IMPACT OF CERCOSPORA LEAF SPOT DISEASE SEVERITY ON SUGARBEET ROOT STORAGE

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Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola* (Crous et al., 2001), is the most damaging foliar disease of sugarbeet in North Dakota and Minnesota (Khan and Hakk, 2016). Historically, fungicides have been used to control disease symptoms. However, *C. beticola* has developed tolerance to several fungicides that are used against this disease, increasing the likelihood that disease symptoms will develop during production and that roots harvested from CLS-diseased plants will be incorporated into storage piles.

In Minnesota and North Dakota, sugarbeet roots are stored in ventilated or frozen piles for up to eight months. While other production diseases such as Aphanomyces root rot, Fusarium yellows, rhizomania, and rhizoctonia root and crown rot, are known to have a negative impact on storage (Campbell and Klotz, 2006; Campbell and Klotz, 2008; Klotz and Campbell, 2009; Campbell et al., 2011; Campbell et al., 2014), the effects of CLS on sugarbeet root storage properties are not known. It is suspected that roots harvested from CLS-diseased plants do not store as well as healthy roots. However, the effects of CLS on storage properties such as respiration rate, sucrose loss, losses in recoverable sugar, and the accumulation of invert sugars and other impurities that increase sucrose loss to molasses have not been determined.

Research was initiated in 2018 to determine the impact of different levels of CLS disease severity on sugarbeet root storage properties after short-term and long-term storage. Roots with varying levels of CLS disease severity were obtained from a field that was inoculated with *C. beticola* and contained plots that received variations in fungicide treatments. After field plots were rated for CLS severity, roots from plots with very low, low, moderate, and severe CLS symptoms were harvested and used for evaluating storage properties. These roots are presently in storage, with storage properties to be determined after 30, 90 and 120 days in storage.

MATERIALS AND METHODS

Plants with varying severities of CLS were produced in a field near Foxhome, MN. Six-row plots (11 ft wide by 30 ft long) were planted with Hilleshög 9528 sugarbeet seed on 12 May 2018 using 22-inch rows and 4.7-inch spacing within rows. Plants were produced using recommended agronomic practices (Khan, 2018) and were inoculated with 5 lb ac^{-1} dried *C. beticola*-infected leaves on 28 June 2018. Varying severity of CLS symptoms were obtained using the fungicide treatments described in Table 1, with all fungicides used at their full rates and applied to the middle four rows of each plot. A randomized complete block design with four replicates was used. CLS disease severity was rated using a 1 – 10 scale where 1 indicates an absence of disease symptoms and 10 indicates complete defoliation and leaf regrowth. The middle two rows of each plot were

Table 2: Fungicide treatments and application dates used to obtain plants with varying severity of Cercospora leaf spot symptoms.

Disease Severity	Fungicide Treatment	Application Date
Very Low	Minerva Duo	07/05/18
	Supertin + Topsin	07/18/18
	Proline + Badge SC + NIS	07/31/18
	Mankocide	08/16/18
	Supertin + Manzate	08/31/18
Low	Supertin + Manzate + Topsin	07/18/18
	Supertin + Manzate + Topsin	07/31/18
	Supertin + Manzate + Topsin	08/16/18
	Supertin + Manzate + Topsin	08/31/18
Moderate	Minerva Duo	07/05/18
	Supertin + Topsin	07/18/18
	Proline + Badge SC + NIS	07/31/18
High	untreated	

harvested on 27 September 2018. Roots were washed and roots within a plot were randomly assigned to 10 root samples which served as the experimental unit for the storage study. A 10-root sample from each plot was ground to brei after harvest for the determination of sucrose content, loss to molasses, invert sugar concentrations, impurity concentrations, and recoverable sugar per ton prior to storage. The remaining 10-root samples from each plot were stored at 5°C and 95% humidity in a cold room. Respiration rates of 10-root samples were determined after 30 days in storage using a Licor infrared CO_2 analyzer (Campbell et al., 2011). Additional respiration rate determinations will be made after roots are stored for 90 and 120 days. Following respiration rate determinations, samples were/will be ground into brei. Brei samples will be used for determining sucrose content, loss to molasses, invert sugar concentrations, impurity concentrations, and recoverable sugar per ton after 0, 30, 90, and 120 days in storage.

PROGRESS REPORT

The storage study is currently in progress. Brei samples were collected on the day of harvest and from roots that were stored for 30 days. The sucrose content of these samples has been determined (Table 2) and additional analyses to determine invert content, sodium and potassium concentrations, and amino nitrogen levels are underway. Respiration rate of roots after 30 days storage has also been determined.

At harvest, roots from plants with moderate to severe symptoms had significantly lower sucrose content relative to roots with very low or low CLS symptoms (Table 2). After 30 days in storage, sucrose concentrations for roots from the different disease classifications were similar to those found at harvest with the differences in sucrose content between disease classes at 30 days after harvest (DAH) mirroring the differences that existed at harvest. After 30 days in storage, respiration rate of roots with the four levels of disease were statistically similar.

Table 2: Effect of Cercospora leaf spot severity on sucrose content and storage respiration rate of roots after 30 days in storage. CLS disease severity was rated on a 1-10 scale where 1 indicates an absence of disease and 10 indicates complete defoliation and regrowth of new leaves. DAH = days after harvest. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with $\alpha = 0.05$. n = 4.

CLS severity class	Disease rating	Sucrose content				Respiration rate	
		0 DAH		30 DAH		30 DAH	
		- - - - - - - - (%) - - - - - - -				- - (mg $kg^{-1}hr^{-1}$) - -	
Very low	3	16.0	a	15.8	a	2.48	a
Low	3	15.7	a	15.7	a	2.71	a
Moderate	6	14.1	b	13.6	b	2.41	a
Severe	10	13.7	b	14.0	b	2.76	a

With the limited data available at the time of writing, no evidence has been found to indicate that Cercospora leaf spot affects sugarbeet storage properties. However, this study is not complete and storage properties after 90 and 120 days storage remain to be determined. A full summary of this experiment will be provided in next year's report.

ACKNOWLEDGEMENTS

The authors thank Peter Hakk and Joe Thompson for technical assistance and the Sugarbeet Research & Education Board of MN & ND for partial financial support of this research. Mention of trade names or commercial products is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

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