IMPACT OF ROOT DISEASES ON STORAGE: EXTRACTABLE SUGAR AND RESPIRATION

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In recent years root diseases have become more prevalent throughout Minnesota and eastern North Dakota. Rhizomania was positively identified in southern Minnesota in 1996 (Roehl and Widner, 1997) and has since been observed in the southern Red River Valley. Rhizomania (beet necrotic yellow vein virus) resistant hybrids are available and provide the only practical control. Because of its persistence in the soil and the lack of effective control methods, Aphanomyces is especially threatening. Rhizoctonia sometimes causes substantial losses but does not threaten the production potential of the region to the same extent as Rhizomania and Aphanomyces. Any increase in root rots in the field will be accompanied by an increase in the proportion of roots with rot that are placed in storage piles. Information on the effects of root-rot severity on initial quality and storability would assist growers and agriculturalists when determining the disease severity that would justify not harvesting a field or if roots from diseased fields should be segregated and processed first.

Three Clay County, Minnesota fields were sampled in 2000. Roots from each field were divided into four groups, based upon root rot (primarily Aphanomyces) severity. The most severely infected roots were substantially lower in extractable sugar per ton (Table 1) and had considerably higher respiration rates (produced more CO_2) than healthy roots. The results suggested

Table 1. Extractable sugar and storage respiration rates of roots with rot from three fields south of Moorhead, Minnesota, stored for 16, 44, and 57 days. Harvested 29 September 2000.

DISEASE SEVERITY	PRODUCER			
	Nyquist	Rosenfeldt	Jacobson	Mean
		16-day extractable sugar, lb/ton		
No rot	322	288	337	315
Russet	313	301	315	310
Moderate	294	263	266	274
Severe	123	110	150	128
		16-day respiration - mg CO2/kg/hr		
No rot	6.45	5.62	3.70	5.26
Russet	6.65	6.48	4.95	5.94
Moderate	6.24	6.13	10.34	7.57
Severe	19.99	22.91	23.41	21.94
		44-day respiration - mg CO2/kg/hr		
No rot	4.62	5.40	4.81	4.94
Russet	3.82	4.66	9.64	6.04
Moderate	4.67	6.35	16.66	9.23
Severe	19.44	27.17	33.96	25.44
		57-day respiration - mg CO2/kg/hr		
No rot	4.54	5.28	4.54	4.78
Russet	5.60	5.24	5.23	5.36
Moderate	5.04	7.36	20.42	10.94
Severe	19.05	-----	-----	-----

that roots with some russeting may have slightly lower sugar concentrations and slightly higher respiration rates but the effects

were small compared with roots with more severe Aphanomyces. Respiration rates of roots classified as moderate or severe increased over time while rates for roots with no rot remained relatively constant. The higher respiration rates of diseased roots would increase pile temperatures, increasing storage losses of adjacent healthy roots. These results are based on a few samples collected in a single year and should be considered preliminary. However, they provided a basis for research that is continuing into the 2001-2002 campaign.

Roots were again harvested from three Clay County fields with Aphanomyces in 2001. Disease severity for each root was rated on a 0 = healthy to 7 = severe scale (Beale et al., 1995). These ratings were used to calculate a root rot index (0 = healthy to 100 = severe) for each 12-root sample. The trends observed in the 2000 crop were apparent in the 2001 crop. Respiration rate increased and extractable sugar decreased only slightly in roots with moderate disease severity. Eighteen days

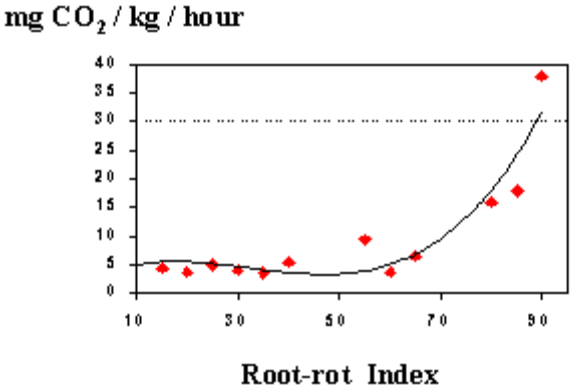

Figure 1. Effect of root rot severity on respiration rate (mg carbon dioxide/kg/hour) of roots 18 days after harvest. Harvested 28 September 2001, Clay County, Minnesota.

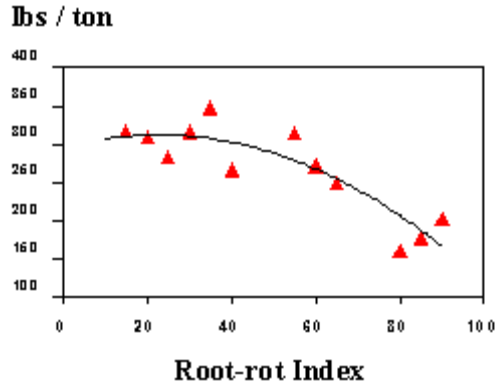

Figure 2. Effect of root rot severity on extractable sugar per ton 18 days after harvest. Harvested 28 September 2001, Clay County, Minnesota.

after harvest the severely damaged roots had respiration rates nearly five times that of relatively healthy roots from the same field (Figure 1) and extractable sugar decreased from 300 lbs/ton for the healthy beets to 180 lbs/ton for the most diseased roots (Figure 2). These roots are currently in storage and will be evaluated again after 120 days in storage.

In addition to the samples from growers' fields, roots were harvested from American Crystal and Southern Minnesota variety trials in 2001. Six hybrids with a range of Aphanomyces resistance were harvested from trials near Hillsboro, ND and Perley, MN. Aphanomyces was severe at Hillsboro and the value of resistant hybrids was evident. In contrast, disease pressure was light at Perley and the resistant hybrids had no apparent advantage and maybe a slight disadvantage in extractable sugar per ton. Roots from six Rhizomania and/or Aphanomyces resistant hybrids were obtained from two variety trials in southern Minnesota and one in northern North Dakota (St. Thomas). Yields at one southern Minnesota site were reduced by Rhizomania and perhaps Beet Soil-Borne Mosaic Virus and the other had no apparent virus symptoms. The North Dakota trial was in a region where Rhizomania and Beet Soil-Borne Mosaic Virus have not been found. It appears that Rhizomania infected roots may have slightly higher storage respiration rates than healthy roots but the effect is considerably less than that associated with Aphanomyces. Based upon the trial at St. Thomas, neither Rhizomania nor Aphanomyces resistance is associated with increased respiration rates, in the absence of the disease.

The results presented in this report are based upon a preliminary study conducted in 2000-2001 and early results from 2001-2002 storage trials. Hence, they should be interpreted with caution. The detrimental effects of severe Aphanomyces seems evident but the impact of light to moderate disease severity on storability is less clear. The impact of Rhizomania is not as apparent and confirmation of the trends observed in the early 2001-2002 evaluations is needed. Roots harvested in 2001 will be evaluated for storage respiration rate and extractable sugar after 120 days of storage and additional data will be collected on the 2002 crop.

Literature Cited

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

Roehl, Steve and Jim Widner. 1997. Rhizomania and other furoviruses in the southern Minnesota sugar beet growing area. *In* 1996 Sugarbeet Res. and Extension Rep., Cooperative Extension Service, North Dakota State Univ. 27: 225-227.
