Cercospora leaf spot, damage, and variety impacts on postharvest storage rots in sugarbeet, 2023-24

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Objective 1: Evaluate the impact of Cercospora leaf spot (CLS) field infection on storage rot symptom development on bruised beets. Previous results show that CLS levels in the field do not affect rot development in storage for the pathogens and varieties tested when beets are hand harvested (REACh 2021, 2022). Feedback from the industry indicated CLS may impact storability following commercial harvest.

Methods: CLS was rated on the KWS scale of 0 (disease-free) to 10 (>50% necrotic). Healthy-appearing beets were harvested by hand, washed with water, and bruised on one side using a 1.5-kg weight dropped from a 1-meter height. Beets were stored at 7 °C in plastic bags with wood shavings to reduce free moisture. At each timepoint, beets were removed from storage and inoculated with a known storage rot pathogen or with a sterile clarified V8 (CV8) plug as a control. Based on common pathogens from 2019-22 MSC pile samples, *Penicillium vulpinum, Botrytis cinerea*, and *Fusarium graminearum* were chosen for storage trials. Inoculated beets were incubated with the agar plug at ambient temperature for 7 days before the plug was removed. Rot length, width, and depth were measured, and overall rot volume was calculated using those values.

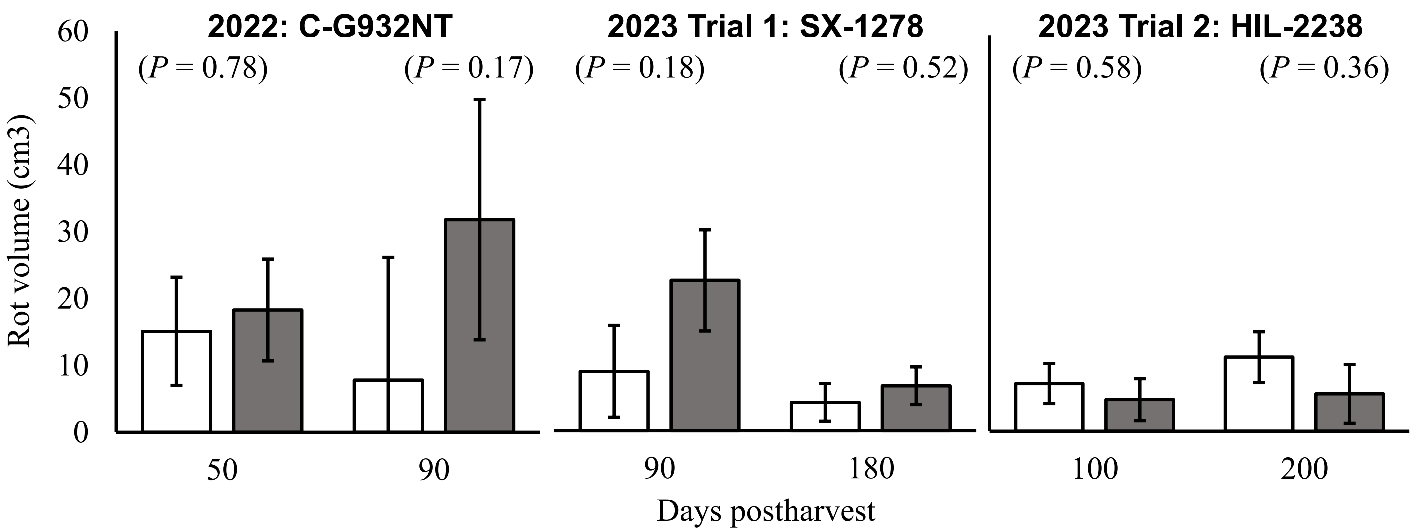

Figure 1. Volume of rotted tissue at mid-beet bruise point in beets with high or low in-season CLS levels inoculated with storage pathogens after 4- (2022) or 8- (2023) week incubation. Beets inoculated with *Fusarium graminearum, Botrytis cinerea,* or *Penicillium vulpinum*. CLS did not have a significant impact on rate of rot development in 2022 or in 2023 trial 1 or trial 2 ($P > 0.05$, n=12 beets per treatment). All values were corrected for control before statistical analysis. Analyses were conducted within each timepoint and year. Beet roots were harvested from a randomized complete block trial grown in Frankenmuth, Michigan in the growing seasons 2022 and 2023.

Summary: There was no significant difference in rate of rot development between CLS levels across all three pathogens during any timepoint in either year ($P > 0.05$) (Figure 1). Correlation analyses within symptomatic bruised tissues indicated area under the disease progress curve (AUDPC) calculated from in-season CLS severities was significantly associated with volume of storage rot symptoms ($r = 0.26$, $P < 0.05$). Despite numerically elevated values, CLS level also did not significantly impact relative electrolyte leakage in the two years and four timepoints measured ($P > 0.05$, data not shown). Overall, these results indicate CLS may predispose beets to harvest damage and subsequently increase storage rot susceptibility. Bruise significantly increased rot development at 4 of the 6 tested timepoints ($P < 0.01$). At 200-days postharvest, there was a significant interaction between CLS and bruise ($P < 0.05$), which is approaching the maximum time in storage.

Objective 2: Determine susceptibility of varieties to post-harvest rot pathogens. Twelve varieties were tested for storage rot susceptibility.

Methods: Beets were harvested by hand in 2022, and machine-harvested in 2023 before being stored at 7°C in plastic bags with wood shavings. At each timepoint, visually healthy beets of each variety were removed from storage, washed, and cut into approximately 3-cm thick sections. Root sections were inoculated with *Botrytis cinerea, Fusarium graminearum, Penicillium vulpinum,* or with a CV8 plug as a control. There were four replications of each Variety*Pathogen combination. Inoculated beets were incubated for 24 hr before removal of agar plugs, and after one week at ambient temperature, the lesion length and depth were measured.

Table 1: Varietal differences in storage rot development in sugarbeet roots inoculated with *Botrytis cinerea, Fusarium graminearum, Penicillium vulpinum,* or CV8. Rot diameter and depths were averaged across all tested pathogens. Beet roots were harvested from a randomized complete block trial on a commercial farm in the Thumb and Bay regions of Michigan in the growing seasons 2022 and 2023.

Days postharvest		**50**		**130**			
		Diameter	**Depth**	**Diameter**	**Depth**		
2022	BTS-1065	32.4	6.4	31.1	5.5	-	-
	BTS-1606N	38.5	8.5	33.3	6.7	-	-
	BTS-1703	40.3	6.8	34.1	9.7	-	-
	C-G021	38.5	7.4	33.5	7.6	-	-
	C-G049	32.3	6.8	32.8	5.7	-	-
	C-G675	37.3	6.1	33.4	7.6	-	-
	C-G932NT	35.8	7.3	31.3	5.6	-	-
	HIL-2332NT	34.5	6.7	24.9	7.1	-	-
	HIL-2361	38.8	8.6	37.3	8.3	-	-
	HIL-9865	38.3	10.1	33.7	6.8	-	-
	SX-2295	39.0	6.6	29.6	4.8	-	-
	SX-2296N	35.3	5.2	31.8	8.2	-	-
	Std Error	2.6	1.0	4.0	1.4		
	P-value	0.4803	0.1240	0.7906	0.4320		
Days postharvest		**40**		**120**		**180**	
		Diameter	**Depth**	**Diameter**	**Depth**	**Diameter**	**Depth**
2023	BTS1065	32.2	5.8 b-e	47.3 a-c	4.5 de	44.7	9.1 a-c
	BTS1122	28.3	7.4 a-c	48.8 a-c	6.3 b-d	41.9	8.0 a-d
	BTS1183	27.5	4.5 de	49.9 a-c	7.5 a-c	46.0	9.9 ab
	BTS197N	28.2	3.7 e	49.7 a-c	8.0 ab	36.4	6.5 c-e
	C-G049	29.4	6.7 a-d	41.7 c	8.0 ab	44.7	9.3 a-c
	C-G151	24.9	7.4 a-c	40.3 c	3.6 e	37.0	7.3 b-d
	C-G932NT	35.9	8.8 a	44.7 bc	5.7 c-e	38.1	10.6 a
	HIL2332NT	40.1	5.6 b-e	52.9 ab	6.0 b-d	43.0	5.8 de
	HIL2361	30.9	4.9 c-e	57.5 a	6.4 b-d	46.8	6.1 de
	HIL9865	32.9	7.6 ab	43.1 bc	9.2 a	39.7	7.5 b-d
	SX2295	35.0	5.2 b-e	55.1 a	5.5 c-e	38.9	4.1 e
	SX2296N	35.4	7.6 ab	49.5 a-c	5.8 c-e	42.7	7.9 b-d
	Std Error	3.5	1.0	4.3	1.0	3.9	1.1
	P-value	0.1830	0.0080 **	0.0461 *	0.0001 **	0.4055	0.0003 **

All values were corrected for control before statistical analysis. Asterisk designations correspond to P value thresholds as follows: *P<0.05; **P<0.01; ***P<0.0001. Analyses were conducted within each timepoint and year.

Summary: There was variability in pathogen response among the twelve tested varieties, although no varieties consistently performed better or worse than others. It is interesting to note that some varieties with the largest rot diameters for one pathogen may have one of the lowest diameters for another. For example, SX-2295 had one of the deeper rot depths when inoculated with *B. cinerea,* and one of the shallower depths when inoculated with *F. graminearum* and *P. vulpinum* (Figure 2). This may be of interest for breeding programs in the future. No significant effects of pathogen on variety performance were observed in 2022 or 2023 ($P > 0.05$) (Figure 2). Across all pathogens, there were no significant differences in varietal responses in 2022, however, there were significant differences in depth at all timepoints and diameter at one timepoint in 2023 ($P < 0.05$) (Table 1). This may be because beets were hand-harvested in 2022, and machine-harvested in 2023. Future work could investigate varietal responses to pathogens after typical mechanical damage experienced during harvest and postharvest handling. At most timepoints, *Botrytis cinerea* resulted in the largest rot diameter and depth, or statistically similar to the largest measurements ($P < 0.05$). This emphasizes the importance of continuing to prioritize research on management of *Botrytis cinerea* in sugarbeet storage.

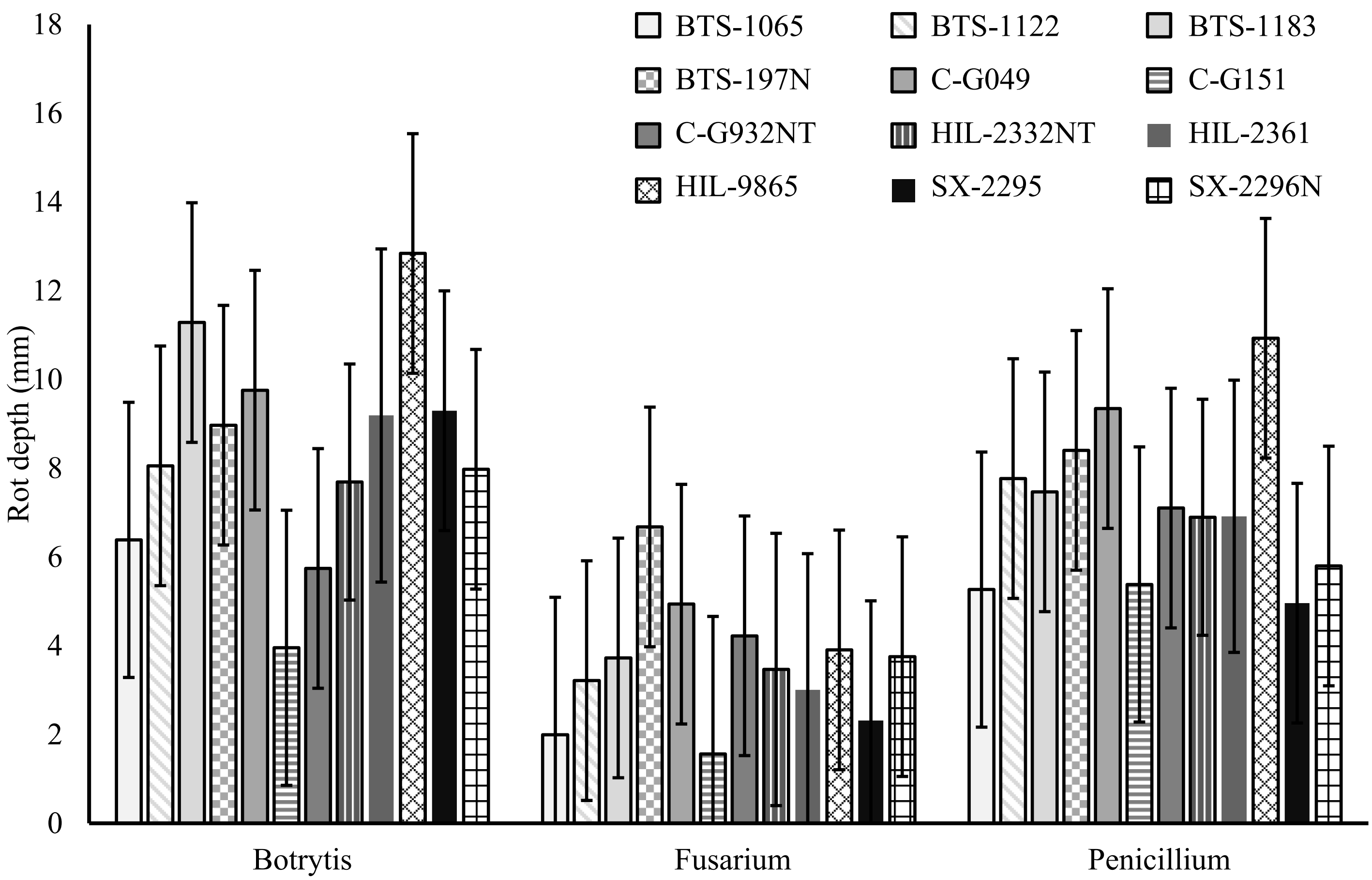

Figure 2: Varietal differences in storage rot development in sugarbeet roots inoculated with *Botrytis cinerea, Fusarium graminearum, Penicillium vulpinum* or CV8 at 120-days postharvest in 2023. Beet roots were harvested from a randomized complete block trial on a commercial farm in the Thumb and Bay regions of Michigan. All values were corrected for control before statistical analysis, and error bars represent 95% confidence interval.

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