

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

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Kimberly sugar beet germplasm evaluated for rhizomania and storage rot resistance in Idaho, 2023.

Thirty-three sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Kimberly 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 caused by *Athelia*-like sp., *Botrytis cinerea*, and *Penicillium* spp. 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 postharvest 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 93:632-638). At harvest, eight roots per plot selected arbitrarily 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 7 (Maritima/KEMS08_7), 31 (KEMS2), and 32 (KEMS4) 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 2 and 3 had 3 to 8% foliar symptoms and a low root rating, which indicates that resistance based on the *Rz2* gene is reasonably good. Check 4 had a foliar rating of 48% indicating single gene resistance based on *Rz1* is rather poor, but the root ratings were still low. Entries 21, 24, 25, 29, and 33 had root ratings similar to Check 3, but foliar ratings for entries 21, 25, and 29 were poor. Entries 13, 14, 28, and 36 had root disease ratings similar to the single gene checks and good foliar ratings. Entries 21, 26, 33, and 36 performed well for rot in storage along with having good root ratings, but only entries 33 and 36 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 (<i>Rz1Rz1 Rz2Rz2</i>) = <i>Rz1</i> + <i>Rz2</i> resistant check	18 m-o	3 fg	16 m
21	CR11-6	19 l-o	58 b	18 lm
24	CR11-88	40 d-j	5 fg	20 lm
25	CR11-88C	57 b-d	12 e-g	20 klm
29	CR11-88-545	47 c-f	25 de	20 klm
Check 2	BTSSALCHK2 (<i>Rz2Rz2</i>) = <i>Rz2</i> resistant check	70 b	8 e-g	21 klm
33	KEMS11	15 m-o	8 fg	21 klm
Check 4	BTSSALCHK4 (<i>Rz1Rz1</i>) = <i>Rz1</i> resistant check	44 d-h	48 bc	21 klm
26	CR11-88-505	14 m-o	42 b-d	22 j-l
14	Maritima/KEMS08 14	35 f-l	0 g	22 j-l
28	CR11-88-536	46 c-g	7 fg	22 j-l
36	KEMS4/5	21 k-o	0 g	23 i-k
35	KC944	41 d-i	50 bc	23 i-k
13	Maritima/KEMS08 13	36 e-k	0 g	23 i-k
3	Maritima/KEMS08 3	29 h-m	17 e-g	24 h-j
5	Maritima/KEMS08 5	7 o	14 e-g	25 g-i
23	CR951-210	29 g-m	9 e-g	25 g-i
10	Maritima/KEMS08 10	14 m-o	10 e-g	25 g-i
20	Maritima/KEMS08 20	61 bc	7 fg	25 g-i
11	Maritima/KEMS08 11	12 no	0 g	25 f-i
16	Maritima/KEMS08 16	27 i-n	12 e-g	25 f-i
2	Maritima/KEMS08 2	20 k-o	7 fg	26 e-i
8	Maritima/KEMS08 8	39 e-j	43 bc	26 e-h
34	KEMS16	48 c-f	16 e-g	26 e-h
1	Maritima/KEMS08 1	24 j-n	12 e-g	27 d-g
4	Maritima/KEMS08 4	26 i-n	12 e-g	27 d-f
19	Maritima/KEMS08 19	22 k-o	20 ef	27 de
22	CR11-7	47 c-f	87 a	29 c-e
15	Maritima/KEMS08 15	14 mn	38 cd	29 c-e
30	KEMS1	21 k-o	8 e-g	29 c-e
17	Maritima/KEMS08 17	48 c-f	14 e-g	30 b-d
6	Maritima/KEMS08 6	48 c-f	0 g	31 b-d
9	Maritima/KEMS08 9	15 m-o	5 fg	32 a-d
12	Maritima/KEMS08 12	49 c-f	12 e-g	33 a-c
18	Maritima/KEMS08 18	39 e-j	25 de	36 a-c
Check 1	BTSSALCHK1 (<i>rzrz</i>) = susceptible sugar beet check	70 b	100 a	44 ab
27	CR11-88-515	52 c-e	0 g	49 ab
Red beet	Detroit Dark Red (<i>rzrz</i>) = susceptible red beet check	100 a	100 a	51 a
$P > F^w$		<0.0001	<0.0001	<0.0001
LSD		17	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.

^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.