 g-l
19951016HO	PI639917	FC723	6.3 g-l
20021016	PI591334	FC725	6.3 g-l
20051006		<i>B.v</i> .ssp. <i>maritima</i> (Greece [BGRC 45511] - annual) x Sucrose _{MM}	6.3 g-l
19941029HO	PI558513	FC401	6.2 h-m
1986A048	PI590871	FC607 (4X)	6.2 h-m
1997A051	PI590838	FC607CMS	6.2 h-m
20041012		20021022 - '2859/FC607&FC604 MM = FC123 _{MM} , ½ sib of FC301	6.2 h-m
20051025		Sucrose _{MM} x LSR _{MM} Fargo & LSR _{MM} Fargo x Sucrose _{MM}	6.2 h-m
20061014		(Best FC LSR x Best EL LSR) - M- seedballs Increased	6.2 h-m
20061005HO1		03-124 CMS equivalent	6.2 h-m
20001025HO	PI558506	FC604	6.0 i-n
1986A045	PI590844	FC606CMS (4X)	6.0 i-n
1986A047	PI590872	FC607CMS (4X)	6.0 i-n
20011007		(907 x 709-2)F ₃	6.0 i-n
20061008HO		03-FC1014-22 (half sib selection within FC201) - sel in 6R	6.0 i-n
20071003H2		Z325 x (Sucrose _{MM} x BGRC 45511)	6.0 i-n
19911043HO1	PI558515	FC403CMS	5.8 j-n
20061008HO1		03-FC1014-22 x C833-H5 CMS	5.8 j-n
20001025HO1	PI558507	FC604CMS	5.7 k-n
20061005HO		03-124	5.7 k-n
20071015		Inc. 2005A020 - half sibs of FC123mm (FC301); monogerm	5.3 l-n
2005A019		C790-15cms x FC20021023 (½ sibs of FC123mm (FC301))	5.3 l-n
2005A018		C833-5cms x FC20021023 (½ sibs of FC123mm (FC301))	5.2 mn
1978A045	PI590844	FC606CMS	5.0 n
1996A008		Beta G6040 - Resistant Check	5.0 n
Overall mean			7.0
<i>P</i> > <i>F</i>			< 0.0001
Coefficient of variation			9.8
LSD (<i>P</i> < 0.05)			1.1

^z The PI (Plant Introduction) number is given to accession entered into USDA-ARS National Plant Germplasm System (NPGS) and a W6 prefix refers to an accession, which is held by the Western Regional Plant Introduction Station at Pullman, WA, (where the active beet collection is held) but has not been entered into the NPGS.

^y DI = Disease index on a scale of 0 (no damage) to 9 (dead plant).

^x Seed from two seed productions was combined to have enough for the test. Seed from 19771019 was combined with 20081010 and seed from 20001019 was combined with 20081008.