

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

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USDA-ARS Plant Introduction lines evaluated for rhizomania and storage rot resistance in Idaho, 2020.

Thirty sugar beet (*Beta vulgaris* L.) USDA-ARS Plant Introduction (PI) lines 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 2019. In the spring the field was plowed and fertilized (110 lb N and 120 lb P₂O₅/A) and roller harrowed on 27 Mar 20. The germplasm was planted (density of 51,840 seeds/A) on 20 Apr. 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 24 Aug. The plants were mechanically topped and hand harvested on 13-14 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), with disease index (DI) treated as a continuous variable. 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 15 Oct. On 22 Feb 21, after 131 days in storage, the roots were evaluated for the percentage of root surface area covered by fungal growth or rot. Except for the 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 rank transformed prior to analysis with the mixed linear models (Proc MIXED) procedure, but the non-transformed means have been presented in the table.

Rhizomania symptom development was uniform and other disease problems were not evident in the plot area. The stand for four lines (6, 19, 20, and 21) was poor to non-existent. Thus only 26 PI lines were included in the table. The BNYVV susceptible check plots (Check 1 and Red beet) had 100% foliar symptoms and high root disease ratings. Resistant check 3 had 1% foliar symptoms and a low root rating which indicates that resistance based on two genes is holding up. Single gene resistance (Checks 2 and 4) had foliar ratings ranging from 8 to 13% indicating single gene resistance is not completely effective, but the root ratings were still good. Ten entries (2, 3, 4, 12, 15, 22, 27, 28, 29, and 30) had a level of BNYVV resistance similar to at least one of the resistant checks based on root ratings. Entry 11 was highly susceptible with a root rating worse than the sugar beet susceptible check. A number of the entries had resistance to fungal rots in storage, but only entry 4 performed well for all three variables. Some entries may serve as a starting point for identifying additional sources of resistance to BNYVV and storage rots.

Entry ^z	Description	Root rot in storage (%) ^y	RZ foliar rating (% susceptible plants)	RZ root rating ^x
Check 3	BTSSALCHK3 ($R_zIR_zI R_z2R_z2$) = $R_zI + R_z2$ resistant check	5 h-j	1 j	17 p
3	PI line 658061; FC1020	5 h-j	39 d-f	19 op
28	PI line 628755; C869 CMS	17 ef	20 g-i	20 op
Check 2	BTSSALCHK2 (R_z2R_z2) = R_z2 resistant check	18 ef	8 ij	21 n-p
4	PI line 658062; FC1022	6 g-j	11 ij	22 m-o
Check 4	BTSSALCHK4 (R_zIR_zI) = R_zI resistant check	11 f-h	13 ij	22 m-o
15	PI line 665053; FC1028	8 g-j	39 d-f	22 m-o
27	PI line 652891; CR933	6 g-j	45 c-e	23 m-o
2	PI line 658060; FC1019	5 h-j	56 b-d	23 l-o
12	PI line 634018; FC201	9 g-i	17 h-j	24 k-n
30	PI line 671963; FC305	35 bc	35 e-g	24 k-n
29	PI line 681717; FC1740	6 g-j	67 b	24 j-m
22	PI line 664917; EL62	13 fg	13 ij	25 j-m
1	PI line 658059; FC1018	9 g-j	24 f-i	26 i-l
13	PI line 599668; FC709-2	5 h-j	88 a	27 h-k
17	PI line 590845; FC708	9 g-i	85 a	28 g-j
14	PI line 590661; FC701	4 h-j	66 b	28 f-i
9	PI line 632251; FC724	6 g-j	94 a	30 f-h
23	PI line 658654; F1024	1 j	100 a	30 fg
16	PI line 594910; FC721	6 g-j	88 a	31 ef
26	PI line 590696; F1002	28 cd	100 a	32 ef
10	PI line 599669; FC727	11 f-h	32 e-h	33 d-f
7	PI line 590837; FC607	13 fg	90 a	38 c-e
5	PI line 590755; FC702/7	2 ij	100 a	38 cd
8	PI line 590754; FC705/1	7 g-j	58 bc	38 bc
Check 1	BTSSALCHK1 (r_zr_z) = susceptible sugar beet check	21 de	100 a	39 bc
24	PI line 608437; F1016	26 d	85 a	40 bc
18	PI line 574627; FC716	34 bc	95 a	41 bc
25	PI line 676971; F1043	41 b	100 a	42 a-c
Red beet	Early Wonder (r_zr_z) = susceptible red beet check	ND	100 a	48 ab
11	PI line 687276; FC242	62 a	99 a	66 a
$P > F^w$		<0.0001	<0.0001	<0.0001
LSD		8	17	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:

$$[(A)0+(B)1+(C)2+(D)3+(E)4+(F)5+(G)6+(H)7+(I)8+(J)9]/90 \times 100$$
, where A-J are the number of plants in categories 0-9, respectively. Trans = the root ratings were rank transformed prior to analysis with mixed linear models procedure, but the non-transformed means have been presented in the table.

^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.