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, 2022.

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 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. The BNYVV susceptible check plots (Check 1 and Red beet) had 95 to 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 8% foliar ratings indicating *Rz2* resistance is not completely effective, but the root ratings were still good. Entries 28 and 29 had a level of BNYVV resistance similar to the resistant checks based on both foliar and root ratings. Entry 24 also had root ratings similar to the resistant checks but had higher foliar ratings. Entries 23 and 27 had very good foliar ratings, but the root ratings were subpar. Entries 23, 24, and 27 should be evaluated again to be sure these evaluations can be repeated. A number of the entries had resistance to fungal rots in storage, but only entry 29 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 (*Rz1Rz1 Rz2Rz2*) = *Rz1 + Rz2* resistant check	11 mn	0 d	19 p
Check 4	BTSSALCHK4 (*Rz1Rz1*) = *Rz1* resistant check	36 h-k	0 d	22 p
29	W6 45822; Mar12-002; Morocco, Rabat-Salé-Kénitra, Kénitra 2012	8 n	0 d	26 p
Check 2	BTSSALCHK2 (*Rz2Rz2*) = *Rz2* resistant check	32 i-l	8 c	26 p
24	PI 540573; WB 827; France 1990	77 c-f	94 ab	28 op
28	W6 45821; Mar12-001; Morocco, Rabat-Salé 2012	38 h-k	0 d	32 nop
20	PI 518307; WB 629; United Kingdom, England 1988	42 h-j	0 d	35 m-o
22	PI 518354; WB 676; United Kingdom, England 1988	32 i-k	5 cd	36 m-o
21	PI 518345; WB 667; United Kingdom, England 1988	80 b-e	0 d	39 mn
3	Ames 22164; Long smoothe dark red; United States, Iowa 1976	29 i-l	100 a	39 l-n
8	NSL 183370; 223; United States, Utah 1983	16 l-n	100 a	42 k-m
10	NSL 183406; 1122; United States, Utah 1983	38 h-k	100 a	44 k-m
30	W6 45823; Mar12-003; Morocco, Rabat-Salé-Kénitra, Kénitra 2012	80 b-e	100 a	47 j-l
7	NSL 183366; 127; United States, Utah 1983	42 hi	100 a	50 i-k
25	PI 540654; WB 908; France 1990	22 k-n	94 ab	52 i-k
9	NSL 183376; 342; United States, Utah 1983	34 i-k	100 a	52 i-k
12	PI 176427; Kocabas; Turkey 1949	78 b-f	97 ab	52 i-k
23	PI 531253; Dama; Denmark 1989	51 gh	3 cd	53 i-k
19	PI 518166; Monogerm (No. 1); China 1988	27 j-m	92 b	60 h-j
11	PI 175598; Kocabas; Turkey 1949	66 e-g	100 a	60 g-i
2	Ames 22163; Iowa; United States, Iowa 1976	86 a-d	100 a	64 gh
Check 1	BTSSALCHK1 (*rzrz*) = susceptible sugar beet check	59 g	100 a	65 gh
4	NSL 28024; Extra early; United States, Wyoming 1963	86 a-d	100 a	68 f-h
17	PI 407523; Kirgizskaja 058; Kyrgyzstan 1976	64 fg	100 a	69 e-h
1	Ames 15637; BO-85; United States, California 1991	75 d-f	92 b	71 d-h
6	NSL 86579; 72/4-41-2-T4; United States, Colorado 1974	87 a-d	100 a	72 c-g
27	W6 44518; Mar10-025; Morocco 2012	28 i-l	0 d	78 b-f
5	NSL 28026; Gardeners model; United States, Wyoming 1963	100 a	100 a	80 b-f
26	W6 44508; Mar10-015; Morocco 2012	83 b-d	100 a	82 b-e
18	PI 507848; 3700001; Hungary 1987	100 a	100 a	84 a-d
16	PI 381638; Mezhotnensk 080; Latvia 1973	65 e-g	100 a	85 a-d
Red beet	Detroit Dark Red (*rzrz*) = susceptible red beet check	92 ab	100 a	87 a-c
13	PI 256052; No. 1; Afghanistan 1959	91 a-c	95 ab	88 ab
15	PI 357364; Tetovska; North Macedonia 1970	100 a	100 a	89 ab
14	PI 355957; Af'Jun-Karagissarskaja; Asia Minor 1971	91 a-c	100 a	95 a
P > F[w]		<0.0001	<0.0001	<0.0001
LSD		16	7	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.

[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 the root ratings was based on a PDIFF comparison with a probability cutoff of 0.05.