SUGAR BEET (*Beta vulgaris*)
Rhizomania; *Beet necrotic yellow vein virus*
Storage rot; *Athelia*-like sp., *Botrytis cinerea*, and *Penicillium* spp.

K. Dorn, USDA-ARS Sugar Beet Res. Unit, Crops Res. Lab, 1701 Centre Ave., Ft. Collins, CO 80526 and C. A. Strausbaugh and R. Majumdar, USDA-ARS NWISRL, 3793 N. 3600 E., Kimberly, ID 83341

Evaluation of USDA-ARS sugar beet germplasm for resistance to rhizomania and storage rot in Idaho, 2022.

Thirty sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Ft. Collins sugar beet program and five check cultivars were screened for resistance to *Beet necrotic yellow vein virus* (BNYVV), the causal agent of rhizomania, and to storage rot. The rhizomania evaluation was conducted at the USDA-ARS North Farm in Kimberly, ID which has Portneuf silt loam soil and had been in barley in 2021. In the spring the field was plowed and fertilized (110 lb N and 160 lb P_2O_5/A) and roller harrowed on 6 Apr 22. The germplasm was planted (density of 114,048 seeds/A) on 3 May. The plots were one row 10-ft long with 22-in. between-row spacing and arranged in a randomized complete block design with 6 replicates. The crop was managed according to standard cultural practices for southern Idaho. The trial relied on endemic field inoculum for rhizomania and storage rot development. The plots were rated for rhizomania foliar symptom (percentage of plants with yellow, stunted, upright leaves) development on 15 Aug. The plants were mechanically topped and hand harvested on 11-12 Oct. At harvest, ten roots per plot were rated for rhizomania symptom development using a scale of 0 to 9 (0 = healthy and 9 = dead; Plant Disease 93:632-638). At harvest, eight roots per plot were also placed in a mesh-onion bag and kept in an indoor commercial storage facility (temperature set point 34°F) in Paul, ID on 13 Oct. On 14 Mar 23, after 152 days in storage, the roots were evaluated for the percentage of root surface area covered by fungal growth or rot. Except for root ratings, data were analyzed in SAS (Ver. 9.4) using the general linear model (Proc GLM) procedure, and Fisher's protected least significant difference ($\alpha = 0.05$) was used for mean comparisons. The root ratings were analyzed in a nonparametric analysis as described by Shah and Madden (Phytopathology 94:33-43).

Rhizomania symptom development was uniform and other disease problems were not evident in the plot area. Lines 21 (F1016) and 29 (FC403) failed to produce enough plants, so there is no data for them in the table. The BNYVV susceptible check plots (Check 1 and Red beet) had 100% foliar symptoms and high root disease ratings. Resistant checks 3 and 4 had 0% foliar symptoms and a low root rating, which indicates that resistance based on these genes is holding up. Single gene resistance in Check 2 had foliar ratings of 8% indicating single gene resistance is not completely effective, but the root ratings were still good. The germplasm panel tested here represent a selected set of pre-breeding lines aimed at isolating the genomic region harboring the *Rz1* resistance gene. Selection of germplasm for this panel targeted half of the panel to lack any known rhizomania resistance, with the other half of the panel harboring only Rz1-based resistance (by pedigree). FC1036, FC1028, FC1020, and FC705/1 from the Fort Collins pre-breeding program had a level of BNYVV resistance similar to the resistant checks based on the root ratings, but foliar ratings were higher than those for the resistant checks. FC1037, CR933, C869, FC1022, FC221, and FC1038 had foliar ratings similar to the resistant checks and root ratings similar to some of the resistant checks. FC1036, FC1028, and FC1020 performed well for rot in storage along with having good root ratings, but only FC1037 and FC1038 performed well for all three variables. Of the 14 most resistant entries based on root ratings, all but one (FC705/1) are predicted to possess *Rz1*-based resistance. The only entry with *Rz1*-based resistance falling outside of this grouping was FC221, however, this line had excellent foliar ratings. BNYVV resistance data from these lines may serve as a starting point for developing molecular markers for *Rz1*. Some of these entries may also serve as a starting point for improving resistance to storage rots.

Entry[z]	Description	Root rot in storage (%)[y]	RZ foliar rating (% susceptible plants)	RZ root rating[x]
4	20111027; FC1028[v]	10 op	28 hi	18 j
Check 3	BTSSALCHK3 (*Rz1Rz1 Rz2Rz2*) = *Rz1* + *Rz2* resistant check	13 n-p	0 l	19 j
8	2009A043; FC1020[v]	10 op	30 h	21 ij
Check 4	BTSSALCHK4 (*Rz1Rz1*) = *Rz1* resistant check	30 kl	0 l	22 ij
15	20171021[v]	38 h-k	26 h-j	22 hij
1	20121011; FC1036[v]	15 m-p	16 h-k	24 hij
22	19851032H; FC705/1	14 m-p	62 fg	24 hij
10	20091009; FC1022[v]	20 l-o	8 kl	24 g-i
3	20111025; FC1037[v]	7 op	8 kl	24 g-i
6	20101011; FC1019[v]	8 op	48 g	25 g-i
2	20101009; FC1018[v]	27 k-m	18 h-k	26 f-h
Check 2	BTSSALCHK2 (*Rz2Rz2*) = *Rz2* resistant check	33 jk	8 kl	26 f-h
9	2005A004; C869[v]	51 e-h	13 i-l	26 f-h
14	20131007; FC1038[v]	5 p	8 kl	28 e-g
5	2009A030; FC1038[v]	17 l-p	68 ef	28 e-g
7	20161019PF; CR933[v]	29 kl	12 j-l	30 ef
13	20061005H01; Fort Collins pre-release[v]	19 l-o	90 a-d	30 ef
12	2012A019; F1024	44 g-j	84 b-d	33 de
28	20202509; F1002	35 i-k	94 a-d	35 d
23	20111007; FC702/7	25 k-n	93 a-d	36 d
24	20041010H0; FC712/monohyA4	48 f-i	98 ab	37 d
11	20141004; FC221[v]	57 ef	12 i-l	38 d
20	19971019; FC716	50 e-h	83 c-e	41 cd
25	20151043pf; Fort Collins pre-release	82 bc	98 a-c	43 cd
16	1997A050; FC607	62 e	90 a-d	44 cd
30	20211001; FC609	51 e-h	100 a	46 bc
18	19951017; FC727	63 de	87 a-d	48 bc
17	20221002 A1; F1043	75 cd	100 a	49 bc
27	20202522; US15	38 h-k	82 de	60 ab
19	2013A021; NSL80221	94 ab	95 a-d	61 ab
Check 1	BTSSALCHK1 (*rzrz*) = susceptible sugar beet check	56 e-g	100 a	65 ab
26	2013A081; PI 535827 'Rekord Poly' fodder beet	89 ab	100 a	85 a
Red beet	Detroit Dark Red (*rzrz*) = susceptible red beet check	98 a	100 a	87 a
P > F[w]		<0.0001	<0.0001	<0.0001
LSD		13	15	Trans

[z] All lines were *Beta vulgaris* subsp. *vulgaris*. Five commercial cultivars were included as checks.

[y] Root rot in storage = the percent of root surface area covered by fungal growth or rot. Fungal growth was dominated by an *Athelia*-like basidiomycete (Mycologia 104:70-78), *Penicillium expansum*, and *Penicillium cellarum*. Trace levels of *Botrytis cinerea* were also present. ND = no data.

[x] Ten roots per plot were evaluated for rhizomania symptoms using a scale of 0-9 (0 = healthy and 9 = dead; Plant Disease 92:581-587). Root rating = a disease severity index value for each plot established using the following formula: [((A)0+(B)1+(C)2+(D)3+(E)4+(F)5+(G)6+(H)7+(I)8+(J)9)/90]100, where A-J are the number of plants in categories 0-9, respectively.

[w] *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. Trans = root ratings were rank transformed prior to analysis with the mixed linear models (Proc MIXED) procedure, but the non-transformed means have been presented in the table. Mean separation for root ratings was based on a PDIFF comparison with a probability cutoff of 0.05.

[v] Entry contains *Rz1*-based resistance to rhizomania based on pedigree