Evaluation of Cercospora leaf spot and postharvest rot pathogen impacts on sugar beet storage

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Introduction

- In Michigan, sugar beets are stored for up to 200 days post-harvest while awaiting processing. During the storage period, there are several factors that cause the beets to rot, reducing the sugar content and overall profit. In addition, fungal mycelium, lipopolysaccharides and pectinase byproducts may clog filters and slow the extraction process. Michigan Sugar Co. estimates that delaying onset of storage rot by one month could save $1 million per year.
- It is not well understood how foliar disease in the field will affect the storability or respiration rate of the beet. Preliminary research in North Dakota suggests that Cercospora leaf spot (CLS) does not affect physiological root storage properties [1], however, the relationship between CLS and susceptibility to storage pathogens requires further examination.
- Proper identification and characterization of the pathogens affecting stored beets also will allow for better targeting of disease management.

Objectives

1. Investigate the impacts of variety and CLS field infection on rate of storage rot symptom development
2. Determine the effect of CLS infection on beet respiration rate in storage
3. Monitor and characterize storage pathogens affecting sugarbeets postharvest

Methods

Objective 1: High and low CLS levels were established using combinations of fungicide treatments and field inoculation. After 60 days of storage at 42°F, beet slices were inoculated with *Botrytis cinerea, Penicillium vulpinum, Fusarium graminearum* and *Geotrichum* sp. Fungal growth was measured one week post-inoculation. At least three timepoints are planned.

C-G333NT:	F1042:	HIL-9865:	EL50/2:
CLS Susceptible, Good Storage	CLS Susceptible, Root maggot tolerant	CLS Resistant, Fair Storage	CLS Resistant, Low sugar

Trial 1: CLS impact on susceptibility of sugar beet to four postharvest diseases

Location: Saginaw (SVREC)	**Treatments:** Non-treated (high CLS), grower standard (low CLS)
Planting Date: April 7, 2020	**Variety:** C-G333NT (Inoculated July 9 and July 23, 2020)
Harvest: September 18, 2020	**Replicates:** 4 plots/treatment in field, 3 roots/plot in storage
Storage Trial Timepoint 1: November 24, 2020	**Days Postharvest Timepoint 1:** 67

Figure 1. Beets inoculated with storage pathogens.

Trial 2: Effects of *C. beticola* and beet variety

Location: Saginaw (SVREC)	**Treatments:** Inoculated (high CLS), non-inoculated (low CLS)
Planting Date: May 22, 2020	**Varieties:** F1042, EL50/2, C-G333NT, HIL-9865
Harvest: October 15, 2020	**Inoculated:** July 9 and July 23, 2020
Storage Trial Timepoint 1: December 15, 2020	**Days Postharvest Timepoint 1:** 61

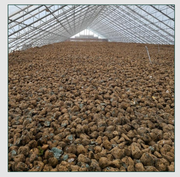


Figure 2. Michigan Sugar Co. hoop structure in Sebewaing.

Objective 2: Roots of C-G333NT and HIL-9865 with high and low CLS ratings from Trial 2 were stored in vented respirometry chambers at 42°F. Samples will be taken periodically throughout the storage season to measure the beet respiration rate/kg.

Objective 3: The storage pathogens were isolated from indoor and outdoor piles at the Sebewaing processing location in spring of 2020 and 2021. Diseased beets were again collected from this location in December 2020 by Michigan Sugar Co. Additional piling facilities will be monitored in the future.

Figure 3. Respirometry chambers and flow board used to measure the rate of respiration.

Figure 4. Sugar beet infected with *Penicillium* and *Botrytis* spp.

Figure 5. Beet with high and low CLS levels, achieved with grower standard fungicide application, or non treated.

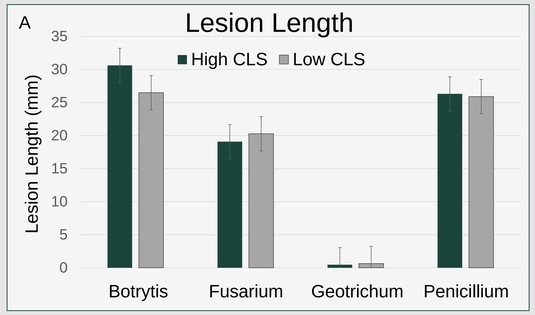
Discussion & Conclusions

1. In Trial 1, no significant differences were detected in storage rot susceptibility of beets with high or low CLS levels in the field ($P > 0.05$, Fig. 6). In Trial 2, however, the interaction between CLS rating, pathogen, and variety significantly affected rot depth ($P < 0.05$, Table 1). In addition, the interaction between pathogen and variety affected lesion length ($P < 0.05$, Fig. 7). These experiments will be repeated to validate these observations.

2. There was no significant difference in respiration rate of beets with high or low CLS levels following timepoint 1 and 2, 60- and 80- days post-harvest ($P > 0.05$, Fig. 8). Additional rate measurements will be collected 100- and 120-days post-harvest. Storage pathogen impacts on respiration rate will be evaluated in the future.

3. In 2019 and 2020, *Botrytis cinerea, Penicillium spp*., and *Fusarium* spp. were most frequently isolated from Michigan piling grounds (Fig. 9). *Geotrichum* spp. were isolated in 2020 and has not previously been reported in Michigan. *Geotrichum candidum* was recently reported on sugar beet in North Dakota and Minnesota [4]; this fungus causes rubbery or sour rot on potato and is often characterized by a sour odor. Future goals include determining the pathogenicity, virulence, and spore dispersal mechanisms of these storage pathogens to help reduce infection.

Results



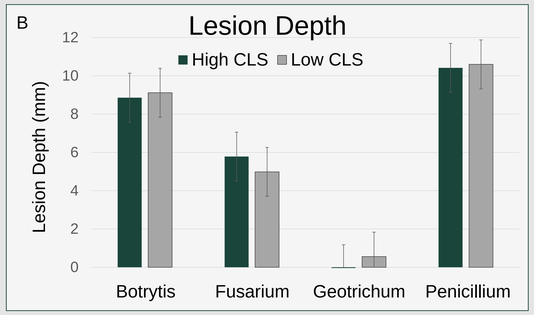


Figure 6. Mean lesion lengths (A) and depths (B) measured from roots inoculated with postharvest pathogens. Beet roots originated from plots with high or low levels of CLS in field studies, achieved from either a non-treated or grower standard treated check. Measurements corrected for nontreated control (n=40). Fisher's Protected Least Squares Difference showed difference of 6.6 mm is considered significant for length, and 3.5 mm for depth at α = 0.05.

Type III Tests of Fixed Effects

			Lesion Length		Lesion Depth	
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**	**F Value**	**Pr > F**
CLS Level	1	2	3.52	0.2015	4.37	0.1717
Pathogen	3	48	24.49	<.0001	50.20	<.0001
CLS*Pathogen	3	48	0.05	0.9832	0.53	0.6654
Variety	3	12	0.77	0.5350	0.36	0.7809
CLS*Variety	3	12	0.19	0.9008	0.51	0.6836
Pathogen*Variety	9	48	2.09	0.0492	0.90	0.5351
CLS*Pathogen*Variety	9	48	2.02	0.0569	2.17	0.0415

Table 1. Mean lesion lengths and depths measured from sugar beet roots inoculated postharvest pathogens. C-G333NT and F1042 were selected as CLS-susceptible, HIL-9865 and EL50/2 were selected as CLS-resistant varieties. These varieties were subjected to high and low CLS pressure following inoculation or no inoculation. Statistics indicate that the interaction between the pathogen and variety influences rot depth.

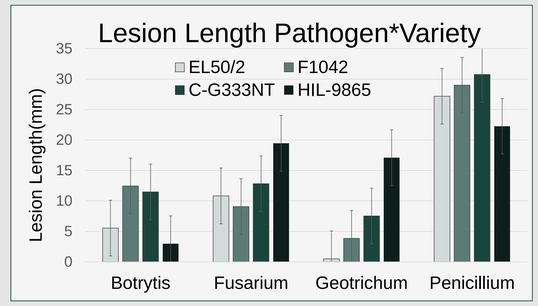


Figure 7. Mean lesion lengths measured from roots inoculated with postharvest pathogens. Beet roots originated from plots with high or low levels of CLS in field studies, achieved from either inoculation or no inoculation. Measurements corrected for nontreated control (n=96). Least Squares Means indicate that the interaction between the pathogen and the variety may affect the lesion length.

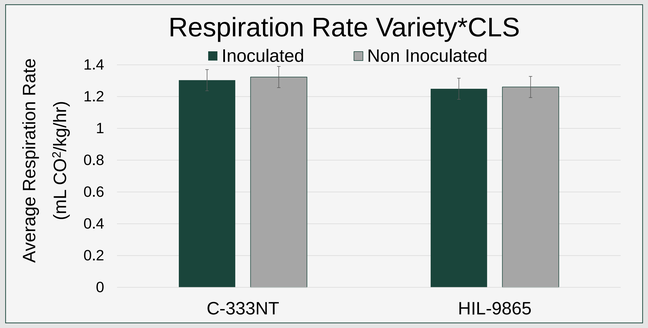


Figure 7. Respiration rate of roots with high and low CLS levels. Beet roots originated from plots with high or low levels of CLS in field studies, achieved from inoculation or no inoculation. Respiration was measured approximately 60- and 80-days post-harvest. They were stored at 42°C and were not inoculated with storage pathogens. Fisher's Protected Least Squares Difference showed no significant difference ($P > 0.05$, n=20)

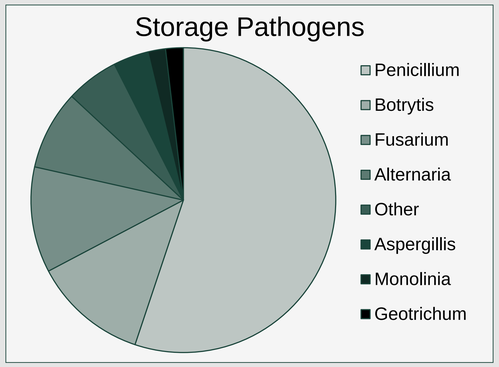


Figure 9. Pathogen survey of storage piles. Storage samples were obtained from Michigan Sugar piling facility in Sebewaing in spring 2020 and 2021 (n=107)

Acknowledgements

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