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IMPACT OF ROOT DISEASES ON STORAGE

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In recent years, root diseases have become more prevalent throughout Minnesota and eastern North Dakota. Rhizoctonia root and crown rot (*Rhizoctonia solani*) can cause substantial yield loss but does not threaten the productive potential of the region to the same extent as rhizomania (beet necrotic yellow vein virus) and Aphanomyces (*Aphanomyces cochlioides*). Because of its persistence in soil and the lack of effective control methods, Aphanomyces is especially threatening. Rhizomania was positively identified in southern Minnesota in 1996 and has since spread throughout the region. Rhizomania resistant hybrids provide the only practical control for heavily infested sites. Rhizomania resistant hybrids were quickly introduced, in response to the rapid spread of the disease, without knowledge of their storage characteristics. Hybrids with resistance to Aphanomyces and Rhizoctonia have been available for some time and provide some protection when used in combination with fungicides and certain cultural practices (Windels and Brantner, 2002). Resistant hybrids generally are not the most productive in the absence of the disease and disease severity depends upon conditions after planting, making it difficult to predict when resistance will be beneficial. Any increase in the prevalence of root rot in commercial fields will be accompanied by an increase in roots with rot that are placed in storage piles. Information on the effects of rot severity on initial quality and storability would assist growers and agriculturalists when determining the disease severity that justifies not harvesting a field or if roots from diseased fields should be segregated and processed first. This report provides information that will aid in making these decisions and in selecting hybrids for areas where root diseases are prevalent.

Three fields near Moorhead, Minnesota were sampled in 2001. Roots from each field were divided into four groups, based upon root-rot (primarily Aphanomyces) severity, and stored at 40° F and 95% relative humidity. Respiration rate (CO_2 production), sugar, extractable sugar per ton, and carbohydrate impurity concentrations (Klotz and Campbell, 2002) were measured 18 and 138 days after harvest. Each root was rated for disease severity prior to obtaining the 18-day measurements and a root-rot index (0 = no rot to 100 = completely rotted) calculated for each 12-root sample (Beale, et al., 1995). Roots of six rhizomania and/or Aphanomyces resistant hybrids were obtained from two variety trials in southern Minnesota and one in northern North Dakota. Yields at one Minnesota site (Degraff, MN) were reduced by rhizomania and perhaps beet soil-borne mosaic virus, and the other two (Clara City, MN and St. Thomas, ND) had no apparent virus symptoms. Respiration rate, sugar, and extractable sugar per ton were measured 18 and 128 days after harvest.

The effects of Aphanomyces root rot on storage of the 2001 crop were similar to those observed for the 2000 crop (Campbell and Klotz, 2002). Respiration rate increased and extractable sugar decreased only slightly in roots with moderate disease severity. Eighteen days after harvest the severely damage roots had respiration rates approximately five times that of relatively healthy roots from the same field (Table 1) and extractable sugar ranged from more than 300 lbs/ton for the healthy roots to 180 lbs/ton for the most diseased. Relative respiration rates 138 days after harvest followed a similar trend, except for the Moorhead-2 field. Respiration rates for roots from this field probably reflect the effects of conventional storage pathogens and are not closely associated with Aphanomyces severity. For the other two fields, respiration rates of the healthy, russet, and moderate roots remained relatively low and extractable sugar losses averaged 37 lbs/ton or 0.3 lbs/ton/day. Respiration rates for roots with severe symptoms continued to be high and extractable sugar losses were approximately one pound per ton per day, three times that observed for the other groups. Invert sugar concentrations increased during storage but the increase was not related to disease severity. Raffinose, the only impurity found to be associated with disease severity, was lowest in severely rotted roots. Other trisaccharides (1-kestose, 6-kestose, and *neo*-kestose) concentrations did not change over time or in response to disease severity. Initial evaluations of the 2002 crop appear to confirm the results reported here and previously (Campbell and Klotz, 2002) and data from the three years will be combined for analysis at the end of the 2002-2003 storage season.

Based upon the initial evaluation of roots from St. Thomas and Clara City and the 128-day results from Clara City, the introduction of rhizomania resistance was not accompanied by an increase in storage respiration rate (Table 2). The results suggest that rhizomania resistance and the genetic factors controlling storage respiration rate are independent and the development of resistant hybrids with low storage respiration rates is feasible. The high 128-day respiration rates and the low extractable sugars for St. Thomas demonstrate the negative impact of conventional storage rots and make comparisons with the other locations meaningless. Lower respiration rates and higher sugar concentrations were observed in the absence of rhizomania. The results suggest that the impact of rhizomania on storage losses is considerably less than the effect of severe Aphanomyces. Roots from 2002 variety trials in southern Minnesota and from strip trials in fields with severe rhizomania south of Crookston, MN are being evaluated with the intent of obtaining more information on the impact of rhizomania on losses in storage.

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References

Beale, Julie W., Carol E. Windels, and Linda L. Kinkel. 1995. Variability of Aphanomyces populations and root rot severity in sugarbeet fields. 1994 Sugarbeet Res. and Ext. Rep., Coop. Ext. Ser. North Dakota State Univ. 25: 77-83.

Campbell, Larry, and Karen Klotz. 2002. Impact of root diseases on storage: Extractable sugar and respiration. 2001 Sugarbeet Res. and Ext. Rep., Coop. Ext. Ser. North Dakota State Univ. 32: 181-182.

Klotz, Karen, and Larry Campbell. 2002. Impact of root diseases on storage: Carbohydrate impurity formation. 2001 Sugarbeet Res. and Ext. Rep., Coop. Ext. Ser. North Dakota State Univ. 32: 183-185.

Windels, Carol E., and Jason R. Brantner. 2002. Integrated management of Aphanomyces root rot on sugarbeet. 2001 Sugarbeet Res. and Ext. Rep., Coop. Ext. Ser. North Dakota State Univ. 32: 297-281.

Table 1. Storage characteristics (18 and 138 days after harvest) of roots from three fields with Aphanomyces root rot, Clay County, Minnesota, 2001.

Location/ group	Rot Index	Respiration rate (CO2) 18d	Respiration rate (CO2) 138d	Sugar* 18d	Sugar* 138d	Extractable sugar* 18d	Extractable sugar* 138d
	0 - 100	- mg / kg / hr-		- - - % - - -		- lb/ton -	
Moorhead - 1							
Healthy	20	4.32	5.01	17.2	16.8	318	279
Russet	33	3.83	4.32	17.8	17.2	317	271
Moderate	59	9.29	6.47	17.5	15.8	315	265
Severe	84	37.94	26.18	11.5	6.2	161	47
Moorhead - 2							
Healthy	26	4.89	10.88	15.0	12.3	284	168
Russet	40	5.30	14.07	14.8	12.2	267	161
Moderate	67	6.38	13.78	13.7	10.3	248	112
Severe	85	17.82	17.40	11.1	9.7	178	106
Moorhead - 3							
Healthy	23	3.56	3.80	17.3	17.5	309	305
Russet	37	3.49	4.03	18.4	17.1	348	282
Moderate	58	3.64	4.10	15.5	15.7	272	257
Severe	86	15.75	27.20	12.6	5.5	203	51
3-Field mean							
Healthy	23	4.26	6.56	16.5	15.5	304	251
Russet	37	4.21	7.47	17.0	15.5	311	238
Moderate	61	6.44	8.12	15.6	13.9	278	211
Severe	85	23.84	23.59	11.7	7.1	181	68

*Sugar and extractable sugar for 138 days after harvest are adjusted for changes in dry weight during storage (Based upon weight 18 days after harvest)

Table 2. Storage characteristics (18 and 128 days after harvest) of Aphanomyces and Rhizomania resistant hybrids from two sites in southern Minnesota and St. Thomas, North Dakota, 2001

Location / hybrid	Respiration rate (CO2) 18 d	128d	Sugar** 18d	128d	Extractable sugar** 18d	128d
	- -mg / kg - -		- - - %- - - -		- - lb/ton - -	
St. Thomas						
H-7083	5.61	15.98*	16.8	13.3	305	171
B-4811	7.66	10.29	16.2	13.2	298	213
B-4600	5.82	14.19	17.2	15.2	313	224
A-952	6.16	13.16	18.4	18.4	334	262
V-46109	6.93	20.30	17.0	10.0	313	115
B-3945	6.93	18.43	18.0	13.5	329	179
Mean	6.52	15.39	17.3	13.6	315	194
LSD (0.05)	0.96	5.79	1.0	2.6	20	20
Clara City (healthy)						
H-7083	7.64	5.08	13.3	11.9	240	211
B-4811	6.84	5.31	14.3	12.7	241	236
B-4600	6.98	6.16	14.9	13.3	272	235
A-952	7.08	5.94	15.1	14.2	274	255
V-46109	6.92	5.81	14.1	12.0	257	218
B-3945	7.40	6.37	14.8	14.6	269	242
Mean	7.14	5.78	14.4	13.0	259	233
LSD(0.05)	ns	ns	ns	1.5	27	ns
Degraff (diseased)						
H-7083	9.76	8.28	12.8	12.3	234	218
B-4811	8.27	7.57	12.8	12.8	232	216
B-4600	9.91	7.77	12.8	13.3	228	237
A-952	7.48	5.82	12.9	10.9	231	189
V-46109	8.16	9.01	13.6	12.0	251	214
B-3945	9.05	9.26	14.0	12.7	251	227
Mean	8.78	7.95	13.1	12.2	238	217
LSD(0.05)	ns	ns	ns	ns	ns	ns

H7083 B-4811 B-4600 A-952 V-46109 B3945

|---------- Aphanomyces resistant ------------|

|-- Rhizomania resistant --|

*High respiration rates for St. Thomas 128 days after harvest are due to conventional storage rots - Penicillin, Botrytis, Phoma, etc.

**Sugar and extractable sugar for 128 days after harvest are adjusted for changes in dry weight during storage (Based upon weight at 18 days after harvest).