Assessment of postharvest SaniDate application and variety resistance for management of storage diseases of potato in Michigan, 2022

Emma Schlachter, Celeste Dmytryszyn, Mio Satoh-Cruz, Chris Bloomingdale, Damen Kurzer, Katrina Zavislan, David Douches, Ray Hammerschmidt, Chris Long, Sarah Ruth, and Jaime F. Willbur; Department of Plant, Soil and Microbial Sciences

Managing disease during the postharvest storage of tubers is important for Michigan's potato industry, due to the year-round demand for potato seed and products. SaniDate 5.0 (active ingredient peroxyacetic acid: $C_2H_4O_3$) is a disinfectant used in food and water industries, which breaks down into harmless residual oxygen and hydrogen, unlike many conventional pesticides. Over two years, SaniDate 5.0 was evaluated for in-storage control of the four major postharvest diseases: Fusarium dry rot, bacterial soft rot, pink rot, and Pythium leak. Developing cultivars with genetic resistance to disease is another effective management strategy; thus, chipping, red, and yellow research lines and germplasm were assessed for resistance response to four postharvest diseases. Promising cultivars will be selected for further development based on these findings, as well as other superior traits.

Materials and Methods

i. Assessment of SaniDate 5.0 on storage management disease of four diseases

During 2020 – 2021, efficacy of SaniDate 5.0) application in storage bins for control of four diseases was assessed. This study was performed at the MPIC Cargill Potato Demonstrations Storage Facility (95% relative humidity, 48°F). Potato tubers cv. Mackinaw were mechanically harvested and separated into plastic mesh bags (10/replicate/treatment; 800 tubers). Tubers were washed in tap water twice in mesh baskets, surface disinfested in bleach solution (10% Clorox Bleach, 90% tap water) for 30 seconds, and rinsed once in deionized water, before air-drying overnight in ambient room conditions. Tubers were inoculated with the following treatments: Fusarium dry rot, bacterial soft rot, pink rot, Pythium leak, and potato dextrose broth (control). *Fusarium sambucinum*, *Phytophthora erythroseptica*, and *Pythium ultimum* were inoculated at 2×10^4 spores/mL in potato dextrose broth. *Pectobacterium caratovorum* was inoculated at 8×10^8 cfu/mL. Inoculation using 10uL of each solution was performed no more than three hours after inoculum preparation using Hamilton® syringe (710 series, 100uL volume) at apical and basal ends of each tuber. Tubers were undisturbed for 24 hours prior to organization to prevent leakage, and then organized into four replicates within plastic mesh bags.

Two days after inoculation, samples were placed into tuber piles of Bin 8 (control) and Bin 9 (treatment) during loading at approximately 4-foot increments. Bin 9 was treated post-loading with SaniDate 5.0 at 0.95 fl. oz. per ton of potatoes by fog application (Gun Valley Ag. & Industrial Services, Inc.). After the storage period, bins were emptied, and samples were collected. In 2020, bins were loaded on Oct 14, SaniDate 5.0 was applied on Oct 19, and bins were emptied on Jun 24, 2021. In 2021, bins were loaded on Oct 16, SaniDate 5.0 was applied on Nov 24, and bins were emptied on Jul 6, 2022. Tubers were evaluated for internal and external disease and internal symptom length and width were measured using digital calipers. Analysis of variance (ANOVA) was conducted using the generalized linear mixed model (GLIMMIX), evaluating fixed effects inoculation treatment, SaniDate treatment, and interaction, defining replicate as random effect. Years were analyzed separately due to difference in inoculation treatment and protocol.

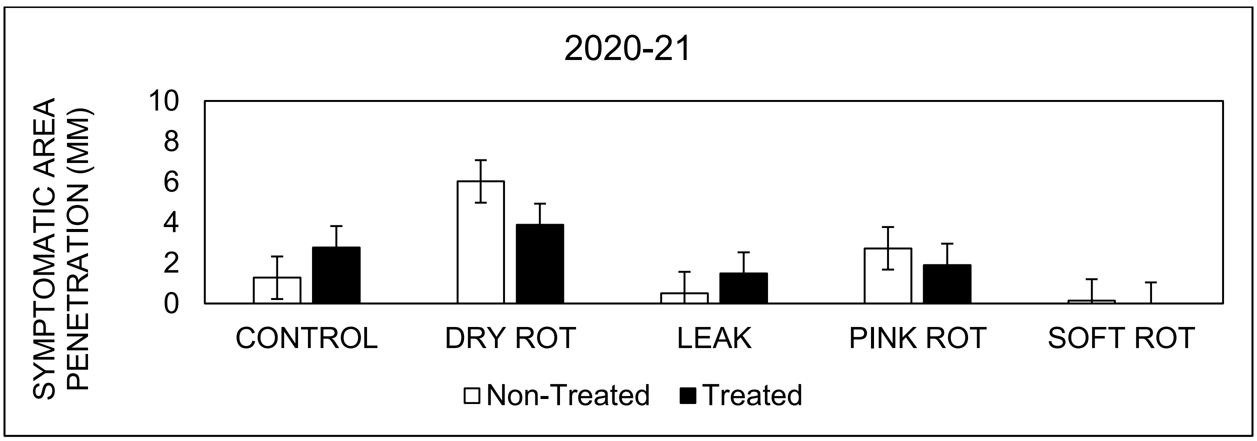
ii. Assessment of chipping and red and yellow potato varieties and early-stage germplasm for resistant to four storage pathogens

During 2021-2022, 35 commercial chip varieties and research germplasm were assessed for resistance response to four diseases, and in 2022, 15 red and yellow varieties were also assessed. Asymptomatic tubers were obtained from Michigan commercial growers, the Michigan Potato Outreach Program, and the Potatoes USA-SNAC International Trial (Kalkaska County) (2-6 tubers/replicate/year). Inoculation was performed as described above. Tubers were placed in paper bags at ambient room temperatures for 47 days, and internal symptom length and width was measured using digital calipers. Analysis of variance (ANOVA) was conducted using the generalized linear mixed model (GLIMMIX), evaluating inoculum treatment, variety, and interaction. Data was analyzed using the GLIMMIX procedure in SAS v. 9.4 and means were compared using Fisher's protected LSD (α=0.05).

Results and Conclusions

i. Assessment of SaniDate 5.0 on storage management disease of four diseases

In 2020-21 and 2021-22, SaniDate 5.0 treatment did not significantly affect disease symptom length, width, or penetration ($P > 0.05$). In both years, greater Fusarium dry rot development was observed compared to bacterial soft rot, pink rot, or Pythium leak ($P < 0.05$).



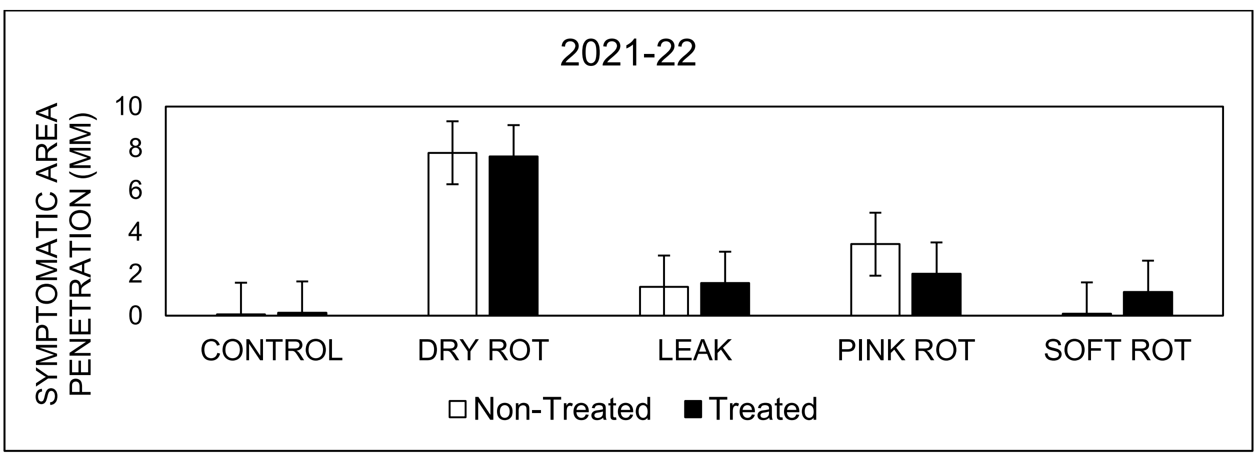


Figure 1. Mean symptomatic area measured on tubers approximately seven months post-inoculation with 2 x 10^4 spores/mL *Fusarium sambucinum*, *Pythium ultimum,* or *Phytophthora erythroseptica* or 8 x 10^8 cfu/mL *Pectobacterium carotovorum*. Each bar represents four replicates of 10-tuber subsamples. SaniDate 5.0 did not significantly affect disease development in 2020-21 or 2021-22 (α = 0.05).

ii. Assessment of chipping and red and yellow potato varieties and early-stage germplasm for resistant to four storage pathogens

Significant variation in Fusarium dry rot resistance response was observed in red and yellow tubers during 2020-21 (Table 1). In chip entries, consistent resistance to dry rot was observed in both years in the chipping research lines MSAA260-3, MSAA570-3, and MSBB058-1 (Table 2). Identifying germplasm with superior disease tolerance will benefit the development of cultivars with excellent processing and storage qualities.

Table 1. Significant variation between Fusarium dry rot symptom development was observed in red and yellow entries in disease response evaluations in 2021-22 ($\alpha = 0.05$). Red-skinned lines are indicated by an asterisk (*) and standard commercial varieties are indicated in bold text. Resistance ratings are based on the highest mean observed in the year sample (S = susceptible [within 75-100% of the greatest mean]; MS = moderately susceptible [50-75%]; MR = moderately resistant [25-50%]; R = resistant [0-25%]). Blue highlighted varieties exhibited MR to R reactions across one to three locations.

	2021-22		
	Fusarium Dry Rot Length (mm)		
Entry	**Mean**	**Group**	**R/S**
***Dark Red Norland**	**5.5**	**c**	**R**
C099076-6R	6.2	bc	R
Yukon Gold	**11.4**	**bc**	**MR**
*NDA050R37B-1R	11.8	bc	MR
Paroli	12.1	bc	MR
Gourmandine	15.2	bc	MR
MSV093-1Y	15.3	bc	MR
*NDAF113484B-1	17.7	bc	MR
Queen Anne	18.5	bc	MR
Allora	18.5	b	MR
Golden Globe	24.2	ab	MS
Constance	25.8	ab	MS
Columba	27.4	ab	MS
W15240-2Y	40.8	a	S
P-value	*$P < 0.05$*		

Overall Summary

Over two years, experimental methods were developed and tested for screening of postharvest management practices and disease resistance in chipping, red, and yellow potato entries using Michigan pathogen isolates. Resistant reactions were identified for Fusarium dry rot and pink rot. Variable reactions were often influenced by year, location, and growing conditions and resistance to multiple diseases was rarely observed. However, ongoing screening will help to inform growing operations, management practices, and breeding efforts. Further optimized experimental protocols were implemented in 2022-23.

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Table 2. Significant variation between Fusarium dry rot symptom development was observed in chipping line research germplasm disease response evaluations in 2020-21 and 2021-22 ($\alpha = 0.05$). Standard commercial lines are indicated in bold text. Resistance ratings are based on the highest mean observed in the year sample (see Table 1 description). Blue highlighted varieties exhibited resistant to MR to R reactions over two site-years of testing.

		Fusarium Dry Rot Symptom Length (mm)					
		2020-21			2021-22		
Entry	**Location**	**Mean**	**Letters**	**Rating**	**Mean**	**Letters**	**Rating**
MSAA570-3	B	5.1	g	R	6.0	d	R
NY163 (B)	B	6.7	f-g	R	9.1	d	MR
MSZ063-2 (B)	B	7.9	fg	R	.	.	.
Snowden (A)	**A**	**8.0**	**fg**	**R**	**.**	**.**	**.**
MSW474-1 (B)	B	8.1	fg	R	19.1	a-d	S
MSZ242-13 (B)	B	8.4	fg	R	12.6	a-b	MS
Petoskey (B)	**B**	**8.4**	**e-g**	**R**	**11.9**	**a-d**	**MR**
ND7519-1	B	8.7	e-g	R	.	.	.
MSZ063-2 (A)	A	8.7	e-g	R	.	.	.
Mackinaw (B)	**B**	**9.2**	**e-g**	**R**	**.**	**.**	**.**
Snowden (B)	**B**	**9.2**	**e-g**	**R**	**6.1**	**b-d**	**MR**
MSAA076-6	B	9.6	d-g	R	.	.	.
MSBB058-1	B	9.9	e-g	R	7.2	b-d	MR
MSY156-2	B	10.0	e-g	R	.	.	.
Lamoka	**B**	**10.2**	**d-f**	**R**	**.**	**.**	**.**
MSZ242-07	B	10.6	e-g	R	16.5	a-b	MS
MSAFB635-3	B	11.4	e-g	R	.	.	.
NY166	B	11.7	e-g	R	.	.	.
MSBB610-13	B	13.0	e-g	MR	.	.	.
MSZ242-13 (A)	A	13.8	d-g	MR	.	.	.
CO11023-9W	B	14.3	d-g	MR	.	.	.
MSW474-1 (A)	A	15.6	d-g	MR	.	.	.
MSAFB609-12	B	15.9	d-g	MR	15.4	a-c	MS
MSAFB635-15	B	16.9	d-g	MR	24.4	a-d	S
NY165	B	20.0	d-g	MR	.	.	.
MSZ120-4	B	20.0	d-g	MR	.	.	.
MSAA260-3	B	20.6	d-g	MR	11.3	a-d	MR
B2869-29	B	20.7	d-g	MR	.	.	.
NY163 (A)	A	20.9	d-g	MR	.	.	.
Lady Liberty	**B**	**22.0**	**d-f**	**MR**	**.**	**.**	**.**
MSZ242-09	B	23.1	d-g	MR	.	.	.
Mackinaw (A)	**A**	**26.2**	**b-e**	**MS**	**.**	**.**	**.**
NYOR14Q9-9	B	27.5	b-e	MS	.	.	.
MSAA373-3	B	28.1	b-e	MS	.	.	.
MSAA217-3	B	29.9	b-d	MS	10.8	a-d	MR
MSAFB605-4	B	38.8	a-c	S	.	.	.
MSZ219-13	B	38.9	ab	S	.	.	.
Petoskey (A)	**A**	**40.5**	**a**	**S**	**.**	**.**	**.**
CO11023-2W	B	50.8	a-c	S	.	.	.
MSV093-1Y	B	.	.	.	19.2	a-b	S
P-value		*P = 0.0002*			*P = 0.0415*		