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

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Ft. Collins sugar beet germplasm evaluated for rhizomania and storage rot resistance in Idaho, 2015.

Fifty-seven sugar beet (*Beta vulgaris* L.) lines from the USDA-ARS Ft. 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 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 2014. The field was fall plowed. In the spring of 2015, it was fertilized (90 lb N and 110 lb P_2O_5/A) and roller harrowed on 9 Apr. Seed of the sugar beet germplasm lines was planted (density of 142,560 seeds/A) on 21 Apr. One-row plots, 10 ft long with 22-in row spacing between rows were arranged in a randomized complete block design with 4 replications. The crop was managed according to standard cultural practices. Plant populations were thinned to 47,500 plants/A on 29 May. The trial relied on natural infection for rhizomania and storage rot development. The plots were rated for foliar symptom (percentage of plants with yellow, stunted, upright leaves) development on 8 and 20 Jul. The plants were mechanically topped and hand harvested with the aid of a single-row lifter on 7 Oct. At harvest, roots in the plots were rated for 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 collected in a mesh-onion bag and placed in an indoor commercial storage facility (temperature set point 34°F) in Paul, ID on 8 Oct. On 11 Feb16 following 126 days in storage, the roots were evaluated for the percentage of root surface area covered by fungal growth. Data were analyzed in SAS (Ver. 9.2) using the general linear models procedure (Proc GLM), and Fisher's protected least significant difference ($\alpha = 0.05$) was used for mean comparisons.

Rhizomania symptom development was uniform and other disease problems were not evident in the plot area. The BNYVV susceptible check (Check 1) had 89 to 92% foliar symptoms and a high root disease severity rating. The three BNYVV resistant checks (2, 3, and 4) had no foliar symptoms and low root ratings. Entry 29 had both high foliar and root ratings that were similar to the susceptible check. Entries 2, 3, and 13 also performed poorly with foliar ratings similar to the susceptible check, but root ratings for these entries were slightly above the cut off, and therefore, were considered different from the susceptible check. Most other entries had fewer foliar symptoms and a better root rating than the susceptible check indicating they have some level of resistance. Based on BNYVV root ratings, the entries not significantly different from the best performing entry (25) were checks 2, 3, 4, and entries 16, 20, 34, and 48). All of these had foliar ratings that were 4% or less (not significantly different from the best performing entries with 0%). Entries 25, 16, and 20 were experimental hybrids with FC1740 (entry 48 – Rz1Rz1Rz2Rz2, based on associated SNP markers) or FC1741 (entry 49 – rz1rz1Rz2Rz2, based on associated SNP markers). Entry 34 is a polycross population developed for resistance to root rot complexes. Because the sugar beet root is a live plant tissue, it respires, depleting stored sucrose after harvest. Therefore another important characteristic of harvested sugar beet is how well it stores after harvest, which includes resistance to fungal rots, and fungal colonization is associated with fungal growth on the root surface. The primary fungal growth was an *Athelia*-like Basidiomycete (Mycologia 104:70-78), but *Botrytis* sp. and *Penicillium* sp. were also frequently present. Entries 9, 11, 18, 31, 34, and 43 were not significantly different from the entry most resistant to fungal growth in storage (entry 18 with only 2%). Entries 14, 20, 21, 48, and 53 performed well for all variables. Some of these entries may serve as a starting point for identifying additional sources of resistance to both BNYVV and storage rots.

			Rhizomania		
			Foliar rating (% susceptible plants)		
Entry[z]	Description	Fungal growth in storage (%)[y]	8 Jul	20 Jul	Root rating[x]
(25) 20131002HO5	Rz1Rz1/rz2rz2 [x C869CMS]	29 b-g	2 m	2 st	16 y
Check 2	BTSSALCHK (*Rz2Rz2*) = *Rz2* resistant check	95 a	0 m	0 t	19 xy
(34) 20131010H12	({SP85657-01 x FC709-2} X FC708) X FC220-1[w]	4 pq	5 m	52 f-j	19 xy
Check 4	BTSSALCHK4 (*Rz1Rz1*) = *Rz1* resistant check	28 b-h	0 m	0 t	20 w-y
Check 3	BTSSALCHK3 (*Rz1Rz1Rz2Rz2*) = *Rz1* + *Rz2* resistant check	39 bc	0 m	0 t	21 v-y
(16)20131001HO11	rest of C869 [x C869CMS]	31 b-f	0 m	0 t	21 u-y
(48) 20141007	FC1740 Population (Rz1Rz1Rz2Rz2)	7 n-q	0 m	0 t	23 t-y
(20) 20131001HO8	Rz1rz1rz2rz2 [x C869CMS]	8 m-q	4 m	6 st	23 s-y
(32) 20131010H10	({SP85657-01 x FC709-2} X EL53) X FC220-1[w]	13 i-q	28 f-m	45 g-l	24 r-x
(17) 20131001HO4	rest of FC708 [x FC708CMS]	24 d-l	15 i-m	19 m-t	24 q-x
(4) 20061005HO	03-124 FC123 derivative	14 h-q	20 h-m	25 k-t	25 p-x
(56) 20141019PF	FC220-2; Rhizoctonia selection	10 l-q	10 k-m	22 l-t	25 o-x
(30) 20131010H08	(FC708CMS X EL 53) X FC220-1[w]	14 g-q	42 c-i	52 f-j	25 o-x
(24) 20131002HO4	Rz1rz1/rz2rz2 [x C869CMS]	12 j-q	8 lm	12 p-t	25 o-x
(19) 20131001HO7	Rz1Rz1rz2rz2 [x C869CMS]	10 l-q	5 m	5 st	26 n-x
(21) 20131001HO9	Rz1_Rz2rz2 [x C869CMS]	6 o-q	0 m	0 t	26 n-x

Entry[z]	Description	Fungal growth in storage (%)[y]	Rhizomania: Foliar rating (% susceptible plants) 8 Jul	Rhizomania: Foliar rating (% susceptible plants) 20 Jul	Rhizomania: Root rating[x]
(31) 20131010H09	(FC708CMS X EL51) X FC220-1 [w]	4 pq	21 g-m	40 g-o	27 m-w
(15)20131001HO10	rest of C869 [x C869CMS]	38 b-d	5 m	10 q-t	27 m-w
(22)20131002HO10	rest of C869 [x C869CMS]	12 k-q	2 m	2 st	27 m-w
(42) 2013A006	C931, 4931, PI 636340	9 m-q	6 lm	14 p-t	28 l-w
(28) 20131008HO	C869, PI 628754	28 b-h	0 m	0 t	28 l-v
(14) 2012A035	R840 (Blk. of R740)	6 o-q	5 m	5 st	28 l-v
(53) 20141015HO1	03-FC1015H5 - CMS equivalent of 03-FC1015 -	8 n-q	0 m	4 st	28 k-v
(52) 20141015HO	03-FC1015 FC201 derivative – selected in 6R	22 e-m	12 j-m	12 p-t	28 j-u
(5) 20061005HO1	03-124 CMS equivalent	15 g-q	12 j-m	28 j-s	29 j-t
(39) 20131010H17	({SP85657-01 x FC709-2} X FC708)F [w]	14 h-p	19 i-m	44 g-m	29 i-t
(35) 20131010H13	(FC708CMS x EL53)F2 [w]	35 b-e	25 f-m	65 c-g	29 i-t
(7) 20101010	C790-15cms/05-FC1018 [RZM-CR-% (C931 x FC709-2)F3]	26 b-j	24 g-m	34 i-q	30 i-t
(38) 20131010H16	({SP85657-01 x FC709-2} X EL51)F2 [w]	13 i-q	28 f-m	75 a-f	30 i-t
(49) 20141009	FC1741 Population (rz1rz1Rz2Rz2)	8 n-q	8 lm	12 p-t	30 h-t
(45) 2013A009	N412, CN12, PI 636338	6 o-q	0 m	0 t	30 h-t
(26) 20131002HO8	rest of C869 [x C869CMS]	27 b-i	15 i-m	15 o-t	30 h-t
(43) 2013A007	5933, CR933, PI 652891	4 pq	10 k-m	15 o-t	30 h-t
(44) 2013A008	4933-14, CR933-14, PI 652892	12 j-q	0 m	8 r-t	30 h-t
(23) 20131002HO3	rz1rz1rz2rz2 [x FC708CMS]	40 b	25 f-m	38 h-p	30 h-t
(50) 20141010	FC201	24 d-l	2 m	16 n-t	30 h-s
(8) 20101012	C790-15cms x RZM-CR-% (FC712 x 9931)F3	14 h-p	38 c-k	58 f-i	31 h-s
(40) 20131011	(Best FC LSR x Best EL LSR) x CR011 (Salinas)F3	14 h-p	6 lm	19 m-t	31 h-r
(55) 20141018	[(FC907/FC709-2) & 9931 (Salinas)]/[C790-15cms/FC1036]	8 n-q	19 i-m	32 i-r	31 g-r
(46) 20141003	FC301	25 c-k	21 g-m	21 l-t	31 g-r
(54) 20141016HO	20121023HO; Bulk increase of C812-41; FC1100 (Rz2)	25 c-k	0 m	11 q-t	31 g-q
(41) 20131012PF	07-FC1015-403	6 o-q	0 m	0 t	31 g-p
(18) 20131001HO6	rest of FC708 [x FC708CMS]	2 q	10 k-m	12 p-t	32 f-p
(33) 20131010H11	({SP85657-01 x FC709-2} X EL51) X FC220-1 [w]	21 e-n	41 c-i	50 f-k	32 f-p
(10) 20111031	20071003H2; LSR {(BGRC 45511/Sucrose}/Z325aa	22 e-m	36 d-k	51 f-j	32 f-o
(51) 20141011PF	20121053; LSR from $Sucrose_{MM}$ x PI 535833 (Saturn)	30 b-f	4 m	11 q-t	32 e-n
(36) 20131010H14	(FC708CMS X EL 51)F2 [w]	18 g-p	40 c-j	72 b-f	33 e-m
(47) 20141004	FC221	31 b-f	39 c-j	52 f-j	34 e-m
(57) 20141021PF	20121054; $Sucrose_{MM}$ x PI 535833 (Saturn)	19 f-o	34 e-l	41 g-n	35 d-l
(27) 20131006	FC305	40 b	58 b-e	61 e-h	35 c-k
(12) 20121013PF	FC221-1	13 i-p	42 c-i	85 a-e	35 c-j
(1) 1997A050	FC607, LSR/CTR, easy bolting, O-type, 2X, mm, self-sterile	9 m-q	48 c-h	61 e-h	36 c-i
(11) 20121012HO	FC302 = 03-FC1014-22 (½ sib FC201) - selected in 6R	4 pq	52 c-f	65 c-g	37 b-h
(37) 20131010H15	({SP85657-01 x FC709-2} X EL53)F2 [w]	13 h-p	49 c-g	95 ab	38 b-g
(6) 20101008	(Best FC LSR x Best EL LSR) - mm seedballs Increased	12 j-q	60 b-e	89 a-c	39 b-f
(9) 20111028	CLR family (BGRC 45511/$Sucrose_{MM)}$ sib line 20111029	5 o-q	65 a-c	62 d-h	39 b-e
(2) 20041010HO	FC712/MonoHy A4	6 o-q	82 ab	100 a	41 b-d
(3) 20041010HO1	FC712/MonoHy A4 - CMS equivalent	8 n-q	85 ab	95 ab	42 b-d
(13) 20121017	20111030; Increase 5 highest CLR families 20071004HO-xs	35 b-e	85 ab	88 a-d	42 bc
(29) 20131009	LSR ½ sib families; LSR (PI 540596) x $Sucrose_{MM}$ pop	6 o-q	62 a-d	92 ab	44 ab
Check 1	BTSSALCHK1 (*rzrz*) = susceptible check	34 b-e	89 a	92 ab	51 a
Overall mean		18	23	34	30
P > F[v]		<0.0001	<0.0001	<0.0001	<0.0001
LSD		14	28	25	7

[z] Entry number followed by dash and line designation. All lines were *Beta 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 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] The pedigree is of a female in a polycross among populations developed for root rot complex resistance.

[v] *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.