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

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Evaluation of Ft. Collins sugar beet germplasm for rhizomania and storage rot resistance in Idaho, 2016.

Fifty sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Fort Collins sugar beet program and four check cultivars were screened for resistance to *Beet necrotic yellow vein virus* (BNYVV), the causal agent of rhizomania, and to fungal growth in storage, which is related to storage rot (Plant Dis. 93:632-638). The rhizomania (RZ) evaluation was conducted at the USDA-ARS North Farm in Kimberly, ID, which has Portneuf silt loam soil and had been in barley in 2015. The field was fall plowed and on 4 Apr 16, fertilized (90 lbs N and 110 lbs P_2O_5/A) and roller harrowed. The germplasm was planted (density of 142,560 seeds/A) on 18 Apr. The plots were single row 10-ft long with 22-in. row spacing and arranged in a randomized complete block design with 6 replications. The crop was managed according to standard cultural practices for southern Idaho. Plants were thinned to 47,500 plants/A on 27 May. The trial relied on endemic field inoculum for rhizomania and storage rot development. The plots were rated for foliar symptom (percentage of plants with yellow, stunted, upright leaves) development on 18 Aug, and were mechanically topped and hand harvested on 13 Oct. At harvest, ten roots per plot (approximately 20 lbs) were rated for rhizomania symptom development using a scale of 0 to 9 (0 = healthy and 9 = dead; Plant Dis. 93:632-638), with disease index (DI) treated as a continuous variable. At harvest, eight of the evaluated roots per plot also were placed in a mesh-onion bag and distributed on top of the pile inside in an indoor commercial storage facility (temperature set point 34°F) in Paul, ID on 14 Oct. On 9 Feb 2017, after 118 days in storage, the roots were evaluated for the percentage of root surface area covered by fungal growth. Data were analyzed in SAS (Ver. 9.4) using the general linear models procedure (Proc GLM), and Fisher's protected least significant difference ($\alpha = 0.05$) was used for mean comparisons. The foliar data were square root transformed prior to analysis.

Rhizomania symptom development was uniform and no other disease symptoms were evident in the plot area. The BNYVV susceptible check plots (Check 1) had 81% foliar symptoms and a high root disease severity rating of 46. The three resistant checks (2, 3, and 4) had 0 to 7% foliar symptoms and low root disease severity ratings (18 to 24). Based on root ratings, all but three entries had some resistance, because these were the only entries not different from the susceptible check. Four entries (20141007, 20141009, 20131010H11, and 20131010H10) had good rhizomania resistance based on both root symptoms and foliar ratings because these did not significantly differ from more of the resistant checks. A number of entries performed well in storage, four entries only had single digit fungal growth and 20 others were not significantly different from these four, although these were not always the same entries that showed resistance to BNYVV. Some of these entries may serve as a starting point for identifying additional sources of resistance to BNYVV and storage rots.

Entry[z]	Description	Fungal growth in storage (%)[y]	RZ foliar rating (% susceptible plants)	RZ Root rating[x]
Check 4	BTSSALCHK4 (*Rz1Rz1*) = *Rz1* resistant check	50 b-d	2 v-x	18 t
Check 3	BTSSALCHK3 (*Rz1Rz1 Rz2Rz2*) = *Rz1* + *Rz2* resistant check	41 b-g	0 x	22 st
Check 2	BTSSALCHK2 (*Rz2Rz2*) = *Rz2* resistant check	70 a	7 p-x	24 rs
20141007	FC1740 Population (Rz1Rz1Rz2Rz2)	41 b-g	8 t-x	26 p-s
20131010H11	female = ({SP85657-01 × FC709-2} X EL51) X FC220-1	41 b-g	30 j-r	26 q-s
20131010H10	female = ({SP85657-01 × FC709-2} X EL53) X FC220-1	28 f-n	14 o-x	27 o-r
20141009	FC1741 Population (rz1rz1Rz2Rz2)	14 m-s	18 n-w	28 m-r
20141007	FC1740 Population (Rz1Rz1Rz2Rz2)	22 i-r	18 m-u	28 n-r
20131010H16	({SP85657-01 × FC709-2} X EL51)F_2	14 m-s	22 l-t	29 k-q
20131010H09	female =(FC708CMS X EL51) X FC220-1	27 g-o	39 f-l	29 l-q
20131011	20081016PF-x; (Best FC LSR × Best EL LSR) x CR011 F_3	12 o-s	18 m-v	30 j-p
20151017	20121018HO-x - Bulk increase of roots selected for RhzcR	18 k-s	17 m-w	30 j-p
20141019PF	FC220-2; 20121037PF&MS; (FC220-1 -BI 20051030) RhzcR	13 n-s	7 s-x	30 k-q
20151014HO	20121019HO & HO1 - Increase 03-FC1015HO & HO1	18 k-s	0 x	31 g-o
20141009	FC1741 Population (rz1rz1Rz2Rz2)	9 q-s	8 t-x	31 h-p
20151016	20111024-x, [(FC907×FC709-2); 9931] × [C790-15cms x FC1036]	12 o-s	6 t-x	31 i-p
20131008HO	C869, PI 628754	30 e-l	2 wx	31 j-p
20131010H14	female = (FC708CMS X EL 51)F2	43 b-f	32 j-q	31 j-p
20131010H08	female =(FC708CMS X EL 53) X FC220-1	34 e-j	24 k-s	32 f-m
20131012PF	07-FC1015-403 - mod. CR, Rz1, CTR, with mm, T-O, %S	27 g-o	12 q-x	32 f-m
20111028	20091028ms; CLR family (BGRC 45511 X $Sucrose_{MM}$)	15 l-s	52 c-i	32 f-n
20141018	20121036; [(FC907 x FC709-2) & 9931 (Salinas)] × [C790-15cms x FC1036]	39 c-h	8 s-x	32 f-n
20151020	20101013-xs; B.I. Roots selected at EL in 2010 & 2011	24 h-q	12 o-x	32 f-o

20101010	C790-15cms × 05-FC1018 [RZM-CR-% (C931 × FC709-2)F_3]	21 i-r	28 k-s	32 g-o
20101012	C790-15cms × RZM-CR-% (FC712 x 9931)F3	17 k-s	27 j-q	33 f-l
20151044PFHO	20101015HO1-x/20131012MS;	13 n-s	7 t-x	33 f-l
20061005HO1	03-124 CMS equivalent	8 rs	28 i-p	33 f-m
20111031	20071003H2; LSR {(BGRC 45511) x Sucrose} × Z325aa	20 j-s	8 r-x	33 f-m
1997A050	FC607, LSR/CTR, easy bolting, O-type, 2X, mm, self-sterile	31 e-k	82 a-d	34 e-j
20151046PFHO	20101016HO1-xs/20101016HO-x; Kimberly sel CTR	9 rs	0 x	34 f-j
20041010HO1	FC712/MonoHy A4 - CMS equivalent	14 m-s	62 b-h	34 f-k
20061005HO	03-124 FC123 derivative	16 l-s	12 n-w	34 f-k
20121012HO	FC302 = 03-FC1014-22 (½ sib sel FC201) - sel in 6R	29 e-m	73 a-e	34 f-k
20151019	20141011MS - LSR sel $Sucrose_{MM}$ × PI 535833 (Saturn)	50 b-d	31 g-n	34 f-k
20151038PF	20071005H2; Bulk of Z325 × ($Sucrose_{MM}$ × BGRC 36538	31 e-k	52 c-j	34 f-k
20101008	(Best FC LSR × Best EL LSR) - mm seedballs Increased	24 h-q	69 a-f	35 e-i
20041010HO	FC712/MonoHy A4	15 m-s	50 h-n	35 e-j
20131006	FC305	14 n-s	57 b-h	35 e-j
20131010H12	female = ({SP85657-01 × FC709-2} X FC708) X FC220-1	5 s	27 j-q	35 e-j
20131010H15	female = ({SP85657-01 × FC709-2} X EL53)F_2	18 k-s	53 c-j	35 e-j
20131010H17	({SP85657-01 × FC709-2} X FC708)F_2	36 d-i	39 f-m	35 e-j
20141021PF	20121054; SucroseMM × PI 535833 (Saturn)	18 k-s	36 g-m	35 e-j
20121017	20111030; Bulk 5 highest CLR families w/Fargo	44 b-e	83 a-c	36 d-f
20141004	FC221	11 p-s	51 c-k	36 d-g
20141011PF	20121053; single ½ sib $Sucrose_{MM}$ × PI 535833 (Saturn)	38 c-h	44 e-l	36 d-g
20141022PF	Bulk 0931 & 9933 × SBCN Res, Iranian sugarbeet landrace	12 o-s	3 u-x	36 d-g
20151042	20101013-xs; B.I. Z325 × ($Sucrose_{MM}$ × BGRC 45511)	17 k-s	26 i-o	36 d-g
20121013PF	FC221-1	24 h-q	48 d-k	36 e-h
20131010H13	female = (FC708CMS x EL53)F2	29 e-m	92 ab	39 c-e
20151043PF	20101013-xs; B.I. Z325 x ($Sucrose_{MM}$ x BGRC 45511)	25 h-p	78 a-d	40 b-d
20151018	20121056 - Bulk RhzcR/LSR ½ sib 10A-1775 for release	38 c-h	100 a	43 a-c
20141035PF	BI LSR ½ sib (biennial - France) PI 540596 × $Sucrose_{MM}$	55 ab	62 a-g	44 ab
20151036PF	BI LSR ½ sib (biennial - France) PI 540596 × $Sucrose_{MM}$	22 i-r	73 a-e	45 a
Check 1	BTSSALCHK1 (*rzrz*) = susceptible check	51 bc	81 a-d	46 a
Overall mean		26	34	33
$P > F^w$		<0.0001	<0.0001	<0.0001
LSD		15	Trans	5

[z] All lines were *Beta vulgaris* subsp. *vulgaris*.

[y] Fungal growth in storage = the percent of root surface area covered by fungal growth. Most of the fungal growth was by a recently described *Athelia*-like basidiomycete (Mycologia 104:70-78).

[x] Ten roots per plot were evaluated for resistance to rhizomania 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 = the foliar rating analysis was conducted on square root transformed means, but untransformed means are presented in the table. The foliar rating analysis was conducted on square root transformed means, but untransformed means are presented in the table.