

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, 2023.

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 2022. The field was fall plowed with a Terrano chisel plow. In the spring the field was fertilized (115 lb N and 140 lb P₂O₅/A) and roller harrowed on 10 Apr 23. The germplasm was planted (density of 114,048 seeds/A) on 2 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 7 Aug. The plants were mechanically topped and hand harvested on 16-17 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 92:581-587). 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 18 Oct. On 11 Mar 24, after 145 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 2 (20161004HO1) and 17 (FC702/7) failed to produce enough plants, so they are not 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 no foliar symptoms and a low root rating, which indicates that resistance based on these genes is holding up. Single gene resistance in Checks 2 and 4 had foliar ratings of 17% indicating single gene resistance is not completely effective, but the root ratings were still good. Eight entries had a level of BNYVV resistance similar to at least one of the resistant checks based on the root ratings, but some foliar ratings were higher than those for the resistant checks. Entries 1, 4, 5, 7, 10, 12, and 26 performed well for rot in storage along with having good root ratings. Entry 1 was the only entry with ratings similar to resistant check 3 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
5	FC1028 PI 665053	9 j-l	32 gh	15 l
1	FC1036 PI 665054	24 ij	7 ij	16 l
Check 3	BTSSALCHK3 (<i>Rz1Rz1 Rz2Rz2</i>) = <i>Rz1</i> + <i>Rz2</i> resistant check	18 i-l	0 j	16 l
7	FC1038 PI 665056	32 hi	48 ef	19 kl
10	FC1020 PI 658061	14 j-l	40 fg	20 jk
Check 2	BTSSALCHK2 (<i>Rz2Rz2</i>) = <i>Rz2</i> resistant check	70 bc	17 hi	21 i-k
Check 4	BTSSALCHK4 (<i>Rz1Rz1</i>) = <i>Rz1</i> resistant check	44 gh	17 hi	21 i-k
12	20171021	8 kl	9 ij	22 ij
4	FC1037 PI 665055	12 j-l	13 ij	23 hi
14	C869 PI 628754	59 c-f	17 hi	23 hi
26	20161004HO	20 i-k	0 j	23 hi
11	FC1022 PI 658062	17 i-l	10 ij	25 gh
9	CR933 PI 652891	60 c-e	6 ij	26 g
8	FC1019 PI 658060	5 l	0 j	26 fg
24	C890 PI 329964	40 gh	67 cd	27 fg
3	FC1018 PI 658059	14 j-l	60 de	28 ef
25	EL54 PI 654357	53 d-g	68 cd	29 de
18	F1016 PI 608437	60 c-e	100 a	30 c-e
27	20231008 FC709-3	19 i-l	100 a	30 c-e
16	FC607 PI 590837	15 j-l	75 b-d	31 cd
13	FC221 PI 651016	52 d-g	73 b-d	31 c
29	FC609 PI 518644	46 e-h	77 bc	32 c
28	US015 PI 590581	48 e-g	97 a	32 c
23	FC727 PI 599669	23 i-k	93 a	32 c
20	F1043 selection from PI 179180	75 b	88 ab	32 c
30	Rekord Poly PI 535827	70 bc	100 a	33 c
22	20041010HO	43 gh	100 a	34 b
6	F1024 PI 658654	54 d-g	100 a	34 b
19	FC716 PI 574627	45 f-h	97 a	36 b
15	SR EL 99J19-00mm; 2001A021	63 b-d	100 a	44 a
Check 1	BTSSALCHK1 (<i>rzz</i>) = susceptible sugar beet check	70 bc	100 a	44 a
21	FC242 PI 687276	74 bc	100 a	47 a
Red beet	Detroit Dark Red (<i>rzz</i>) = susceptible red beet check PI 590605	100 a	100 a	51 a
$P > F^w$		<0.0001	<0.0001	<0.0001
LSD		15	16	Trans

^zAll lines were *Beta vulgaris* subsp. *vulgaris*. Five commercial cultivars were included as checks.

^yRoot 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.

^xTen 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.

^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.