Michigan State University

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In Cooperation With

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MICHIGAN POTATOES
MICHIGAN POTATO INDUSTRY COMMISSION

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January 03, 2020

To all Michigan Potato Growers and Shippers,

The Michigan Potato Industry Commission continues to provide over $180,000 in direct funding on an annual basis for potato research. This research is the one of the core components that continue to move the Michigan potato industry forward. Expanding research has provided increased insights into varieties, disease, soil fertility, and storage management. Research outcomes continue to provide a competitive advantage for the industry in Michigan and to provide Michigan with a highly respected reputation among the national industry professionals.

The following research report was compiled with the help of the Michigan State University AgBioResearch and Michigan State University Extension. On behalf of all parties, we are proud to present you with the results of the 2020 potato research projects.

We hope that each of you see value in the investment made in these projects and can apply some of the results directly to strengthen your own operation.

We would like to thank our many suppliers, researchers, and industry partners who are involved in making this year's research season a success even in the midst of a global pandemic. As the industry faces new challenges and strives to improve upon best practices, we are inspired by the level of cooperation within the industry and look forward to future success together.

Sincerely,

Kelly Turner

Dr. Kelly Turner, Ed. D, CAE
Executive Director

Table of Contents

2020 MICHIGAN POTATO RESEARCH REPORT

C. M. Long, Coordinator

INTRODUCTION AND ACKNOWLEDGMENTS

The 2020 Potato Research Report contains reports of the many potato research projects conducted by Michigan State University (MSU) potato researchers at several locations. The 2020 report is the 52nd volume, which has been prepared annually since 1969. This volume includes research projects funded by the Potato Special Federal Grant, the Michigan Potato Industry Commission (MPIC), Project GREEEN and numerous other sources. The principal source of funding for each project has been noted in each report.

We wish to acknowledge the excellent cooperation of the Michigan potato industry and the MPIC for their continued support of the MSU potato research program. We also want to acknowledge the significant impact that the funds from the Potato Special Federal Grant have had on the scope and magnitude of potato related research in Michigan.

Many other contributions to MSU potato research have been made in the form of fertilizers, pesticides, seed, supplies and monetary grants. We also recognize the tremendous cooperation of individual producers who participate in the numerous on-farm projects. It is this dedicated support and cooperation that makes for a productive research program for the betterment of the Michigan potato industry.

We further acknowledge the professionalism of the MPIC Research Committee. The Michigan potato industry should be proud of the dedication of this committee and the keen interest they take in determining the needs and direction of Michigan's potato research.

Special thanks goes to Mathew Klein for his management of the MSU Montcalm Research Center (MRC) and the many details which are a part of its operation. We also want to recognize Trina Zavislan, MSU for organizing and compiling this final draft.

WEATHER

The overall 6-month average maximum and minimum temperatures during the 2020 growing season were consistent with the 15-year averages at 73ºF and 49ºF respectively (Table 1). May had more variable temperatures than average, with both a higher maximum and lower minimum temperature. The average minimum temperature in July, 68ºF was much warmer than the 15-year average temperature of 60ºF. Daytime extreme heat events were slightly higher than average in 2020 (Table 3) with thirteen hours over three days in which temperatures exceeded 90ºF during the summer. Extreme high nighttime temperatures were also slightly higher than average in 2020, with 125 hours of nighttime temperatures above 70ºF over 31 days, compared to the seven-year average of 107 hours over 25 days.

Rainfall for April through September was 19.04 inches, which was 1.17 inches above the 15-year average (Table 2). A total of 16.5 inches of irrigation water over 20 application timings was applied to Comden 2 between early June and late August. In general, May, July, and September had more precipitation than average while August and June were drier months.

Table of Contents

Table 1. The 15-year summary of average maximum and minimum temperatures (°F) during the growing season at the Montcalm Research Center.*

	April		May		June		July		August		September		Average	
Year	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2006	62	36	61	46	78	54	83	61	80	58	68	48	72	51
2007	53	33	73	47	82	54	81	56	80	58	76	50	74	50
2008	61	33	67	40	77	56	80	58	80	54	73	50	73	49
2009	56	33	67	45	76	54	75	53	76	56	74	49	71	48
2010	64	33	70	49	77	57	83	62	82	61	69	50	74	52
2011	53	33	68	48	77	56	85	62	79	58	70	48	72	51
2012	58	33	73	48	84	53	90	62	82	55	74	46	77	50
2013	51	33	73	48	77	55	81	58	80	54	73	48	73	49
2014	55	33	68	45	78	57	77	54	79	56	72	47	72	49
2015	58	33	71	48	76	54	80	56	77	57	77	54	73	51
2016	53	32	70	45	78	53	82	60	85	60	78	54	74	51
2017	61	39	67	44	78	55	81	58	77	54	77	50	74	50
2018	55	33	81	46	84	58	88	64	84	63	76	52	78	53
2019	55	35	65	45	75	54	84	69	80	55	73	54	72	52
2020	**56**	**29**	**76**	**35**	**77**	**54**	**81**	**68**	**78**	**60**	**70**	**48**	**73**	**49**
15-Year Average	57	33	70	45	78	55	82	60	80	57	73	50	73	50

Table 2. The 15-year summary of precipitation (inches per month) recorded during the growing season at the Montcalm Research Center*

Year	April	May	June	July	August	September	Total
2006	2.73	4.45	2.18	5.55	2.25	3.15	20.31
2007	2.64	1.60	1.58	2.43	2.34	1.18	11.77
2008	1.59	1.69	2.95	3.07	3.03	5.03	17.36
2009	3.94	2.15	2.43	2.07	4.74	1.49	16.82
2010	1.59	3.68	3.21	2.14	2.63	1.88	15.13
2011	3.42	3.08	2.38	1.63	2.57	1.84	14.92
2012	2.35	0.98	0.99	3.63	3.31	0.76	12.02
2013	7.98	4.52	2.26	1.35	4.06	1.33	21.50
2014	4.24	5.51	3.25	3.71	1.78	2.35	20.84
2015	3.71	2.96	4.79	1.72	2.42	3.90	19.50
2016	2.25	2.77	1.33	3.42	5.35	3.05	18.17
2017	4.45	1.98	6.37	0.92	1.36	0.70	15.78
2018	2.04	5.51	3.64	1.19	7.73	2.65	22.76
2019	2.64	5.46	2.9	2.04	3.31	5.72	22.07
2020	**3.49**	**4.75**	**1.40**	**4.07**	**2.21**	**3.12**	**19.04**
15-Year Average	3.27	3.41	2.78	2.60	3.27	2.54	17.87

Table 3. Seven-year heat stress summary (from May 1st – Sept. 30th)*

Year	Temperatures > 90°F		Night (10pm-8am) Temperatures > 70°F	
	Hours	Days	Hours	Days
2014	0	0	58	15
2015	0	0	114	31
2016	10	3	147	31
2017	14	3	80	18
2018	12	4	123	31
2019	5	2	105	20
2020	**13**	**3**	**125**	**31**
Average	8	2	107	25

GROWING DEGREE DAYS

Table 4 summarizes the cumulative growing degree days (GDD) for 2019 while providing historical data from 2007-2019. GDD are presented from May 1st – September 30th using the Baskerville-Emin method with a base temperature of 40ºF. The total GDD base 40 at the end of September in 2020 was 3809 (Table 4), which is32 GDD higher than the 13-year average of 3777.

Table 4. Growing Degree Days* - Base 40°F.

Year	May	June	July	August	September
2008	447	1240	2147	2973	3596
2009	519	1264	2004	2800	3420
2010	610	1411	2424	3402	3979
2011	567	1354	2388	3270	3848
2012	652	1177	2280	3153	3762
2013	637	1421	2334	3179	3798
2014	522	1340	2120	2977	3552
2015	604	1353	2230	3051	3789
2016	547	1318	2263	3274	4053
2017	480	1279	2202	2990	3695
2018	689	1487	2423	3373	4073
2019	457	1189	2179	3024	3731
2020	**488**	**1298**	**2331**	**3241**	**3809**
Average	555	1318	2256	3131	3777

*2008-2020 data from the weather station at MSU Montcalm Research Center "Enviro-weather", Michigan Weather Station Network, Entrican, MI.

PREVIOUS CROPS, TILLAGE AND FERTILIZERS

The general potato research area utilized in 2020 was Montcalm Research Center property in the field referred to as 'Comden 2.' This acreage was planted to rye and wheat in the spring of 2019 with crop residue disked into the soil in fall and sprayed off in the spring of 2020. In the spring of 2020, the recommended rate of potash was broadcast applied following deep-chisel plowing. The ground was vertical tilled and direct planted to potatoes. The area was not fumigated with Vapam prior to potato planting, but Admire Pro® was applied in-furrow at planting.

The soil test analysis for the general crop area (taken in November 2019) was as follows:

	lbs/A			
pH	P	K	Ca	Mg
7.0	316 (158 ppm)	396 (198 ppm)	1510 (755 ppm)	300 (150 ppm)

The fertilizers used in the general plot area are as follows (fertilizer variations used for specific research projects are included in the individual project reports).

Application	Analysis	Rate	Nutrients (N-P_2O_5-K_2O-Ca/Mg/S/Zn)
Broadcast at plow down	0-0-22-11Mg-22S	200 lbs/A	0-0-44-22Mg-44S
	0-0-0-21Ca-16S	150 lbs/A	0-0-0-32Ca-24S
	0-0-0-21Ca-12Mg	300 lbs/A	0-0-0-63Ca-36Mg
	10%B	6 lbs/A	0.6 lb. B
	0-0-62	350 lbs/A	0-0-217
	0-0-0-9Zn	1 qt/A	0.3 lb. Zn
At-planting	28-0-0	24 gpa	72-0-0
	10-34-0	12 gpa	14-49-0
At-cultivation	28-0-0	24 gpa	72-0-0
	10-34-0	12 gpa	14-49-0
At-hilling	46-0-0	120 lbs/A	55-0-0
Late side dress (late varieties)	46-0-0	100 lbs/A	46-0-0

HERBICIDES AND PEST CONTROL

A pre-emergence application of Linex4l/Brawl at 1.25 qts/A and Brawl II at 1.0 pts/A was made in late May. Admire Pro® was applied in-furrow at planting at a rate of 8.7 fl oz/A.

Echo 720 (24 oz/A), Mancozeb (2 lbs/A), Bravo (20 oz/A), and Pencozeb (2 lbs/A) fungicides were applied alone or in combination on twelve dates between June and early September.

Blackhawk (3.3 oz/A), Coragen (6 oz/A), Mustang Maxx (3 oz/A), Asana XL (9 oz/A), and Exirel (13.5 oz/A) insecticides were applied alone or in combination on five dates between June and August.

Potato vines were desiccated with Reglone in late August and early September at a rate of 32 oz/A.

2020 MSU POTATO BREEDING AND GENETICS RESEARCH REPORT
January 2021

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Cooperators: Robin Buell, Ray Hammerschmidt, Jaime Willbur and Chris Long

INTRODUCTION

At Michigan State University, we have been dedicated to developing improved potato varieties for the chip-processing and tablestock markets since 1988. The program is one of four integrated breeding programs in the North Central region supported through the USDA/NIFA Potato Special Grant. At MSU, we conduct a comprehensive multi-disciplinary program for potato breeding and variety development that incorporates plant pathology, entomology, biotechnology and genomics to meet Michigan's needs. Our program integrates traditional and biotechnological approaches to breed for disease and insect resistance that is positioned to respond to scientific and technology opportunities that emerge. We are also developing more efficient methods to breed improved potato varieties at the tetraploid and diploid level.

In Michigan, the primary market requires that we focus on developing high yielding round white potatoes with excellent chip-processing from the field and/or storage. In addition, there is also a need for table varieties (russet, red, yellow, and round white). We conduct variety trials of advanced selections and field experiments at MSU research locations (Montcalm Research Center, Lake City Research Center, Clarksville Research Center, and MSU Agronomy Farm), we ship seed to other states and Canadian provinces for variety trials, and we cooperate with Chris Long on grower trials throughout Michigan. This testing is crucial in determining the commercial potential of the lines. Through conventional crosses in the greenhouse, we develop new genetic combinations in the breeding program, and also screen and identify exotic germplasm that will enhance the varietal breeding efforts. With each cycle of crossing and selection we are seeing directed improvement towards improved varieties (e.g. combining chip-processing, scab resistance, PVY resistance, late blight resistance and higher specific gravity). We continue to see the increase in scab, late blight and PVY resistance in the breeding material and selections. We need to continue to combine these traits in long-term storage chip-processing lines. It has been 11 years since we started the SolCAP project and we are benefiting from the SolCAP SNP array DNA marker technology as we can now query 35,000 SNPs (compared to 8,303 SNPs in initial array). This SolCAP translational genomics project has finally giving us the opportunity to link genetic markers to important traits (reducing sugars, starch, scab resistance, etc.) in the cultivated potato lines and then breed them into elite germplasm. The SNPs also allow us to accurately fingerprint the varieties (DNA

fingerprinting database). In addition, our program has been utilizing genetic engineering as a tool to introduce new genes to improve varieties and advanced germplasm for traits such as insect resistance, late blight and PVY resistance, lower reducing sugar, nitrogen use efficiency and drought. In 2021, we plan to test potatoes with late blight resistance, drought tolerance, invertase silencing and gene editing for PPO and self-compatibility. Furthermore, PotatoesUSA is supporting national early generation trials called the National Chip Processing Trial (NCPT) which will feed lines into the SNAC (SFA) trials and also Fast Track lines into commercial testing (NexGen testing). This national cooperative testing is the key! The PotatoesUSA Fast Track program invests in larger-scale seed increase for early generation promising chip-processing lines for commercial scale evaluation by growers and processors. This has led to the release of Saginaw Chipper (MSR061-1), Manistee (MSL292-A), Huron Chipper (MSW485-2), Mackinaw (MSX540-4), and Petoskey (MSV030-4). The next clones for commercialization are MSZ242-13 and MSW474-1. In the table markets, Blackberry and MSV093-1Y are showing promise. We also have funding to develop genome editing technologies that may not be classified as regulated through a USDA/BRAG grant. This technology can be used to introduce lower sugars, bruising and asparagine as well a number of other traits in the future. We also have a USDA/AFRI diploid breeding grant to develop some foundational diploid breeding germplasm. In 2015, we were awarded the USAID grant to generate late blight resistance potatoes for Bangladesh and Indonesia. This Feed the Future project brings us into cutting edge GM work with Simplot and the International Potato Center (CIP). Lastly, we have NSF-funded grants to better understand the potato genome and study wound-healing in potato. We feel that these in-house capacities (both conventional and biotechnological) put us in a unique position to respond to and focus on the most promising directions for variety development and effectively integrate advanced technologies with the breeding of improved chip-processing and tablestock potatoes.

The breeding goals at MSU are based on current and future needs of the Michigan potato industry. Traits of importance include yield potential, disease resistance (scab, late blight, early die, and PVY), insect (Colorado potato beetle) resistance, chipping (out-of-the-field, storage, and extended cold storage) and cooking quality, bruise resistance, storability, along with shape, internal quality, and appearance. If these goals can be met, we will be able to reduce production input costs, keep potato production profitable as well as reduce the reliance on chemical inputs such as insecticides, fungicides and sprout inhibitors, and improve overall agronomic performance through new potato varieties.

Over the years, key infrastructure changes have been established for the breeding program to make sound assessments of the breeding selections moving through the program. In 2016, we constructed a greenhouse to expand our breeding and certified minituber seed production. This greenhouse is located at the MSU Agronomy Farm facility on south campus. Also in 2016, we began to upgrade the potato washing and grading line. which was completed with funding from MPIC and AgBioResearch. Variable speed control drives, a new lift; custom built barrel washer; grading table; and Kerian speed sizer are all part of the set up as of 2019. Incorporation of bar-coding and scales synchronized to computer hot keys, have improved the speed, accuracy and efficiency of the grading process. All entities of the potato group: Potato Breeding and

Genetics; Potato Outreach Program; pathologists and soil fertility researchers have access to this new equipment. Thank you!

A special thank you goes out to MPIC and TechMark for helping us have some late storage season potatoes chipped. MSU Covid-19 work restrictions prevented us from chip-processing on campus at the end of April. The late storge chip data is valuable in selecting good storage chippers.

Varietal Development

Breeding

The MSU potato breeding and genetics program is actively producing new germplasm and advanced seedlings that are improved for long-term storage chipping, and resistance to scab, late blight, and Colorado potato beetle. For the 2020 field season, progeny from about 300 crosses were planted and evaluated. Of those, the majority were crosses to select for round whites (chip-processing and tablestock), with the remainder to select for yellow flesh, long/russet types, red skin, and specialty market classes. During the 2020 harvest, about 1,500 selections were made from the 37,000 seedlings produced. Most of these first-year selections are segregating for PVY resistance. All second, third or fourth-year potential chip-processing selections will be tested in January and April 2021 directly out of 45°F (7.2°C) storage. Atlantic, Lamoka and Snowden are chip-processed as check cultivars. Selections have been identified at each stage of the selection cycle that have desirable agronomic characteristics and chip-processing potential. At the 12-hill and 30-hill evaluation state, about 200 and 100 selections were made, respectively; based on chip quality, specific gravity, scab resistance, late blight resistance and DNA markers for PVY and Golden nematode resistance. Selection in the early generation stages has been enhanced by the incorporation of the scab and late blight evaluations of the early generation material. *Unfortunately, in 2020 we were unable to get effective late blight infection to collect useful data.* We are pushing our early generation selections from the 30-hill stage into tissue culture to minimize PVY issues in our breeding and seed stock. We are now using a cryotherapy method as well as the traditional methods that was developed in our lab to remove viruses. This technique predictably and quickly removes virus from tissue culture stocks. Our results show that we are able to remove both PVY and PVS from lines, but PVS can still be difficult to remove in certain lines. We tested the removal of PLRV and succeeded. Over 1500 different varieties and breeding lines are maintained in tissue culture for the breeding and genetics program.

Chip-Processing

Over 80% of the single hill selections have a chip-processing parent in their pedigree. Our most promising advanced chip-processing lines are Mackinaw (MSX540-4) (scab, late blight and PVY resistant), Petoskey (MSV030-4) (scab resistant), Huron Chipper (MSW485-2) (late blight resistant), MSZ242-13 (scab resistant), MSW474-1 (scab resistant) and MSZ219-1 (scab, late blight and PVY resistant). We have some newer lines to consider, but we are removing virus from those lines. We are using the NCPT trials to more effectively identify promising new selections. Manistee was licensed to Canada and Chile. Saginaw Chipper and Mackinaw are being tested in Australia and South Korea.

Tablestock

Efforts have been made to identify lines with good appearance with an attractive skin finish, low internal defects, good cooking quality, high marketable yield and resistance to scab, late blight and PVY. Our current tablestock development goals now are to continue to improve the frequency of scab and PVY resistant lines, incorporate resistance to late blight along with marketable maturity and excellent tuber quality, and select more russet, red-skinned, and yellow-fleshed lines. We have also been selecting some pigmented skin and tuber flesh lines that fit some specialty markets. There is also interest in some additional specialty mini-potatoes for the "Tasteful Selections" market. We have interest from some western specialty potato growers to test and commercial these lines. From our breeding efforts we have identified mostly round white lines, but we also have a number of yellow-fleshed and red-skinned lines, as well as some purple skin selections that carry many of the characteristics mentioned above. We are also selecting for round white, red-skin, and improved Yukon Gold-type yellow-fleshed potatoes. Some of the tablestock lines were tested in on-farm trials in 2020, while others were tested under replicated conditions at the Montcalm Research Center. Promising tablestock lines include MSV093-1Y (yellow, scab resistant), MST252-1Y (scab resistant), MSV179-1 (scab resistant), and MSX324-2R (scab resistant). MSZ109-8PP and MSZ109-10PP (Blackberry) are purple-fleshed chippers with deep purple flesh, round shape and attractive skin as well as scab resistance. Jacqueline Lee (late blight resistant) was licensed to Australia and is being grown in Central America for its late blight resistance. Spartan Splash, Raspberry, Blackberry, MSQ558-2RR (Ruby Rose) and our PVY resistant Red Marker #2 potato are being marketed in the specialty markets. Blackberry is also being chip-processed by the Great Lakes Chip Co. in Traverse City, MI.

Disease and Insect Resistance Breeding

Scab: In 2020, we had two locations to evaluate scab resistance: a commercial field with a history of severe scab infection (we thankfully acknowledge the support of Sackett Potatoes for this important trial) and a highly infected site at the Montcalm Research Center. In 2020, the commercial site and the Montcalm Research Center both gave us very high scab infection levels. The susceptible checks of Snowden and Atlantic were highly infected with pitted scab. Promising resistant selections were MST252-1Y, MSV179-1, MSX324-1P, MSW474-01, MSZ219-1, MSZ219-13, MSZ219-14, as well as the Z-series selections MSZ242-07, MSZ242-09 and MSZ242-13 from the commercial scab site. If you examine the variety trials at MRC you will notice that many of the lines are scab resistant. We need to continue in this direction of many selections with scab resistance so we can find the great scab resistant chipper as well as table yellow and red. The high level of scab infection at the on-farm site with a history of scab infection and MRC has significantly helped with our discrimination of resistance and susceptibility of our lines. The MRC scab site was used for assessing scab susceptibility in our advanced breeding lines and early generation material and is summarized below (Figure 1). All susceptible check plots (Snowden and Atlantic) were scored as susceptible.

Fig. 1. Scab Disease Nursery Ratings from Montcalm Research Center Trials

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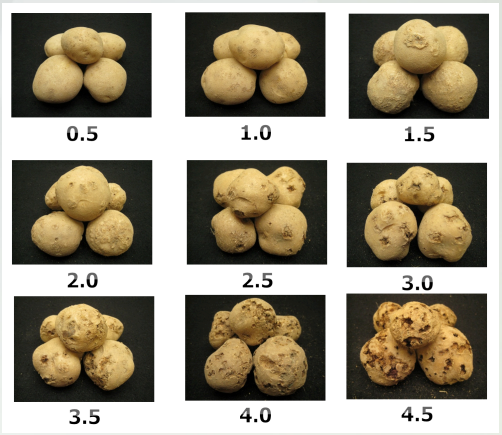
Breeding for Scab Resistance

	Scab Disease Rating (0-5)									
Trial	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	Total
Variety Trial	33	76	80	41	23	6	3	0	0	262
Early Generation	29	56	54	65	32	8	1	1	0	246
Diploid	58	79	85	61	37	14	3	1	0	338

Reference Variety	Scab Rating
Pike	1.5
Lamoka	1.5
Snowden	2.4
Atlantic	2.8



Based upon this data, scab resistance is strong in the breeding program. We lead the nation in scab resistant lines. This is evident in the NCPT. These data were also incorporated into the early generation selection evaluation process at Lake City. We are seeing that this expanded effort is leading to more scab resistant lines advancing through the breeding program. The ability to select under commercial settings at Sackett Potatoes is accelerating our ability to select for highly scab resistant varieties. MSZ052-13, MSZ219-1, MSZ219-13, MSZ219-14, MSZ022-07, MSZ242-09 and MSZ242-13 are some of the first scab resistant chippers to advance through this effort.

Late Blight: Our specific objective is to breed improved cultivars for the industry that have foliar and tuber resistance to late blight using a combination of conventional breeding, marker-assisted strategies and transgenic approaches. Through conventional breeding approaches, the MSU potato breeding and genetics program has developed a series of late blight resistant advanced breeding lines and cultivars that have diverse sources of resistance to late blight. In 2020 we conducted late blight trials at the MSU campus. We inoculated with the US23 genotype and obtained infection, but the infection would not spread through the field due to dry and breezy field conditions. We are not reporting late blight trial results this year. We will continue with late blight trials in 2021 on the MSU campus.

PVY: We are using PCR-based DNA markers to select potatoes resistant to PVY. The gene is located on Chromosome 11. In our first round we made crosses in 2013 to generate over 7,000 progeny segregating for PVY resistance. Each year since 2013 we are making new crosses, making selections and expanding the germplasm base that has PVY resistance (Fig. 2). In the past year we tested over 1,100 progeny for the PVY resistance marker. The 550 that were marker positive were evaluated at Lake City. About 170 selections were made to advance for further evaluation. We are also using DNA markers to also screen for PVX resistance, PLRV resistance, late blight resistance and Golden nematode resistance. As a result of this work, Mackinaw has PVY resistance. More PVY resistant advanced selections are in the queue that will be evaluated in 2021. We have identified an advanced breeding line, MSCC725-232 that combines three virus resistance genes (PVY, PVX and PLRV).

Fig. 2 PVY resistant selections in the breeding program

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Breeding for PVY Resistance

Year	Family	PVYR
YR1	MSGG	88 Selections
YR2	MSFF	35 Selections
YR3	MSEE	39 Selections
YR4	MSDD	16 Selections
YR5	MSCC	9 Selections
YR6	MSBB	22 Selections

MSU Lines with Commercial Tracking

MSV093-1Y

Parentage: McBride x MSP408-14Y
Developers: Michigan State University and the MSU AgBioResearch.
Plant Variety Protection: To Be Applied For

Strengths: MSV093-1Y is a high yield potential yellow-flesh breeding line with an attractive, round tuber shape. This line has demonstrated excellent high yield potential in replicated trials at the MSU Montcalm Research Center and on grower field trials throughout Michigan. This yellow flesh line has excellent internal quality (few defects) and a low incidence of blackspot bruise. MSV093-1Y also has moderate scab tolerance. MSV093-1Y has a strong vine and a mid-early season maturity.

Incentives for production: High yield potential with an attractive tuber shape with good yellow flesh with excellent internal quality.

Mackinaw (MSX540-4)

Parentage: Saginaw Chipper x Lamoka
Developers: Michigan State University and the MSU AgBioResearch.
Plant Variety Protection: To Be Applied For.

Strengths: MSX540-4 is a chip-processing potato with resistance to potato virus Y (PVY), late blight (*Phytophthora infestans*), tolerance to common scab (*Streptomyces scabies*), and demonstrated tolerance to *Verticillium* wilt. This variety has average yield with a high specific gravity, and a high percentage of A-size tubers with an attractive, uniform shape. MSX540-4 has a strong vine and a mid- to late-season

maturity and has demonstrated excellent long-term storage chip-processing quality. MSX540-4 has performed well in multiple locations in the PotatoesUSA National Chip Processing Trials (NCPT).

Incentives for production: Long-term chip-processing quality with resistance to PVY and late blight, and tolerance to common scab.

Morphological Characteristics:
Plant: Medium height vine, semi-erect with a balance between stems and foliage visible, and flowers.
Tubers: Round tubers with lightly netted, tan colored skin. Tubers have a creamy-white flesh with a low incidence of internal defects.

Agronomic Characteristics:
Vine Maturity: Mid- to late-season maturity.
Tubers: Smooth shaped tubers with lightly netted, tan colored skin and a creamy-white flesh.
Yield: Average yield under irrigated conditions, with uniform A-size tubers.
Specific Gravity: Averages similar to above Snowden in Michigan.
Culinary Quality: Chip-processes from short to long-term storage.
Diseases: Resistant to PVY and late blight (*Phytophthora infestans*), tolerant to common scab (*Streptomyces scabies*).

Petoskey
(MSV030-4)

Parentage: Beacon Chipper x MSG227-2
Developers: Michigan State University and the MSU AgBioResearch.
Plant Variety Protection: To Be Applied For.

Strengths: Petoskey is a chip-processing potato with resistance to common scab (*Streptomyces scabies*). This variety has high specific gravity and yield potential, with attractive, uniformly round tubers. Petoskey has a medium vine and a mid-season maturity and has demonstrated excellent long-term storage chip-processing quality. MSV030-4 has performed well in Michigan and multiple locations in the PotatoesUSA National Chip Processing Trials (NCPT) and national SFA (SNaC) trials.

Incentives for production: Excellent chip-processing quality out of the field and long-term chip quality with high specific gravity and resistance to common scab, and a good size profile of uniform, round tubers.

Morphological Characteristics:
Plant: Medium height vine, semi-erect with a balance between stems and foliage visible, and flowers.
Tubers: Uniform, smooth, round tubers with lightly netted, tan colored skin. Tubers have a white flesh with a low incidence of internal defects.

Agronomic Characteristics:
Vine Maturity: Mid-full season maturity.
Tubers: Smooth, round tubers with lightly netted, tan colored skin and white flesh.
Yield: Above average yield under irrigated conditions, with uniform tubers.
Specific Gravity: Averages higher than Atlantic and Snowden.
Culinary Quality: Chip-processes from short and long-term storage.
Diseases: Resistant to common scab (*Streptomyces scabies*).

Huron Chipper (MSW485-2)

Parentage: MSQ070-1 x MSR156-7
Developers: Michigan State University and the MSU AgBioResearch.
Plant Variety Protection: To Be Applied For.

Strengths: MSW485 is a chip-processing potato with resistance to and late blight (*Phytophthora infestans*), and stronger tolerance to common scab (*Streptomyces scabies*) than Atlantic. This variety has high yield and good specific gravity, with attractive, uniformly round tubers. MSW485-2 has a strong vine and a mid-season maturity and has demonstrated excellent long-term storage chip-processing quality. MSW485-2 has performed well in multiple locations in the PotatoesUSA National Chip Processing Trials (NCPT) and national SFA (SNaC) trials.

Incentives for production: Excellent chip-processing quality out of the field and long-term chip quality with resistance to late blight and a good size profile.

Morphological Characteristics:

Plant: Medium height vine, semi-erect with a balance between stems and foliage visible, and flowers.
Tubers: Uniform, smooth, round tubers with lightly netted, tan colored skin. Tubers have a white flesh with a low incidence of internal defects.

Agronomic Characteristics:
Vine Maturity: Mid-season maturity.
Tubers: Smooth, round tubers with lightly netted, tan colored skin and a white flesh.
Yield: Above average yield under irrigated conditions, with uniform tubers.
Specific Gravity: Averages similar to above Atlantic and Snowden.
Culinary Quality: Chip-processes from short to long-term storage.
Diseases: Resistant to late blight (*Phytophthora infestans*) and tolerant to common scab (*Streptomyces scabies*).

Blackberry
(MSZ109-10PP)

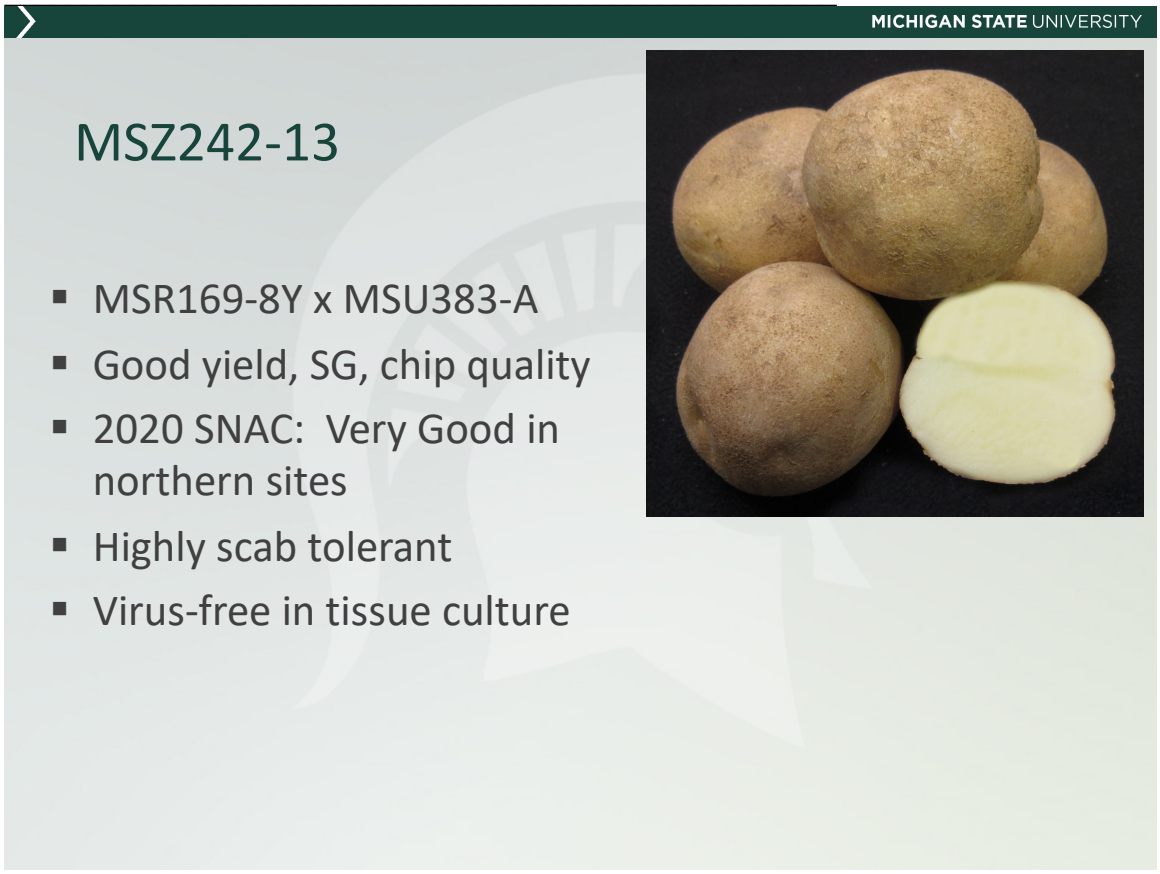
Parentage: COMN07-W112BG1 x MSU200-5PP
Developers: Michigan State University and the MSU AgBioResearch
Plant Variety Protection: To Be Applied For.

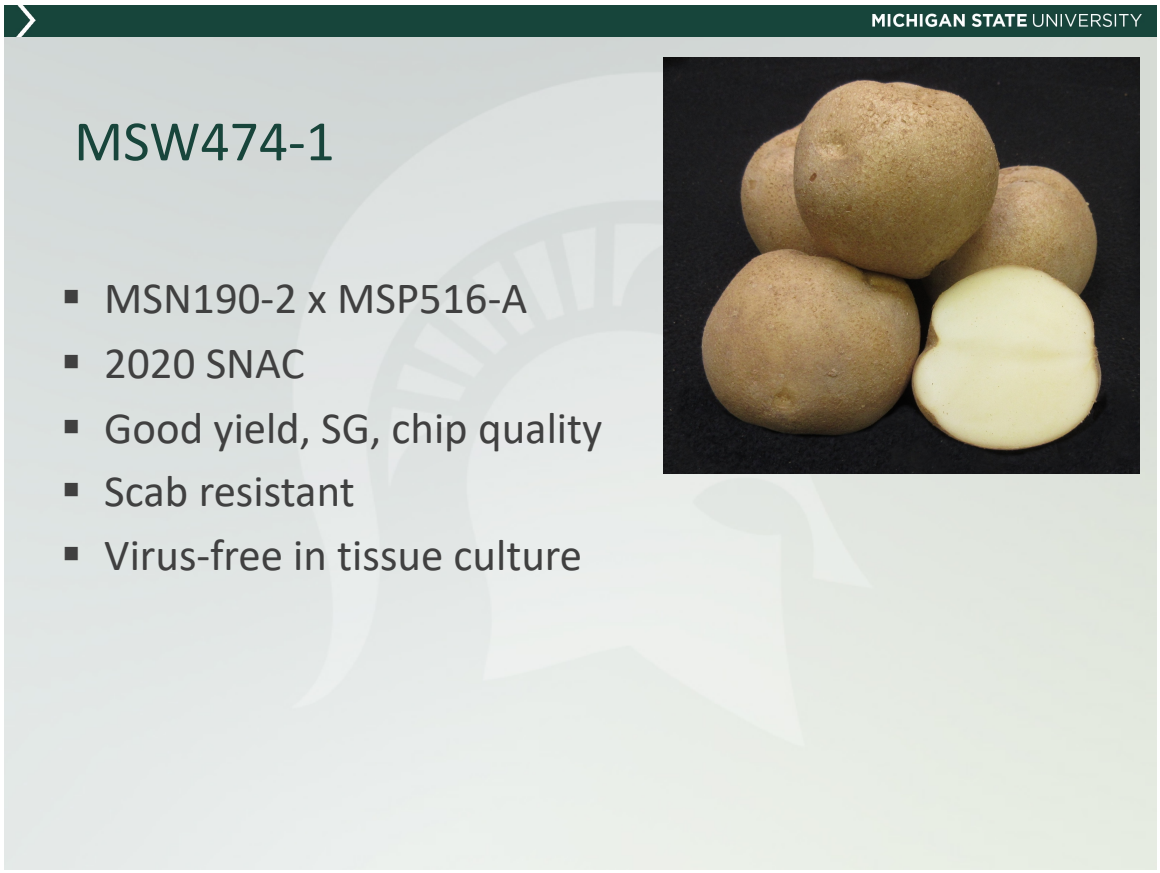
Strengths: Blackberry is a tablestock variety with unique purple skin and a deep purple flesh. The tubers have an attractive, uniform, round shape and a purple flesh with common scab resistance and low incidence of internal defects. Yield can be high under irrigated conditions. Blackberry will also chip-process out of the field.

Incentives for production: The unique purple skin and purple flesh of the tubers of Blackberry offer a unique potato that could lend itself to the specialty variety market, such as gourmet restaurants and food stores, as well as farm and road-side markets. The primary market for this clone will be farm market and direct retail sale growers, and home gardeners. This variety is also used as a gourmet chip processing variety.

Morphological Characteristics:
Plant: Full-sized vine, semi-erect with a balance between stems and foliage visible, and flowers.
Tubers: Round tubers with a smooth skin and unique purple skin and purple flesh color. Tubers have a deep purple flesh with a low incidence of internal defects.

Agronomic Characteristics:
Maturity: Mid-season.
Tubers: Round tubers with unique purple skin and deep purple flesh.
Yield: Above average yield.
Specific Gravity: Averages 1.065 in Michigan.
Culinary Quality: Gourmet specialty with deep purple flesh and also chip-processes.
Diseases: Good common scab resistance.





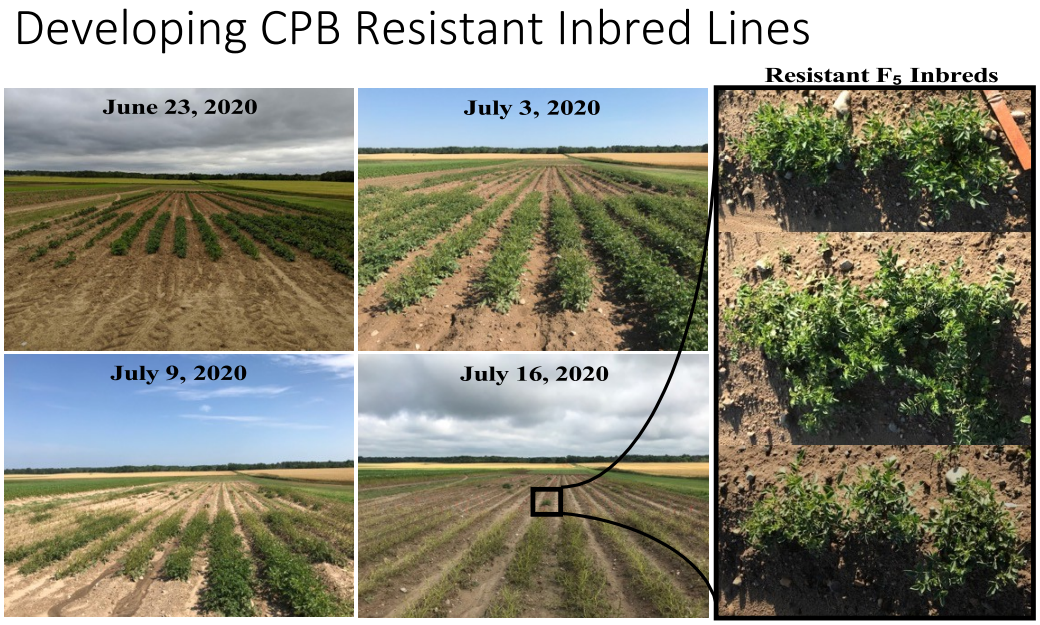
Application of Molecular Markers in MSU Potato Breeding

With the development of molecular markers for potato breeding, marker-assisted selection has been incorporated into our routine breeding practice and greatly facilitate the selection process. Some of the main markers that are used at MSU include: *RYSC3* and M6, *Potato virus Y* (PVY) resistance markers; *RxSP*, a *Potato virus X* (PVX) resistance marker; *TG689*, a Golden Nematode resistance marker; RB and R8, late blight resistance marker. PVY markers have been the most frequently used tools to assist selection in our program due to the importance of PVY resistance. According to the pedigrees, selections from our single-hill trial (1st year of field selection) are screened for PVY markers every year. This allowed for a prioritization of the space in the field, and for earlier, more informed decisions in variety selection.

The trait mapping populations have been a major research focus for us over the previous four years as we try to correlate the field data with the genetic markers. We now have DNA SNP markers linked to late blight resistance, scab resistance, chip color, tuber asparagine and specific gravity. We will now start using this linkage information to assist us in breeding. Our first SNP marker is linked to a gene for late blight resistance on Chr. 9 and the second is located on Chr. 10 with new ones recently identified on Chr. 4 and Chr. 5. The ability to use the DNA markers to stack a set of late blight resistance genes will lead to durable late blight resistance. We are now bringing in late blight resistance genes from germplasm from Europe and China.

Decoding *S. Chacoense*-derived Colorado Potato Beetle Resistance

Introgression of Colorado potato beetle resistance from *S. chacoense*-derived diploid recombinant inbred lines into cultivated backgrounds is being conducted through GREEEN funding. Subsequent marker assisted selection will yield diploid breeding lines with beetle resistance and desirable tuber traits. The spatio-temporal durability of this glycoalkaloid-based host plant resistance will be assessed using Colorado potato beetle populations from potato growing regions across the nation and examining 10 successive generations of beetles grown on host plant resistant material. Furthermore, the development of cross-resistance by beetles grown on host plant resistant material to commercial insecticides will be examined to inform the most sustainable deployment of this germplasm. We have made crosses to introgress the beetle resistance. We will be able to use DNA markers to track the resistance genes as we continue to breed.



Overcoming Self-Incompatibility in Diploid Potato Using CRISPR-Cas9

The aim of this project was to generate a targeted knock-out (KO) of the *S-RNase* gene, involved in gametophytic self-incompatibility in diploid potatoes, using CRISPR/Cas9 technology in an effort to avoid self-pollen degradation. We identified *S-RNase* alleles with flower-specific expression in two diploid self-incompatible lines using genome resequencing data. *S-RNase* gene mapped to chromosome 1 within a low recombination region. *S-RNase* KO lines were obtained causing premature stop codons. Fruits were set in selected KO and produced viable T1 seeds, and a Cas9-free KO line. Our results suggest that creating *S-RNase* KO can contribute to generation of self-

compatible lines as a first step for the generation of commercial diploid cultivars. This is now an important trait to work with in our diploid breeding.

Gene Editing in Diploid Potato

The MSU Potato Breeding and Genetics program has developed diploid germplasm with important agronomic qualities. These lines can be further characterized on traits for the use of gene editing. Thus, the first objective of this project is to characterize the MSU diploid germplasm for important molecular and morphological traits such as regeneration capability. The second major objective is to use gene editing, namely, CRISPR-Cas9 to knockout vacuolar invertase (*VInv*) and PPO in select diploid lines. The overall goal is to further advance the diploid breeding program by introducing economically important traits and proving the utility of gene editing in potato.

Dihaploid Potato Production at Michigan State University

The benefits of developing a richer germplasm of dihaploid potatoes brings the industry ever closer to the expansive changes that would come with diploid potatoes. Many of the difficulties associated with tetraploid potatoes, such as problems with seed storage, would be greatly reduced if the potato had a lower, and therefore less complicated, ploidy. Our goal is to develop a broad-based dihaploid germplasm that can be used in diploid potato breeding. We started by crossing currently established MSU tetraploid germplasm with a known haploid inducer, *S. phureja* IVP 101. Parent lines were selected based on traits such as high yield, disease resistance, and good chip quality, among others. Resulting seeds were inspected for a purple embryo spot and grown in tissue culture before transplanting in the greenhouse. Chloroplast numbers in guard cells were counted to determine ploidy level. Plants that we determined to be diploid were also SNP genotyped with the Infinium 22 or 30K Potato SNP array for ploidy determination. These dihaploids were then tested for disease resistance markers: RYSC3+ (Potato Virus Y extreme resistance), GN (Golden Nematode) resistance, and PVX resistance. Those with a Jacqueline Lee lineage were also tested for presence of late blight resistance via a SNP KASP assay. Confirmed dihaploids were crossed with a diploid self-compatible inbred line of *S. chacoense*, M6 to introgress self-compatibility. Of the hundreds of seeds produced in the past 6 years from these dihaploid crosses with 24 breeding lines or varieties, about 200 progeny have been confirmed as diploid. These dihaploids (diploids derived from tetraploid varieties) are the foundation of our diploid breeding program for round white potatoes for the chip and table markets. We have also now selected some russet dihaploids and will be selecting some red dihaploids and well as more chippers, table and russets in 2021.

Introgressing Self-compatibility to *Solanum tuberosum* Dihaploids for Diploid Variety Development

Dihaploids of cultivated potato (*Solanum tuberosum* L.) have been produced for over 50 years to reduce the breeding and genetic challenges of autopolyploidy. Most dihaploids are male sterile (MS) that reduces the benefit of lower ploidy level of cultivated tetraploid potato. In this study, we used three self-compatibility (SC) donors to introgress SC into a wide range of dihaploid germplasm through a series of crosses to dihaploids which we refer to as *S. tuberosum* backcrossing. The SC increased from 11%

in the F_1 generation to 33% in the BC_2 generations. Over 6,000 genome-wide SNPs were used to characterize the germplasm diversity, heterozygosity, and structure in two backcrossing generations. The BC_3 generation was significantly improved regarding maturity, scab resistance, average tuber number. In 2020, we yield tested 12 lines. Eight lines were equal or better than Norland in yield.

Certified NFT Minituber Production at Michigan State University

Since 2016, the MSU Potato Breeding program has operated its own certified NFT minituber production greenhouse. The ability to produce certified seed allows faster introduction of early generation material to the potato industry. It also helps position the program for participation in international trials.

MICHIGAN STATE UNIVERSITY

2020 Certified Seed Production at MSU

- 40 Clones, 32,000 Minitubers

Line	Tubers	Remarks
Blackberry	4200	
Mackinaw	1400	
Michigan Purple	700	
Petoskey	1400	
Raspberry	1000	
Spartan Red #2 (Red Marker #2)	3000	
MSV093-1Y	1500	
MSW343-2R	850	
MSX324-1P	1000	
MSZ109-05RR	1000	
MSZ109-06PP	240	
MSZ109-07PP	450	
MSZ120-4	260	
MSZ219-13	340	
MSZ242-13	1400	

Line	Tubers	Remarks
Kalkaska	1100	Check
Kal.91.03	1500	GE-Invertase
Desiree	950	Check
Des.98.08	650	GE-Drought
Ranger Russet	500	Check
RR.120.3	450	GE-Drought
RR.120.4	430	GE-Drought
RR.98.32	470	GE-Drought
Spunta	450	Check
Spunta-G2	400	USAID-Bt-cry5
Diamant	500	Check
DIA-MSU-UB 3 events	1000 ea.	USAID-LB
Granola	300	Check
GRA-MSU-UG 6 events	300 ea.	USAID-LB

Germplasm Enhancement

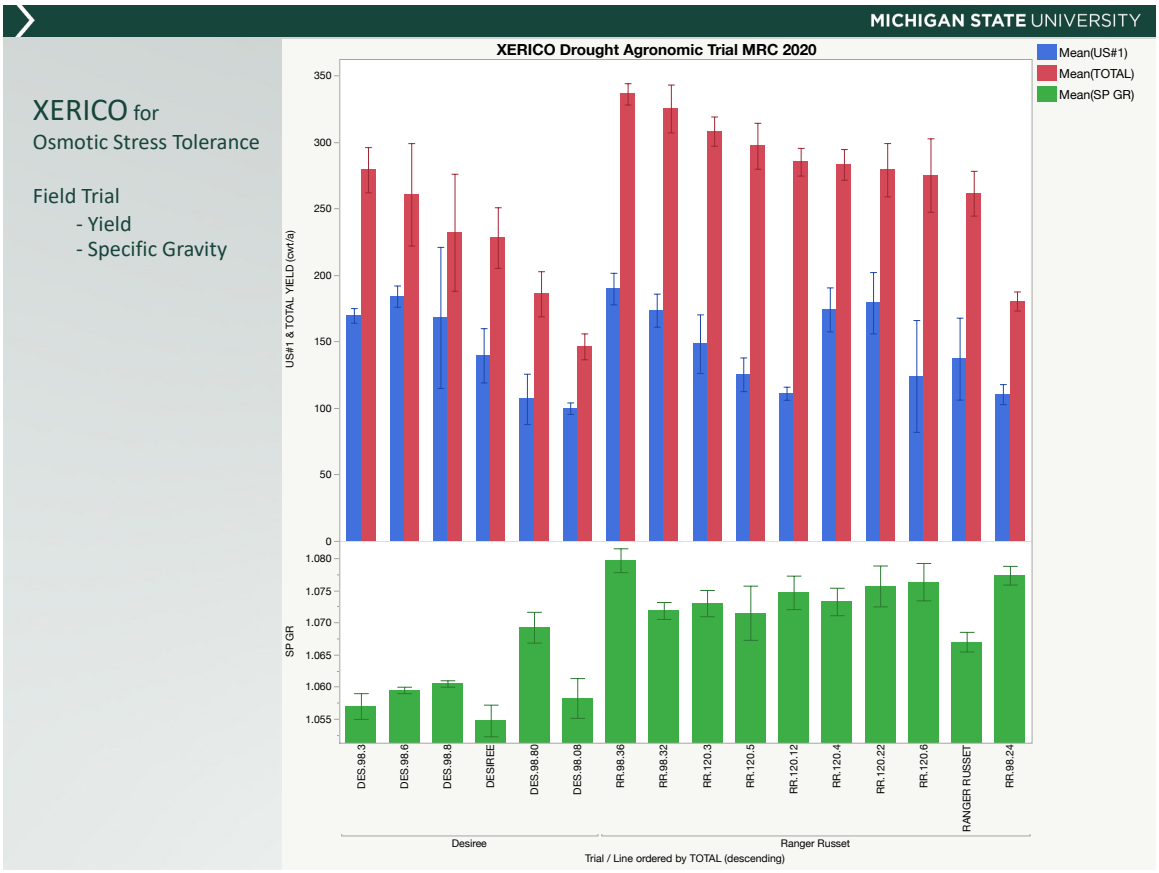
The diploid genetic material represent material from South American potato species and other countries around the world that are potential sources of resistance to Colorado potato beetle, late blight, potato early die, and ability to cold-chip process. We are now placing more emphasis on the diploid breeding effort because of the advantages the breeding system brings when we introduce the ability to self-pollinate a line. Features of diploid breeding include 1) a simpler genetic system than current breeding methods, 2) tremendous genetic diversity for economic traits, 3) minimal crossing barriers to cultivated potato, 4) the ability to reduce genetic load (or poor combinations) through selfing and 5) the ability to create true breeding lines like wheat, soybeans and dry beans. We are also using some

inbred lines of *S. chacoense* that have fertility and vigor (also a source of *Verticillium* wilt resistance to initiate our efforts to develop inbred lines with our own diploid germplasm. We have over 40 populations that we have cycled 5 generations to improve for self-compatibility and tuber traits. We have also been crossing self-compatible donors to the dihaploids of Atlantic, Superior, Manistee, MSZ219-14, Kalkaska, MSR127-2, MSS576-5SPL and others so we can develop inbred chip-processing diploid lines. This new diploid potato breeding project is expanding to develop promising lines to use as parents in the future as well as to think about F1 hybrid varieties.

Integration of Genetic Engineering with Potato Breeding

MSU conducts genetic engineering research to introgress and test economically important traits into potato. We have a USAID-funded project to create and commercialize 3-R-gene potato varieties in Bangladesh and Indonesia. This a partnership with Simplot Plant Sciences. Simplot has been creating the plants for the target countries. 2019 and 2020 greenhouse and field trials show that a high level of resistance to late blight has been achieved in events that have no backbone and are single inserts. Further trials are planned for 2021.

We have also generated lines with the genes for water use efficiency. The XERICO gene is showing the most promise. From 2018 to 2020, we conducted trials at MRC with Ranger Russet events. These results are indicating that we are not seeing a yield reduction from the XERICO gene and the XERICO events also had a higher specific gravity than Ranger Russet. In 2020, we will continue field trials at MRC. Lastly, we have generated and selected a Kalkaska invertase silencing line (Kal91.03) that has resistance to accumulating reducing sugars in cold (40°F) storage. We tested the agronomic characteristics of Kal91.03 from 2016-2019. The initial results are suggesting that the invertase silencing line has good tuber type, size and similar specific gravity. This suggests that we can correct sugar issues in a chip processing lines with this genetic engineering strategy. In 2020, we produced XERICO events and Kal91.03 in the NFT greenhouse to run larger trials in 2021.



Chipped directly after 3 months at 40F

Funding: Fed. Grant/MPIC/Potatoes USA

2020 POTATO VARIETY EVALUATIONS

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INTRODUCTION

Each year, the MSU potato breeding and genetics team conducts a series of variety trials to assess advanced potato selections from the Michigan State University and other potato breeding programs at the Montcalm Research Center (MRC). In 2020, we tested over 150 varieties and breeding lines in the replicated variety trials, plus over 120 lines in the National Chip Processing Trial (NCPT). The variety evaluation also includes disease testing in the scab nursery (Montcalm Research Center) and foliar late blight evaluation (MSU Campus Plant Pathology Farm). The objectives of the evaluations are to identify superior varieties for fresh or chip-processing markets (chip, round white/yellow table, specialty/red and russet). The varieties were compared in groups according to market class, tuber type, skin color, and to the advancement in selection. Each season, total and marketable yields, specific gravity, tuber appearance, incidence of external and internal defects, chip color (from the field as well as from 45°F (7.2°C) and 50°F (10°C) storage at 3 and 6 months), along with susceptibilities to common scab, late blight (foliar and tuber), and blackspot bruising are determined.

We would like to acknowledge the collaborative effort of the Michigan Potato Industry and research colleagues Matthew Klein and the MSU Potato Breeding Team (especially graduate students Natalie Kirkwyland, Ruben Almiron, Sarah Lee and Will Behling) for helping to get the field research done.

PROCEDURE

The field variety trials were conducted at the Montcalm Research Center in Entrican, MI. Due to COVID-19-related university research constraints, trial replication was reduced to a maximum of two. A randomized complete block design was used. The plots were 23 feet (7 m) long and spacing between plants was 10 inches (25.4 cm). Inter-row spacing was 34 inches (86.4 cm). Supplemental irrigation was applied as needed. Nutrient, weed, disease and insect management were similar to recommendations used by the commercial operations in Montcalm County. The field experiments were conducted on a sandy loam soil that has been out of potato production for 5 years. Oats were grown in 2019 on this ground. A severe rain event in late May flooded 40% of the trial ground. That section of the trials did not emerge so the number of lines and replications were lost for the season.

The most advanced selections were tested in the Advanced chip and tablestock trials, representing selections at a stage after the preliminary trials. The other field trials were the Russet, Preliminary (chip-processors and tablestock), Preliminary Pigmented, the NCPT and the early observational trials.

2020 was the tenth year of the National Chip Processing Trial (NCPT). The purpose of the trial is to evaluate early generation breeding lines from the US public breeding programs for their use in chip-processing. The NCPT has 9 trial locations (Northern sites: NY, MI, WI, ND, OR and Southern: NC, FL, CA, TX) in addition to a scab trial Wisconsin.

In each of these trials, the yield was graded into four size classes (pick outs, Bs, As, oversize) using the new Kerian sizer on the grading line, incidence of external and internal defects in >3.25 in. (8.25 cm) diameter potatoes were recorded. Samples were taken for specific gravity, chip-processing, disease tests and bruising tests. Chip quality was assessed on 25-tuber composite samples, taking two slices from each tuber. Chips were fried at 345°F (174°C) for 2 minutes 15 seconds or until fully cooked. The chip color was measured visually with the SFA 1-5 color chart. Tuber samples were also stored at 45°F (7.2°C) and 50°F (10°C) for chip-processing out of storage in January and April. Select advanced selections are also placed in the MPIC B.F. Burt Cargill Commercial Demonstration Storage in Entrican, MI for monthly sampling. This testing was not done since we did not have enough tubers from the trials this year to sample. The lines in the agronomic trials were assessed for common scab resistance at the nursery at the Montcalm Research Center. There has been very strong scab disease pressure at the new Montcalm Scab Disease Nursery for eight years now. The 2020 late blight trial was conducted at the MSU campus Plant Pathology Farm but weather conditions were not conducive. The simulated blackspot bruise (from 50°F tuber temperature) results for average spots per tuber have also been incorporated into the summary sheets.

RESULTS

A. Advanced Chip-Processing Trials (Table 1)

A summary of the 47 entries evaluated in the trial results is given in **Table 1**. Overall, the yields for the Advanced trial (147 days) were above average. The check varieties for this trial were Lamoka, Manistee, Snowden and Atlantic. The highest yielding and most promising lines were MSAA252-7, MSZ219-1, MSBB611-3, and MSAA076-6. Internal defects were minimal for 2020. Specific gravity was average with a trial average of 1.083. Snowden and Atlantic had a specific gravity of 1.084 and 1.085, respectively. All chip-processing entries in the trial had excellent chip-processing quality out of the field, with an SFA score of 1.0. Almost all of the MSU breeding lines have scab resistance. Nineteen MSU chipping lines were classified as having scab resistance scores equal or better than Lamoka. Mackinaw (MSX540-4) has PVY and late blight resistance while MSZ219-1 has scab, PVY and late blight resistance. Other promising

lines to watch are MSZ242-13, MSZ242-09, MSBB058-1, MSBB617-2 and MSAA217-3.

B. Russet Trial (Table 2)

In 2020, 11 lines were evaluated after 134 days. The results are summarized in **Table 2**. Russet Norkotah and GoldRush were the reference varieties used in the trial. In general, the yields were below average for many russet lines while A09086-1LB, Umatilla Russet, Plover Russet and A08433-4Sto were the top tier for yield. In most cases specific gravity was below average with 1.072 average for the trial. Severe hollow heart was observed in Sunset Russet. Bruise incidence was low. Scab resistance was variable with susceptibility was observed in a number of the russet lines.

D. Adaptation Trial (Table 3)

The Adaptation Trial of the tablestock lines was harvested after 134 days and the results of 35 lines are summarized in **Table 3**. The many of the lines evaluated in the Adaptation Trial were tested in the Preliminary Trials the previous year. Two reference cultivars (Yukon Gold and Superior) are reported in the tablestock trial. In general, the yields were below average and internal defects were low. The highest yielding and promising lines were MSZ416-8RY, MSV093-1Y, MSBB213-1SPL and MSZ551-1. Scab tolerance is becoming more prevalent among the advanced selections but the challenge remains to combine scab, PVY and late blight resistance. Other promising lines in the trial are MSCC515-2Y, MSW476-4R, MSV179-1, MST252-1Y and Blackberry. Blackspot bruising was low for most lines.

E. Preliminary Trials (Tables 4, 5 and 6)

The Preliminary trials (chip, table, pigmented) are the first trials for evaluating new advanced selections from the MSU potato breeding program. The division of the trials was based upon pedigree assessment for chip-processing and tablestock utilization. In 2020, there were 82 harvested entries trialed in the three Preliminary trials.

The chip-processing Preliminary Trial (**Table 4**) had 49 harvested entries after 135 days. Many of the lines chip-processed well from the field but specific gravity values were below average with Snowden at 1.077. Internal quality weakness was predominantly vascular discoloration. Promising MSU lines are MSBB017-1, MSEE131-1, MSEE142-1, MSEE149-2, MSEE171-2, MSEE101-2, MSEE018-2 and MSBB625-2 combining yield, specific gravity, scab resistance and chip quality. Some of these lines also have PVY resistance. We continue to make progress selecting for chip-processing with scab resistance with 21 lines in the trial with scab ratings equal or lower than 1.7, whereas Snowden had a scab rating of 2.4.

Table 5 summarizes 17 harvested tablestock entries evaluated in the Preliminary Tablestock Trial. Jacqueline Lee, Reba and Yukon Gold were the check varieties. This tablestock trial was harvested and evaluated after 135 days. MSBB305-2SPL, MSEE199-1, MSCC314-1 and MSBB371-1YSPL all have high yield potential, low

internal defects and scab resistance, as well as low blackspot bruising. In general, the level of scab resistance and internal quality are improving in this pool of lines. We are working towards better skin finish also. This trial also included some European varieties. None of the lines were promising due to poor shape and/or scab susceptibility.

The interest in the specialty market continues to increase. In 2020, 16 harvested entries were evaluated in the Preliminary Pigmented Trial (**Table 6**), which was harvested at 135 days. This trial evaluated breeding lines with unique skin and flesh colors. Many of these MSU lines have commercial agronomic performance and specialty characteristics, as well as some scab resistance. Seven lines were scored as scab resistance. Blackspot bruising is low and internal defects were almost non-existent. MSBB371-1YSPL and MSBB305-2SPL combine high yield and scab resistance.

F. Potato Common Scab Evaluation (Tables 7 and 8)

Each year, a replicated field trial is conducted to assess resistance to common scab. The scab trial is now located at the Montcalm Research Center where high common scab disease pressure was observed in the previous eight years. This location is being used for the early generation observational scab trial (246 lines) and the scab variety trial (262 lines) and diploid scab trial (338). In 2020, the scab infection was a good level with the susceptible controls having some coverage of pitted scab.

We use a rating scale of 0-5 based upon a combined score for scab coverage and lesion severity. Usually examining one year's data does not indicate which varieties are resistant but it should begin to identify ones that can be classified as susceptible to scab. Our goal is to evaluate important advanced selections and varieties in the study at least three years to obtain a valid estimate of the level of resistance in each line. The 2018-2020 scab ratings are based upon the Montcalm Research Center site. **Table 7** categorizes many of the varieties and advanced selections tested in 2020 over a three-year period. The varieties and breeding lines are placed into nine categories based upon scab infection level and lesion severity. A rating of 0 indicates zero scab infection. A score of 1.0 indicates a trace amount of infection. A moderate resistance (1.2 – 1.5) correlates with <10% infection. Scores of 4.0 or greater are found on lines with >50% surface infection and severe pitted lesions.

The check varieties Russet Norkotah, GoldRush, Red Norland, Yukon Gold, Onaway, Pike, Atlantic, and Snowden can be used as references (in bold, **Table 7**). The table is sorted in ascending order by 2020 scab rating. This year's results continue to indicate that we have been able to breed numerous lines with resistance to scab. Scab ratings ranged from 0.3 - 4.0 for the variety trial. A total of 109 entries tested had a scab rating of 1.5 or lower in 2020. Most notable scab resistant MSU lines are found in the trial summaries **(Tables 1-6)**. Of the 246 early generation selections that were evaluated, 138 had scab resistance (scab rating of ≤ 1.5) (**Table 8**).

H. Late Blight Trial

In 2020, the late blight trial was planted at the East Lansing campus Plant Pathology farm. All entries were planted in early June for late blight evaluation. These include lines tested in a replicated manner from the agronomic variety trial and entries in the early generation observation plots. The trials were inoculated three times in August and September with the US-23 genotype of *P. infestans*. Late blight infection was identified in the spreader rows but it would not spread since the weather conditions were too dry and breezy. As a result, we did not collect data that could discriminate resistant from susceptible lines.

I. Blackspot Bruise Susceptibility (Table 9)

Evaluations of advanced seedlings and new varieties for their susceptibility to blackspot bruising are also important in the variety evaluation program. Based upon the results collected over the past years, the non-bruised check sample has been removed from our bruise assessment. A composite bruise sample of each line in the trials consisted of 25 tubers (a composite of 4 replications) from each line, collected at the time of grading. The 25-tuber sample was held in 50°F (10°C) storage overnight and then was placed in a hexagon plywood drum and tumbled 10 times to provide a simulated bruise. The samples were peeled in an abrasive peeler in October and individual tubers were assessed for the number of blackspot bruises on each potato. These data are shown in **Table 9**. The bruise data are represented in two ways: percentage of bruise free potatoes and average number of bruises per tuber. A high percentage of bruise-free potatoes is the desired goal; however, the numbers of blackspot bruises per potato is also important. Cultivars which show blackspot incidence greater than Atlantic are approaching the bruise-susceptible rating. In addition, the data is grouped by trial, since the bruise levels can vary between trials. In 2020, the bruise levels were average compared to previous years. There are many lines with lower blackspot bruise potential across the trials. Some of our advanced selections are similar to or less than Atlantic and Snowden in their level of bruising. A few lines will high susceptibility to bruise were identified and will be discontinued from testing. All the bruise ratings are also found in the variety trial tables (**Tables 1-6**).

J. National Chip Processing Trial (NCPT) data available on-line

The Potatoes USA-funded National Chip Processing Trial (NCPT) is an effort to synergize the strengths of the public breeding programs in the U.S. to identify improved chip-processing varieties for the industry. Cooperating breeding programs include the USDA (Idaho and Maryland) and land grant universities (Colorado, Maine, Michigan, Minnesota, North Carolina, North Dakota, New York, Oregon, Wisconsin and Texas). The coordinated breeding effort includes early stage evaluation of key traits (yield, specific gravity, chip color, chip defects and shape) from coordinated trials in 10 locations. Since the inception of the trial in 2010, over 1,000 different potato entries, including reference varieties, have been evaluated. The data for all the lines tested are summarized on a searchable, centralized database housed at Medius (https://potatoesusa.medius.re). More than 40 promising new breeding lines from the trials have been fast-tracked for larger-scale commercial trials and processor evaluation.

The NCPT is also a feeder for the national SNAC International trials. We are using the NCPT trials to more effectively identify promising new selections. Notable MSU lines that have been identified are MSW485-2 (Huron Chipper), MSX540-4 (Makinaw), MSV030-4 (Petoskey), MSW474-1, and MSZ242-13. Minituber production and/or commercial seed have been produced of the newer lines and will be tested in Michigan in 2021.

Table 1

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADVANCED CHIP-PROCESSING TRIAL
MONTCALM RESEARCH CENTER
May 5 to September 29, 2020 (147 days)
DD Base 40°F 3216[8]

		CWT/A		PERCENT OF TOTAL[1]						CHIP	OTF	PERCENT (%) TUBER QUALITY[4]							3-YR AVG US#1
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	SED[3]	HH	VD	IBS	BC	SCAB[5]	MAT[6]	BRUISE[7]	CWT/A
MSAA252-7	1	389	409	95	5	95	0	0	1.083	1.0	0	10	0	0	0	1.5	5.0	3.6	-
MSBB626-11	2	378	409	93	8	92	1	0	1.085	1.5	1	5	0	0	0	0.8	4	3.0	-
MSZ219-01	1	375	390	96	4	89	7	0	1.080	1.0	0	0	0	0	0	0.7	3.0	1.3	341
MSAA076-6	1	370	413	90	10	90	0	0	1.092	1.0	0	0	0	10	0	1.3	3.0	2.7	334*
MSAA328-4	1	348	362	96	3	96	0	1	1.081	1.0	0	0	0	0	0	1.3	3.0	2.8	-
Huron Chipper	1	337	379	89	11	89	0	0	1.083	1.0	0	0	20	0	0	1.3	3.0	0.9	338
MSBB079-2	1	325	371	88	11	88	0	1	1.083	1.0	0	0	0	0	0	1.3	3.0	2.3	-
MSZ120-04	1	324	358	91	8	91	0	2	1.082	1.0	0	0	20	0	0	1.5	5.0	2.5	370*
MSBB611-3	1	320	360	89	10	89	0	1	1.086	1.5	0	0	0	0	0	2.5	3.0	3.6	-
MSBB635-14	2	318	353	91	9	91	0	2	1.081	1.0	0	0	10	0	0	1.7	2.5	1.3	-
MSBB610-13	1	317	338	94	5	94	0	1	1.083	1.0	0	0	0	0	0	0.8	2.0	1.3	-
MSBB617-2	1	315	339	93	6	93	0	1	1.083	1.0	0	20	10	0	0	1.5	2.0	0.6	-
MSAA100-1	1	314	326	96	4	96	0	0	1.069	ND	ND	0	70	0	0	1.3	3.0	ND	-
MSBB058-1	1	307	342	90	10	90	0	1	1.093	1.0	0	0	0	0	0	1.3	3.0	3.5	-
MSX245-2Y	1	304	329	92	4	90	2	4	1.081	1.0	1	0	0	0	0	1.8	4.0	1.0	404*
MSAA498-18	2	303	330	92	8	92	1	0	1.086	1.0	0	5	0	0	0	0.8	3.5	2.9	-
MSZ219-13	1	296	320	93	7	93	0	0	1.086	1.0	0	0	0	0	0	1.2	3.0	2.9	325
MSAA513-1	1	293	321	91	5	89	2	3	1.078	1.0	0	0	20	0	0	1.5	2.0	3.0	-
MSCC058-1	1	291	323	90	7	88	2	3	1.086	1.0	0	30	0	0	0	1.7	3	2.5	-
Mackinaw	2	291	319	91	9	91	0	1	1.090	1.0	0	0	0	0	0	1.7	3.5	1.3	277
MSAA232-4	1	285	329	87	9	87	0	4	1.081	1.0	0	10	0	0	0	2.2	3.0	0.5	-
Manistee	**1**	**279**	**331**	**84**	**16**	**84**	**0**	**0**	**1.079**	**1.0**	**0**	**0**	**0**	**0**	**0**	**2.5**	**2.0**	**0.5**	**276**
MSZ052-14	1	276	314	88	12	88	0	0	1.077	ND	ND	0	0	0	0	1.5	3.0	ND	278
MSZ052-11	1	271	328	83	15	83	0	2	1.078	ND	ND	0	0	0	0	0.5	3.0	ND	-
MSZ242-09	1	263	318	83	9	83	0	8	1.089	1.0	0	10	0	0	0	1.3	4.0	1.0	269
MSCC168-1	1	259	298	87	13	87	0	0	1.076	1.0	0	0	0	0	0	2.0	2.0	3.3	-
MSZ242-13	1	259	294	88	9	88	0	3	1.099	1.0	0	0	0	0	0	1.2	3.0	2.8	276
MSZ063-2	1	252	342	74	25	74	0	1	1.084	1.0	0	0	0	0	0	1.8	2	0.8	-
MSAA260-3	1	251	305	82	7	80	2	11	1.080	1.0	1	0	0	0	0	1.2	4.0	2.0	-
MSV498-1	1	248	269	92	8	92	0	0	1.078	ND	ND	0	80	0	0	1.7	2.0	ND	310
MSAA217-3	1	247	256	96	4	96	0	0	1.091	1.0	0	30	10	0	0	2.3	3	2.3	-
MSZ194-2	1	245	258	95	5	95	0	0	1.078	ND	ND	0	0	0	0	2.0	2.0	ND	-
MSZ242-07	1	241	288	84	12	84	0	4	1.098	1.0	0	0	0	0	0	1.0	3.0	1.4	305
Lamoka	**2**	**238**	**288**	**83**	**17**	**83**	**0**	**1**	**1.082**	**1.0**	**0**	**0**	**10**	**0**	**0**	**0.8**	**2.5**	**2.6**	**277**
MSBB618-9	1	229	295	78	15	76	2	8	1.066	ND	ND	0	0	0	0	1.5	2.0	ND	-
MSY156-2	1	229	280	81	18	81	0	0	1.084	1.0	0	0	0	0	0	1.0	4.0	0.3	331*
MSZ219-14	1	229	283	81	11	81	0	8	1.081	ND	ND	50	0	0	0	1.0	3.0	ND	329
FL2137	**2**	**221**	**256**	**86**	**10**	**86**	**0**	**4**	**1.085**	**1.0**	**1**	**5**	**5**	**0**	**0**	**1.8**	**2.0**	**1.3**	**227***
MSZ052-13	1	214	243	88	12	88	0	0	1.085	ND	ND	0	0	0	0	0.5	3	ND	234*
Snowden	**1**	**211**	**286**	**74**	**26**	**74**	**0**	**1**	**1.084**	**1.0**	**0**	**0**	**20**	**0**	**0**	**2.4**	**2.0**	**2.3**	**239**
MSX526-1	2	203	235	86	14	86	0	0	1.083	1.0	0	0	0	0	0	1.3	2	1.4	-
Petoskey	1	200	236	85	15	85	0	0	1.092	1.0	1	0	0	0	0	1.3	2.0	1.0	199*
MSW163-3	1	190	243	78	6	78	0	16	1.074	ND	ND	0	0	0	0	1.2	3.0	ND	-
MSCC266-1	1	165	180	92	7	92	0	1	1.066	ND	ND	0	0	0	10	1.2	1.0	ND	-
Atlantic	**2**	**149**	**170**	**87**	**13**	**87**	**0**	**1**	**1.085**	**1.0**	**0**	**10**	**5**	**0**	**0**	**1.9**	**2.0**	**1.8**	**242**
MSZ248-10	1	122	159	77	6	77	0	17	1.083	ND	ND	0	0	0	0	1.0	4.0	ND	269*
MSBB614-10	1	107	121	88	8	88	0	4	1.078	1.0	0	0	0	0	0	1.2	3.0	0.4	-
MEAN		268	304						1.083							1.4	2.9	1.9	

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.
[2]CHIP SCORE: SNAC Scale (Out of the field); Ratings: 1-5; 1: Excellent, 5: Poor.
[3]SED: Stem End Defect, Based on Paul Bethke's (USDA/UWisconsin - Madison) 0 - 5 scale. 0 = no SED; 3 = significant SED; 5 = severe SED
[4]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 40 Oversize and/or A-size tubers cut.
[5]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[6]MATURITY RATING: August 20, 2019; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[7]BRUISE: Simulated blackspot bruise test, average number of spots per tuber.

Plant Date: 5/5/20
Vine Kill: 9/1/20
Days from planting to vine kill: 119
[8]Enviroweather: Entrican Station. Planting to vine kill

Table 2

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

RUSSET TRIAL
MONTCALM RESEARCH CENTER
May 05 to September 16, 2020 (134 days)
DD Base 40°F 3216[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]							3-YR AVG US#1
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]	CWT/A
A09086-1LB	1	354	471	75	24	75	0	1	1.077	0	0	0	0	3.2	4.0	0.1	-
Umatilla Russet	1	335	494	68	26	68	0	6	1.084	10	0	0	0	0.8	4.0	1.5	-
Plover Russet	1	333	364	92	6	92	0	2	1.066	0	0	0	0	1.5	2.0	1.0	-
A08433-4Sto	1	330	392	84	13	84	0	3	1.072	30	0	0	0	2.3	4.0	0.2	-
CO09205-2Rus	1	312	384	81	19	81	0	0	1.070	10	0	0	0	2.7	3.0	1.1	-
Alverstone Russet (HZPC)	1	289	411	70	13	70	0	17	1.074	30	0	10	0	2.3	3.0	0.4	-
Dakota Russet	1	278	309	90	9	90	0	1	1.081	30	30	0	0	1.8	3.0	0.8	293*
SunSet Russet (TX13590-9Rus)	1	270	321	84	14	84	0	2	1.077	90	30	0	0	2.0	3.0	0.7	-
AO06191-1	1	248	281	88	10	88	0	2	1.079	0	0	0	0	0.5	2.0	0.5	-
Vanguard Russet	1	235	261	90	10	90	0	0	1.058	10	0	0	0	1.5	1.0	0.5	204
Goldrush Russet	**1**	**213**	**339**	**63**	**23**	**63**	**0**	**14**	**1.061**	**0**	**50**	**0**	**0**	**0.3**	**2.0**	**0.4**	**201**
Russet Norkotah/Texas 112	**1**	**197**	**288**	**69**	**31**	**69**	**0**	**1**	**1.064**	**30**	**20**	**10**	**0**	**2.5**	**1.5**	**0.1**	**201**
MEAN		283	359						1.072					1.8	2.7	0.6	202

* Two-Year Average

[1]SIZE: B: < 4 oz.; A: 4-10 oz.; OV: > 10 oz.; PO: Pickouts.
[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 40 Oversize and/or A-size tubers cut.
[3]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[4]MATURITY RATING: August 20, 2019; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.
[6]Enviroweather: Entrican Station. Planting to vine kill

Plant Date: 5/5/20
Vine Kill: 9/1/20
Days from planting to vine kill: 119

Table 3

ADAPTATION TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH CENTER
May 05 to September 16, 2020 (134 days)
DD Base 40°F 3216[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]
MSZ416-8RY	1	430	490	88	9	49	37	4	1.056	0	10	0	0	1.2	2.0	0.8
MSAA120-1	1	410	437	94	5	92	2	1	1.071	30	0	0	0	2.2	3.0	1.2
MSBB213-1Spl	1	406	427	95	4	95	0	1	1.078	0	30	0	10	1.5	3.0	0.9
MSV093-1Y	1	405	437	93	3	93	0	4	1.067	0	0	0	0	1.7	4.0	0.4
MSZ551-1	1	388	419	93	5	87	6	2	1.075	0	10	0	0	1.8	4.0	1.9
MSX156-1Y	1	381	399	95	3	94	2	2	1.068	0	0	0	0	2.2	3.0	1.7
MSAA196-1	1	316	351	90	8	90	0	2	1.063	0	0	0	0	1.7	4.0	0.3
MSCC300-1	1	313	358	87	8	84	3	5	1.073	30	0	0	0	2.0	2.0	0.5
Blackberry	1	312	496	63	36	63	0	1	1.066	0	0	0	0	1.3	4.0	0.0
MSV443-1PP	2	292	350	84	17	83	1	0	1.062	0	0	0	0	1.3	2.0	0.2
MSY111-1	2	284	327	87	9	86	1	5	1.089	5	35	0	0	1.3	3.5	0.6
MSZ436-2Spl	1	268	289	93	7	91	2	0	1.054	0	10	0	0	1.8	2.0	0.1
MSCC302-1	1	260	296	88	12	88	0	0	1.076	0	0	0	0	2.0	3.0	1.9
MSW476-4R	1	259	317	82	17	82	0	1	1.073	0	30	0	0	2.0	2.0	0.8
Superior	**1**	**247**	**269**	**92**	**8**	**92**	**0**	**0**	**1.056**	**0**	**10**	**10**	**0**	**1.8**	**1.0**	**0.5**
MSCC515-2Y	1	242	269	90	9	90	0	1	1.066	0	0	0	0	2.0	2.0	0.1
MSV179-1	2	241	250	97	2	65	33	1	1.069	0	0	0	0	1.5	3.0	0.4
MSZ427-3R	1	239	290	83	15	83	0	2	1.055	0	10	0	0	2.0	2.0	0.4
MSW038-4Y	1	228	290	79	11	79	0	10	1.069	0	0	0	0	2.3	2.0	0.7
MSBB351-1	1	225	244	92	6	89	3	2	1.059	10	0	0	0	0.8	2.0	0.3
MSX193-1Y	1	225	273	82	18	82	0	0	1.073	0	10	0	0	2.7	2.0	0.3
MSX324-2R	1	218	285	76	20	76	0	4	1.066	0	0	0	0	1.2	1.0	0.6
MSX497-6	1	208	218	96	4	96	0	0	1.069	0	10	0	0	2.8	2.0	nd
MSAA174-1	1	204	234	87	11	87	0	2	1.056	0	10	0	0	1.7	2.0	0.2
MSX137-6	1	199	325	61	38	59	2	0	1.075	0	0	0	0	1.7	3.0	0.3
MSZ109-8PP	1	199	279	71	23	71	0	5	1.063	0	0	0	0	1.2	3.0	0.3
MSX324-1P	1	195	272	72	28	72	0	1	1.076	0	0	0	0	1.0	1.0	0.5
Yukon Gold	**1**	**194**	**202**	**96**	**4**	**93**	**3**	**0**	**1.064**	**20**	**0**	**0**	**10**	**2.5**	**1.0**	**0.5**
MSX293-1Y	1	191	228	84	16	84	0	0	1.066	0	10	0	0	2.7	2.0	0.2
MST252-1Y	1	186	246	76	24	76	0	0	1.066	0	0	0	0	0.8	1.0	0.6
MSZ268-1Y	1	185	263	70	7	70	0	23	1.072	10	10	0	0	1.0	4.0	0.4
MSZ590-1	1	184	260	71	28	71	0	1	1.061	10	0	0	0	0.7	2.0	1.1
MSY507-2	1	164	225	73	21	73	0	6	1.076	0	10	0	0	1.0	2.0	1.7
Queen Anne	1	157	245	64	34	64	0	2	1.061	0	0	0	0	1.8	1.0	0.1
MSZ615-2	2	139	176	81	18	79	2	2	1.066	0	20	0	0	1.5	1.0	0.5
MEAN		206	257						1.066					1.7	1.9	0.5

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.
[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 40 Oversize and/or A-size tubers cut.
[3]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[4]MATURITY RATING: August 20, 2019; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.
[6]Enviroweather: Entrican Station. Planting to vine kill

Plant Date: 5/5/20
Vine Kill: 9/1/20
Days from planting to vine kill: 119

Table 4

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH CENTER
May 5 to September 17, 2020 (135 days)
DD Base 40°F 3216[8]

		CWT/A		PERCENT OF TOTAL[1]						CHIP	OTF	PERCENT (%) TUBER QUALITY[4]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	SED[3]	HH	VD	IBS	BC	SCAB[5]	MAT[6]	BRUISE[7]
MSCC725-232	1	457	533	86	7	84	1	7	1.068	1.0	0.0	30	0	0	0	1.2	4.0	0.1
MSBB017-1	1	439	545	81	19	81	0	1	1.079	1.5	0.0	0	20	0	0	1.8	3.0	1.2
MSEE033-2	1	434	453	96	4	92	4	0	1.071	1.0	0.0	10	20	10	0	1.7	3.0	0.5
MSEE131-1	1	420	443	95	4	93	1	1	1.077	1.5	0.0	10	0	0	0	1.7	4.0	0.4
MSEE063-6	1	414	428	97	3	93	4	0	1.076	1.0	0.0	0	10	0	0	1.0	4.0	0.2
MSBB621-3	1	413	460	90	10	90	0	0	1.069	1.5	2.0	0	30	0	0	2.0	4.0	0.9
MSEE163-1	1	403	450	90	9	90	0	1	1.074	1.0	0.0	0	30	0	0	1.0	4.0	ND
MSDD497-B	1	374	386	97	3	95	1	0	1.056	1.5	2.0	0	10	0	0	1.2	4.0	0.0
MSEE157-1	1	371	408	91	9	88	3	0	1.077	1.5	2.0	0	0	0	0	0.8	3.0	0.4
MSEE207-02	1	363	402	90	7	90	0	2	1.075	1.0	1.0	0	20	0	0	0.7	4.0	0.8
MSEE142-1	1	358	384	93	7	93	0	0	1.081	1.0	1.0	0	20	0	0	1.8	3.0	ND
MSEE149-2	1	336	339	99	1	95	4	0	1.084	1.5	2.0	0	10	0	0	1.3	4.0	1.3
MSBB179-1	1	335	351	95	5	90	5	0	1.072	1.0	0.0	0	60	0	0	1.2	3.0	1.1
MSEE136-1	1	331	375	88	12	88	0	0	1.072	2.0	2.0	0	0	0	0	2.0	2.0	0.9
MSEE171-2	1	330	341	97	3	93	4	0	1.082	1.5	2.0	0	10	70	0	1.0	4.0	2.9
MSEE031-3	1	326	358	91	9	91	0	0	1.078	1.5	1.0	0	10	20	0	1.0	2.0	0.6
MSEE101-2	1	325	358	91	9	91	0	0	1.083	1.5	1.0	0	0	0	0	1.0	2.0	1.4
Snowden	**1**	**324**	**382**	**85**	**15**	**85**	**0**	**0**	**1.077**	**1.0**	**0.0**	**0**	**80**	**0**	**0**	**2.4**	**2.0**	**1.5**
MSBB623-12	1	322	345	93	6	93	0	1	1.070	1.0	1.0	0	50	0	0	1.7	2.0	0.4
MSEE180-3P	1	317	393	81	19	81	0	0	1.076	ND	ND	0	10	0	0	0.8	2.0	0.2
MSEE149-1	1	313	324	97	3	82	15	0	1.075	1.0	0.0	10	20	0	0	1.3	5.0	1.6
MSBB190-1	1	306	324	95	5	90	4	0	1.068	1.5	1.0	10	0	0	0	1.7	3.0	0.4
MSEE151-2	1	296	343	86	10	86	0	3	1.075	1.0	1.0	0	20	10	0	1.2	2.0	1.4
MSEE018-2	1	283	317	89	7	88	2	3	1.092	1.5	1.0	0	10	0	0	2.0	4.0	2.1
MSEE151-3	1	280	339	83	17	83	0	1	1.078	1.0	0.0	0	10	0	0	2.7	2.0	0.3
MSEE052-5	1	275	316	87	10	87	0	3	1.070	1.0	1.0	0	10	0	0	1.2	3.0	0.0
MSBB107-1	1	273	315	87	12	87	0	1	1.068	1.0	0.0	0	0	0	0	2.3	3.0	0.1
MSX042-3	1	269	293	92	7	92	0	2	1.079	1.0	0.0	0	0	0	0	1.5	2.0	0.6
MSBB651-4	1	266	312	85	15	85	0	0	1.071	1.0	0.0	0	0	0	0	1.0	ND	0.4
MSDD530-1	1	249	281	88	12	88	0	0	1.065	1.0	0.0	0	0	0	0	1.8	3.0	0.2
MSBB166-1	1	240	297	81	18	81	0	1	1.071	1.5	0.0	10	0	0	0	1.0	2.0	1.0
MSAA241-1	1	234	265	88	12	88	0	0	1.077	1.0	0.0	0	30	0	0	1.2	3.0	0.9
MSEE137-3	1	227	272	84	16	84	0	0	1.077	1.0	1.0	0	0	0	0	1.8	2.0	0.2
MSBB625-2	1	217	259	84	16	84	0	0	1.089	1.5	0.0	10	20	10	0	0.8	3.0	1.0

Table 4

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH CENTER
May 5 to September 17, 2020 (135 days)
DD Base 40°F 3216[8]

		CWT/A		PERCENT OF TOTAL[1]								PERCENT (%) TUBER QUALITY[4]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	CHIP SCORE[2]	OTF SED[3]	HH	VD	IBS	BC	SCAB[5]	MAT[6]	BRUISE[7]
MSZ219-46	1	208	215	97	3	97	0	0	1.074	1.0	0.0	0	20	0	0	1.3	3.0	0.5
Pike	**1**	**207**	**268**	**77**	**19**	**77**	**0**	**3**	**1.075**	**1.0**	**1.0**	**0**	**10**	**0**	**0**	**0.8**	**2.0**	**0.3**
Atlantic	**1**	**196**	**233**	**84**	**16**	**84**	**0**	**0**	**1.082**	**1.0**	**1.0**	**30**	**30**	**20**	**0**	**1.9**	**2.0**	**1.2**
MSEE074-2	1	192	207	93	7	93	0	0	1.073	1.0	0.0	0	0	0	0	0.8	1.0	0.4
MSAA085-1	1	183	233	79	21	79	0	0	1.071	1.0	0.0	10	20	0	0	1.8	2.0	0.2
MSEE010-3	1	177	199	89	10	89	0	1	1.070	1.5	1.0	0	20	0	0	1.3	2.0	0.3
MSBB634-8	1	174	195	89	10	89	0	1	1.071	1.0	1.0	0	30	20	0	1.2	3.0	0.1
MSEE025-1	1	174	185	94	4	94	0	1	1.076	1.0	0.0	0	30	0	0	0.8	3.0	0.8
MSEE141-2	1	167	184	91	9	91	0	0	1.079	1.5	1.0	0	10	0	0	1.2	1.0	0.6
MSEE038-1	1	134	190	71	29	71	0	0	1.057	1.0	0.0	0	0	0	0	1.8	1.0	0.2
MSEE190-1	1	132	165	80	20	80	0	0	1.073	1.0	1.0	0	30	0	0	1.3	3.0	0.6
MSEE154-1	1	129	185	70	30	70	0	0	1.059	1.0	0.0	0	10	0	0	1.7	1.0	0.2
MSBB020-8	1	92	174	53	46	53	0	1	1.076	1.0	0.0	0	0	0	0	0.8	2.0	0.9
MSEE022-8	1	51	140	37	63	37	0	0	1.077	1.5	1.0	0	0	0	0	1.7	3.0	0.0
MEAN		278	316						1.074							1.4	2.7	0.7

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.

[2]CHIP SCORE: SNAC Scale (Out of the field); Ratings: 1-5; 1: Excellent, 5: Poor.

[3]SED: Stem End Defect, Based on Paul Bethke's (USDA/UWisconsin - Madison) 0 - 5 scale. 0 = no SED; 3 = significant SED; 5 = severe SED

[4]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 40 Oversize and/or A-size tubers cut.

[5]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.

[6]MATURITY RATING: August 20, 2019; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

[7]BRUISE: Simulated blackspot bruise test average number of spots per tuber.

Plant Date: 5/5/20
Vine Kill: 9/1/20
Days from planting to vine kill: 119

[8]Enviroweather: Entrican Station. Planting to vine kill

Table 5

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH CENTER
May 5 to September 17, 2020 (135 days)
DD Base 40°F 3216[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]
MSBB305-2SPL	1	351	410	86	14	86	0	0	1.060	0	10	0	0	1.7	3.0	0.3
MSEE199-1	1	274	332	83	5	66	17	13	1.073	0	0	0	0	0.3	3.0	0.9
MSCC314-1	1	259	289	90	6	88	2	4	1.065	10	10	0	10	1.5	2.0	0.1
Paroli	1	259	306	85	14	85	0	2	1.054	0	0	0	0	2.0	1.0	0.0
Melody	1	255	304	84	14	84	0	2	1.067	0	0	0	0	2.3	4.0	0.8
MSBB371-1YSPL	1	247	333	74	24	74	0	2	1.070	0	10	0	0	1.2	1.0	0.5
MSAA342-2	1	242	254	95	5	88	7	0	1.065	0	10	0	0	1.7	3.0	1.0
Reba	**1**	**234**	**274**	**85**	**14**	**85**	**0**	**1**	**1.063**	**10**	**0**	**0**	**0**	**2.7**	**3.0**	**0.5**
Constance	1	234	336	69	20	69	0	10	1.060	0	0	10	0	2.8	2.0	0.7
Allora	1	201	267	75	18	75	0	7	1.064	0	0	0	0	2.5	3.0	0.5
Jacqueline Lee	**1**	**182**	**357**	**51**	**35**	**51**	**0**	**14**	**1.081**	**0**	**10**	**0**	**0**	**3.0**	**3.0**	**1.8**
Golden Globe	1	179	357	50	21	50	0	29	1.060	0	0	0	0	2.2	2.0	0.2
MSCC724-1Y	1	168	208	81	12	81	0	7	1.066	0	0	0	0	ND	1.0	0.3
Yukon Gold	**1**	**136**	**156**	**87**	**8**	**87**	**0**	**4**	**1.062**	**10**	**0**	**0**	**0**	**2.5**	**2.0**	**ND**
Nixie	1	120	257	47	50	47	0	3	1.065	0	0	0	0	2.8	3.0	0.1
MSEE255-1	1	120	144	83	8	76	7	9	1.073	10	20	10	0	1.5	3.0	1.4
MSEE085-1	1	58	235	25	75	25	0	1	1.075	0	0	0	0	1.5	3.0	0.7
MEAN		207	283						1.066					2.0	2.5	0.6

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 40 Oversize and/or A-size tubers cut.

[3]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.

[4]MATURITY RATING: August 20, 2019; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.

[6]Enviroweather: Entrican Station. Planting to vine kill

Plant Date: 5/5/20
Vine Kill: 9/1/20
Days from planting to vine kill: 119

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, PIGMENTED LINES
MONTCALM RESEARCH CENTER
May 5 to September 17, 2019 (135 days)
DD Base 40°F 3216[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	Bruise[5]
Fenway Red	1	325	391	83	14	81	2	3	1.072	0	10	0	0	2.3	3.0	0.5
CO99076-6R	1	275	327	84	11	84	0	5	1.067	0	10	0	0	2.8	2.0	0.7
MSZ107-6PP	1	243	341	71	28	71	0	1	1.075	0	0	0	0	1.8	1.0	0.2
MSEE247-6WP	1	236	278	85	14	85	0	1	1.060	10	0	0	0	1.0	2.0	0.1
MSBB308-2P	1	228	288	79	19	79	0	2	1.056	0	50	0	0	1.2	2.0	0.1
MSAA101-1RR	1	226	344	66	31	66	0	4	1.081	0	10	0	0	0.8	3.0	0.2
Dark Red NorlaND	**1**	**207**	**255**	**81**	**17**	**81**	**0**	**1**	**1.052**	**0**	**20**	**0**	**0**	**ND**	**1.0**	**0.1**
MSAA127-7PP mini	1	187	258	73	27	73	0	0	1.053	0	0	0	0	1.7	1.0	0.4
MSCC614-1RYSPL	1	179	333	54	45	54	0	1	1.079	0	10	0	0	1.7	2.0	0.2
MSZ427-1R mini	1	141	253	56	44	56	0	1	1.057	0	0	0	0	0.8	1.0	0.1
MSBB250-1PP	1	140	399	35	63	35	0	2	1.078	0	0	0	0	1.7	4.0	0.2
MSAA706-7PP	1	122	146	84	16	84	0	0	1.065	0	0	0	0	1.7	3.0	0.3
Vicki (HZPC)	1	118	238	50	37	50	0	13	1.065	0	0	0	0	0.7	3.0	0.1
MSX443-3P mini	1	97	305	32	68	32	0	0	1.074	0	0	10	0	1.8	4.0	0.1
MSCC542-1P	1	86	128	67	31	67	0	2	1.054	0	10	0	0	1.5	2.0	0.1
MSAA157-2PY	1	70	106	66	33	66	0	1	1.067	0	0	0	0	2.8	3.0	0.3
MEAN		180	274						1.066					1.6	2.3	0.2

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 40 Oversize and/or A-size tubers cut.

[3]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible. Plant Date: 5/5/20

[4]MATURITY RATING: August 20, 2019; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering). Vine Kill: 9/1/20

[5]BRUISE: Simulated blackspot bruise test, average number of spots per tuber. Days from planting to vine kill: 119

[6]Enviroweather: Entrican Station. Planting to vine kill

2018-20 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2020 RATING	2020 WORST	2020 N	2019 RATING	2019 WORST	2019 N	2018 RATING	2018 WORST	2018 N
Sorted by ascending 2020Average Rating;										
Goldrush Russet	**0.4**	**0.3**	**0.5**	**3**	**0.7**	**1.0**	**3**	**0.3**	**0.5**	**3**
MSEE199-1	-	0.3	0.5	3						
AO06191-1	-	0.5	0.5	3						
MSCC282-3RR	-	0.5	0.5	3						
MSEE182-3	-	0.5	1.0	3						
MSZ052-11	-	0.5	0.5	3						
MSZ052-13	0.6*	0.5	0.5	3	0.7	1.0	3			
MSEE207-2	-	0.7	1.0	3						
MSZ219-01^{PVYR}	0.6	0.7	1.0	3	0.5	0.5	3	0.5	0.5	3
MSZ590-1	1.0	0.7	1.0	3	1.3	1.5	3	1.0	1.0	3
Vicki	-	0.7	1.0	3						
MSEE025-1	-	0.8	1.0	2						
Lamoka	**1.4**	**0.8**	**1.0**	**3**	**1.5**	**2.0**	**3**	**2.0**	**2.5**	**3**
MSAA101-1RR	0.7	0.8	1.0	3	0.8	1.5	3	0.5	0.5	3
MSAA498-18	-	0.8	1.0	3						
MSBB020-8	0.8*	0.8	1.0	3	0.8	1.0	2			
MSBB351-1	-	0.8	1.5	3						
MSBB610-13	-	0.8	1.0	3						
MSBB625-2	-	0.8	1.0	3						
MSBB626-11	-	0.8	1.5	3						
MSEE074-2	-	0.8	1.0	3						
MSEE157-1	-	0.8	1.0	3						
MSEE180-3P	-	0.8	1.0	3						
MST252-1Y	1.3	0.8	1.0	3	1.7	2.0	3	1.5	1.5	3
MSZ427-1R	0.9	0.8	1.0	3	0.7	1.5	3	1.2	1.5	3
Pike	**1.4**	**0.8**	**1.0**	**3**	**1.5**	**2.0**	**3**	**1.8**	**2.0**	**6**
Umatilla Russet	-	0.8	1.5	3						
MSBB166-1	-	1.0	1.5	3						
MSBB651-4	-	1.0	1.0	3						
MSEE031-3	-	1.0	1.0	3						
MSEE063-6	-	1.0	1.0	3						
MSEE101-2	-	1.0	1.5	3						
MSEE115-1	-	1.0	1.5	3						
MSEE163-1	-	1.0	1.0	3						
MSEE171-2	-	1.0	1.5	3						
MSEE247-6WP	-	1.0	1.5	3						
MSX324-1P	1.1	1.0	1.0	3	1.3	1.5	3	0.8	1.0	3
MSY156-2	-	1.0	1.5	3						
MSY507-2	-	1.0	1.0	2						
MSZ219-14^{PVYR}	0.9	1.0	1.0	3	0.8	1.5	3	0.8	1.0	3
MSZ242-07	1.3	1.0	1.5	3	1.3	1.5	3	1.5	2.0	3
MSZ248-10	-	1.0	1.5	3						
MSZ268-1Y	-	1.0	1.0	3						
MSZ443-1PP	1.6	1.0	1.5	3	1.5	2.0	3	2.2	2.5	3
MSAA241-1	-	1.2	1.5	3						
MSAA260-3	-	1.2	1.5	3						
MSBB179-1	-	1.2	1.5	3						
MSBB308-2P	1.2*	1.2	2.0	3	1.2	1.5	3			
MSBB371-1YSpl	1.5*	1.2	2.0	3	1.8	2.0	3			
MSBB614-10	-	1.2	1.5	3						

2018-20 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2020 RATING	2020 WORST	2020 N	2019 RATING	2019 WORST	2019 N	2018 RATING	2018 WORST	2018 N
MSBB634-8	1.3*	1.2	1.5	3	1.5	2.0	3			
MSCC266-1	-	1.2	1.5	3						
MSCC725-232	-	1.2	1.5	3						
MSDD497-B	-	1.2	1.5	3						
MSEE052-5	-	1.2	1.5	3						
MSEE141-2	-	1.2	2.0	3						
MSEE151-2	-	1.2	1.5	3						
MSW163-3	-	1.2	1.5	3						
MSX324-2R	1.4	1.2	1.5	3	1.2	2.0	3	2.0	2.0	3
MSZ109-8PP	-	1.2	1.5	3						
MSZ219-13^{PVYR}	0.9	1.2	2.0	3	0.7	1.0	3	0.8	1.0	3
MSZ242-13	1.2	1.2	1.5	3	1.2	1.5	3	1.3	1.5	3
MSZ413-6P	1.4	1.2	1.5	3	1.8	2.0	3	1.3	2.0	3
MSZ416-8RY	1.1*	1.2	1.5	3	1.0	1.5	3			
Blackberry (MSZ109-10PP)	1.2	1.3	1.5	3	1.2	1.5	3	1.2	1.5	3
Huron Chipper (MSW485-2)	1.7	1.3	1.5	3	2.0	2.5	3	1.7	2.0	3
MSAA076-6	1.5	1.3	1.5	3	1.8	2.5	3	1.3	1.5	3
MSAA100-1	-	1.3	1.5	3						
MSAA161-4RY	1.2	1.3	2.5	3	1.3	1.5	3	0.8	1.0	3
MSAA182-3R	1.5	1.3	1.5	3	1.7	2.0	3	1.5	2.0	3
MSAA328-4	-	1.3	1.5	3						
MSBB058-1	-	1.3	1.5	3						
MSBB079-2	1.3*	1.3	2.0	3	1.3	1.5	3			
MSBB637-6	-	1.3	1.5	3						
MSEE010-3	-	1.3	1.5	3						
MSEE149-1	-	1.3	1.5	3						
MSEE149-2	-	1.3	2.0	3						
MSEE169-1	-	1.3	1.5	3						
MSEE190-1	-	1.3	1.5	3						
MSV443-1PP	1.4	1.3	2.0	3	1.3	1.5	3	1.5	2.0	3
MSX225-2	1.4	1.3	1.5	3	1.3	1.5	2	1.5	2.0	3
MSX526-1	1.2*	1.3	2.0	3	1.2	1.5	3			
MSY111-1	-	1.3	1.5	3						
MSZ219-46	-	1.3	1.5	3						
MSZ242-09	1.2	1.3	2.0	3	1.5	1.5	2	0.7	1.0	3
Petoskey (MSV030-4)	1.3*	1.3	1.5	3	1.3	2.0	3			
Isle Royale (MSX569-1R)	1.7	1.5	2.5	3	2.3	3.5	3	1.3	2.0	3
MSAA252-7	-	1.5	2.0	3						
MSAA513-1	-	1.5	2.0	3						
MSAA570-3	-	1.5	2.0	3						
MSBB213-1Spl	1.4*	1.5	1.5	3	1.3	1.5	2			
MSBB364-1	1.4*	1.5	2.0	3	1.3	1.5	3			
MSBB617-2	-	1.5	1.5	3						
MSBB618-9	-	1.5	2.0	3						
MSCC314-1	-	1.5	2.5	3						
MSCC542-1P	-	1.5	2.0	3						
MSEE085-1	-	1.5	2.0	3						
MSEE102-1	-	1.5	2.0	2						
MSEE130-1	-	1.5	2.0	3						
MSEE255-1	-	1.5	1.5	3						
MSV179-1	1.5	1.5	2.5	3	1.5	2.0	2	1.5	1.5	1

2018-20 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2020 RATING	2020 WORST	2020 N	2019 RATING	2019 WORST	2019 N	2018 RATING	2018 WORST	2018 N
MSX042-3	-	1.5	1.5	3						
MSX398-2	1.6	1.5	2.5	2	1.5	2.5	3	1.8	2.0	3
MSZ052-14	1.4	1.5	1.5	3	1.3	1.5	3	1.5	2.0	3
MSZ120-4	1.6	1.5	2.0	3	1.7	2.0	3	1.7	2.0	3
MSZ513-2	1.5	1.5	2.0	3	1.7	2.0	3	1.3	2.0	3
MSZ615-2	1.4	1.5	1.5	3	1.2	1.5	3	1.7	2.0	3
Plover Russet	-	1.5	2.0	2						
Vanguard Russet (TX08352-5Rus)	1.6	1.5	2.0	3	1.3	1.5	3	1.8	2.5	3
Mackinaw (MSX540-4)[PVYR, LBR]	1.7	1.7	2.0	3	1.5	2.0	3	1.8	2.0	3
MSAA127-7PP	1.9	1.7	2.5	3	1.8	2.0	3	2.2	2.5	3
MSAA174-1	1.6	1.7	2.0	3	1.5	1.5	3	1.5	2.0	3
MSAA196-1	-	1.7	2.5	3						
MSAA313-1	-	1.7	2.5	3						
MSAA342-2	1.8*	1.7	2.0	3	1.8	2.5	3			
MSAA373-3	-	1.7	2.0	3						
MSAA706-7PP	1.6	1.7	2.5	3	1.3	1.5	3	1.8	3.0	3
MSBB190-1	1.8*	1.7	2.0	3	2.0	2.0	3			
MSBB250-1PP	-	1.7	2.0	3						
MSBB252-1PP	-	1.7	3.5	3						
MSBB305-2Spl	1.6*	1.7	3.0	3	1.5	1.5	2			
MSBB623-12	-	1.7	2.5	3						
MSBB635-14	1.4*	1.7	2.0	3	1.2	1.5	3			
MSCC058-1	-	1.7	2.0	3						
MSCC282-2PP	-	1.7	2.0	3						
MSCC287-1	-	1.7	2.0	3						
MSCC614-1RYSPL	-	1.7	2.5	3						
MSEE022-8	-	1.7	2.5	3						
MSEE033-2	-	1.7	2.0	3						
MSEE131-1	-	1.7	2.0	3						
MSEE154-1	-	1.7	2.5	3						
MSEE187-1	-	1.7	2.0	3						
MSV093-1Y	1.5	1.7	2.0	3	1.2	1.5	3	1.7	2.0	3
MSV498-1	1.6	1.7	2.0	3	1.2	2.0	3	1.8	2.0	3
MSX137-6	-	1.7	2.0	3						
MSX472-2	1.4	1.7	2.0	3	1.3	1.5	2	1.3	2.0	3
MSZ109-7PP	1.7	1.7	2.5	3	1.5	2.0	3	1.8	2.0	3
MSZ248-02	-	1.7	2.0	3						
Queen Anne	1.8	1.8	2.5	2	1.8	2.0	3	1.7	2.0	3
Superior	1.7*	1.8	2.5	2	1.7	2.0	3			
Dakota Russet	-	1.8	2.5	3						
MSAA085-1Y	1.8	1.8	2.0	3	1.8	2.0	3	1.8	2.0	3
MSAA166-2P	-	1.8	2.5	3						
MSBB017-1	-	1.8	2.5	3						
MSBB238-1RY	1.3*	1.8	2.0	3	0.8	1.0	3			
MSCC447-1WR	-	1.8	2.0	3						
MSCC576-1	-	1.8	2.0	3						
MSDD530-1	-	1.8	2.5	3						
MSEE038-1	-	1.8	2.0	3						
MSEE137-3	-	1.8	2.0	3						
MSEE142-1	-	1.8	2.5	3						
MSW164-2	-	1.8	2.5	3						

2018-20 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2020 RATING	2020 WORST	2020 N	2019 RATING	2019 WORST	2019 N	2018 RATING	2018 WORST	2018 N
MSX050-1	-	1.8	2.0	3						
MSX245-2Y	1.9	1.8	2.0	3	2.0	2.0	3	2.0	2.0	3
MSX443-3P	2.1	1.8	2.5	3	2.0	2.5	3	2.5	4.0	3
MSZ063-2	-	1.8	2.5	3						
MSZ107-6PP	2.0	1.8	2.0	3	2.3	2.5	2	2.0	2.5	3
MSZ436-2SPL	1.8	1.8	2.0	3	1.8	2.0	3	1.8	2.0	3
MSZ551-1	1.8*	1.8	2.5	3	1.8	2.0	3			
Atlantic	**2.5**	**1.9**	**3.0**	**6**	**2.5**	**2.5**	**3**	**3.0**	**3.5**	**3**
MSBB272-1P	-	2.0	2.0	3						
MSBB621-3	1.8*	2.0	2.5	3	1.7	2.0	3			
MSCC168-1	-	2.0	2.0	3						
MSCC300-1	-	2.0	2.0	3						
MSCC302-1	-	2.0	2.5	3						
MSCC512-1PP	-	2.0	2.0	3						
MSCC515-2Y	-	2.0	2.5	3						
MSEE018-2	-	2.0	2.0	3						
MSEE055-1R	-	2.0	2.5	2						
MSEE136-1	-	2.0	2.0	3						
MSEE142-2	-	2.0	2.0	3						
MSW476-4R	-	2.0	2.0	3						
MSZ194-2	-	2.0	2.5	3						
MSZ427-3R	1.8	2.0	2.5	3	1.3	2.0	3	2.0	2.5	3
Paroli	-	2.0	2.5	3						
Sunset Russet	-	2.0	2.5	3						
Golden Globe	-	2.2	3.0	3						
MSAA120-1	-	2.2	2.5	3						
MSAA232-4	-	2.2	2.5	3						
MSX156-1Y	2.3	2.2	2.5	3	2.7	3.0	3	2.1	2.5	5
A08433-4sto	-	2.3	3.5	3						
Alverstone	-	2.3	3.5	3						
Fenway Red	-	2.3	3.0	3						
Melody	-	2.3	2.5	3						
MSAA217-3	-	2.3	3.0	3						
MSAA275-3	-	2.3	3.0	3						
MSBB107-1	2.2*	2.3	2.5	3	2.2	2.5	3			
MSBB270-1YSpl	2.1*	2.3	2.5	3	1.8	2.5	3			
MSW038-4Y	-	2.3	2.5	3						
Snowden	**2.7**	**2.4**	**3.5**	**6**	**2.8**	**3.5**	**6**	**3.0**	**3.5**	**3**
Allora	-	2.5	2.5	3						
Manistee	**2.6**	**2.5**	**3.0**	**3**	**3.0**	**3.5**	**3**	**2.2**	**2.5**	**3**
MSBB611-3	-	2.5	3.5	3						
Russet Norkotah	**2.5**	**2.5**	**3.0**	**3**	**2.2**	**3.0**	**3**	**2.8**	**4.0**	**3**
Yukon Gold	**2.7**	**2.5**	**2.5**	**1**	**3.0**	**3.5**	**6**	**2.6**	**3.5**	**6**
CO09205-2Rus	-	2.7	3.5	3						
MSEE151-3	-	2.7	3.0	3						
MSRM#2	-	2.7	3.5	3						
MSX193-1Y	2.3*	2.7	3.0	3	2.0	2.5	2			
MSX293-1Y	-	2.7	3.0	3						
Reba	**2.6**	**2.7**	**3.0**	**3**	**2.5**	**2.5**	**2**	**2.5**	**2.5**	**3**
Michigan Purple	-	2.8	3.0	2						
CO99076-6R	-	2.8	3.5	3						

Table 7

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2018-20 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2020 RATING	2020 WORST	2020 N	2019 RATING	2019 WORST	2019 N	2018 RATING	2018 WORST	2018 N
Constance	-	2.8	3.0	3						
MSAA157-2PY	2.8	2.8	4.0	3	3.3	3.5	3	2.3	2.5	3
MSEE202-4	-	2.8	3.5	3						
MSX497-6^{LBR}	2.7	2.8	3.5	3	2.2	3.0	3	3.0	3.5	3
Nixie	-	2.8	3.0	3						
Jacqueline Lee	-	3.0	3.0	2						
MSBB719-1	2.6*	3.0	3.5	3	2.2	2.5	3			
A09086-1LB	-	3.2	3.5	3						

SCAB DISEASE RATING: MSU Scab Nursery plot rating of 0-5; 0: No Infection; 1: Low Infection <5%, no pitted leisions; 3: Intermediate >20%, some pitted leisions (Susceptible, as commonly seen on Atlantic); 5: Highly Susceptible, >75% coverage and severe pitted leisions.
N = Number of replications.
*2-Year Average.

Table 8

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

2020 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER, MI

LINE	2020 RATING	LINE	2020 RATING
Sorted by ascending 2020 Rating:			
MSCC248-2	0.5	MSEE074-01	1.0
MSCC282-3RR	0.5	MSEE085-01	1.0
MSCC300-1	0.5	MSEE101-02	1.0
MSCC376-1	0.5	MSEE102-01	1.0
MSCC542-1P	0.5	MSEE136-01	1.0
MSCC553-1R	0.5	MSEE149-01	1.0
MSEE025-01	0.5	MSEE157-01	1.0
MSEE054-20	0.5	MSEE163-01	1.0
MSEE074-02	0.5	MSEE169-01	1.0
MSFF018-1	0.5	MSEE187-01	1.0
MSFF032-4	0.5	MSEE199-01	1.0
MSFF037-17	0.5	MSEE204-10	1.0
MSFF044-1	0.5	MSEE204-13	1.0
MSFF061-1	0.5	MSEE255-01	1.0
MSFF073-03	0.5	MSFF006-01	1.0
MSFF111-1	0.5	MSFF017-1	1.0
MSFF142-1P	0.5	MSFF031-06	1.0
MSFF142-2SPL	0.5	MSFF033-10	1.0
MSFF145-1P	0.5	MSFF035-3	1.0
MSFF193-3	0.5	MSFF043-04	1.0
MSFF198-03	0.5	MSFF043-10	1.0
MSFF198-13PY	0.5	MSFF056-1Y	1.0
MSFF223-1RY	0.5	MSFF067-1	1.0
MSFF274-2	0.5	MSFF073-07	1.0
MSFF296-01	0.5	MSFF120-1	1.0
MSFF316-1R	0.5	MSFF131-1SPL	1.0
MSFF321-1	0.5	MSFF134-2RR	1.0
MSFF344-3RY	0.5	MSFF148-1PP	1.0
MSSCC614-01RY	0.5	MSFF171-1	1.0
MSCC009-1	1.0	MSFF178-1	1.0
MSCC129-02	1.0	MSFF211-02	1.0
MSCC168-1	1.0	MSFF234-1R	1.0
MSCC256-2	1.0	MSFF271-3	1.0
MSCC374-1Y	1.0	MSFF277-1	1.0
MSCC409-1	1.0	MSFF283-1	1.0
MSEE022-08	1.0	MSFF297-1	1.0
MSEE031-03	1.0	MSFF303-03	1.0
MSEE035-05	1.0	MSFF316-1	1.0
MSEE049-07	1.0	MSFF323-1RY	1.0
MSEE057-13	1.0	MSFF331-2RR	1.0
MSEE063-06	1.0	MSFF334-1PINTORR	1.0

Table 8

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

2020 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER, MI

LINE	2020 RATING	LINE	2020 RATING
Sorted by ascending 2020 Rating:			
MSFF338-01PP	1.0	MSFF145-2R	1.5
MSFF351-1RR	1.0	MSFF147-1RR	1.5
MSFF079-16	1.3	MSFF149-1	1.5
MSCC248-3	1.5	MSFF189-1Y	1.5
MSCC266-1	1.5	MSFF193-2	1.5
MSCC287-1	1.5	MSFF217-1	1.5
MSCC576-1	1.5	MSFF244-1PP	1.5
MSDD050-B	1.5	MSFF247-2Y	1.5
MSDD085-13	1.5	MSFF261-1	1.5
MSEE002-01	1.5	MSFF271-1	1.5
MSEE002-03	1.5	MSFF292-1	1.5
MSEE016-10	1.5	MSFF305-1RY	1.5
MSEE033-02	1.5	MSFF320-3	1.5
MSEE035-04	1.5	MSFF335-02RR	1.5
MSEE038-01	1.5	MSFF345-1R	1.5
MSEE052-05	1.5	MSFF050-1	1.8
MSEE115-01	1.5	MSCC058-1	2.0
MSEE130-01	1.5	MSCC081-1	2.0
MSEE151-02	1.5	MSCC084-1	2.0
MSEE182-03	1.5	MSCC246-07	2.0
MSEE190-01	1.5	MSCC282-2PP	2.0
MSEE247-6WP	1.5	MSCC302-1	2.0
MSFF011-1	1.5	MSCC314-1	2.0
MSFF013-1	1.5	MSCC515-2Y	2.0
MSFF022-2	1.5	MSCC724-014	2.0
MSFF025-1	1.5	MSEE010-03	2.0
MSFF030-1WR	1.5	MSEE131-01	2.0
MSFF031-03	1.5	MSEE137-03	2.0
MSFF031-16	1.5	MSEE141-02	2.0
MSFF034-07	1.5	MSEE142-02	2.0
MSFF035-2	1.5	MSEE149-02	2.0
MSFF035-4	1.5	MSEE151-03	2.0
MSFF055-01Y	1.5	MSEE154-01	2.0
MSFF058-1	1.5	MSEE171-02	2.0
MSFF069-1Y	1.5	MSEE180-3P	2.0
MSFF072-4	1.5	MSEE207-02	2.0
MSFF091-01	1.5	MSFF003-1	2.0
MSFF120-02Y	1.5	MSFF007-2	2.0
MSFF140-1WP	1.5	MSFF008-1	2.0
MSFF143-1PW	1.5	MSFF009-01	2.0
MSFF143-2PW	1.5	MSFF014-01	2.0

Table 8

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

2020 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER, MI

LINE	2020 RATING	LINE	2020 RATING
Sorted by ascending 2020 Rating:			
MSFF015-01	2.0	MSDD530-01	2.5
MSFF017-2	2.0	MSEE055-1R	2.5
MSFF017-3	2.0	MSEE191-03	2.5
MSFF022-1	2.0	MSEE202-04	2.5
MSFF022-4	2.0	MSFF016-01	2.5
MSFF023-01	2.0	MSFF017-4	2.5
MSFF034-04P	2.0	MSFF022-1	2.5
MSFF036-01	2.0	MSFF022-3	2.5
MSFF037-06	2.0	MSFF029-10	2.5
MSFF037-07	2.0	MSFF038-4	2.5
MSFF038-3	2.0	MSFF075-1	2.5
MSFF054-1	2.0	MSFF098-04	2.5
MSFF072-1Y	2.0	MSFF106-1	2.5
MSFF075-2	2.0	MSFF114-1	2.5
MSFF077-4	2.0	MSFF163-2	2.5
MSFF094-4	2.0	MSFF200-04PYSPL	2.5
MSFF097-6	2.0	MSFF210-1	2.5
MSFF097-7	2.0	MSFF226-1RY	2.5
MSFF097-8	2.0	MSFF230-1	2.5
MSFF109-01	2.0	MSFF247-1	2.5
MSFF117-02	2.0	MSFF263-1PP	2.5
MSFF117-1	2.0	MSFF286-1	2.5
MSFF127-1WP	2.0	MSFF286-2	2.5
MSFF134-1PP	2.0	MSFF304-2R	2.5
MSFF138-1R	2.0	MSFF305-2RY	2.5
MSFF142-3SPL	2.0	MSFF305-4RY	2.5
MSFF143-3P	2.0	MSFF316-6Y	2.5
MSFF182-1R	2.0	MSFF322-1	2.5
MSFF206-1	2.0	MSFF331-1PP	2.5
MSFF206-2	2.0	MSFF335-1RR	2.5
MSFF223-01PY	2.0	MSFF346-1RY	2.5
MSFF230-01PY	2.0	MSFF007-01	3.0
MSFF267-1	2.0	MSFF034-01	3.0
MSFF267-2	2.0	MSFF086-2	3.0
MSFF271-02	2.0	MSFF168-1	3.0
MSFF274-1	2.0	MSFF203-1	3.0
MSFF321-2	2.0	MSFF219-1Y	3.0
MSFF335-3PINTO	2.0	MSFF243-1RR	3.0
MSFF351-2PP	2.0	MSFF321-03	3.0
MSFF354-1RR	2.0	MSFF336-1PP	3.5
MSCC512-1PP	2.5	MSFF138-2P	4.0

Table of Contents

2020 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

ENTRY	SP GR	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
RUSSET TRIAL									
A09086-1LB	1.077	18	1	0	0	0	0	95	0.1
Russet Norkotah/Texas 112	**1.064**	**23**	**2**	**0**	**0**	**0**	**0**	**92**	**0.1**
A08433-4Sto	1.072	21	3	1	0	0	0	84	0.2
Goldrush Russet	**1.061**	**19**	**4**	**1**	**1**	**0**	**0**	**76**	**0.4**
Alverstone Russet (HZPC)	1.074	17	6	2	0	0	0	68	0.4
Vanguard Russet	1.058	19	1	3	0	1	0	79	0.5
AO06191-1	1.079	15	9	0	1	0	0	60	0.5
SunSet Russet (TX13590-9Rus)	1.077	13	7	4	1	0	0	52	0.7
Dakota Russet	1.081	11	7	7	0	0	0	44	0.8
Plover Russet	1.066	8	10	4	2	0	0	33	1.0
CO09205-2Rus	1.070	6	9	7	1	0	0	26	1.1
Umatilla Russet	1.084	7	6	5	6	1	0	28	1.5
ADAPTATION TRIAL, CHIP-PROCESSING LINES									
MSY156-2	1.084	15	5	0	0	0	0	75	0.3
MSBB614-10	1.078	7	2	1	0	0	0	70	0.4
MSAA232-4	1.081	14	3	3	0	0	0	70	0.5
Manistee	1.079	16	4	3	1	0	0	67	0.5
MSBB617-2	1.083	13	4	2	1	0	0	65	0.6
MSZ063-2	1.084	11	9	4	1	0	0	44	0.8
Huron Chipper	1.083	8	6	6	0	0	0	40	0.9
MSZ242-09	1.089	5	12	2	1	0	0	25	1.0
Petoskey	1.092	9	6	4	0	0	1	45	1.0
MSX245-2Y	1.081	7	8	4	0	1	0	35	1.0
Mackinaw	1.090	5	8	5	1	1	0	25	1.3
MSBB610-13	1.083	6	9	2	1	1	1	30	1.3
MSBB635-14	1.081	9	4	1	5	1	0	45	1.3
MSZ219-01	1.080	5	7	6	2	0	0	25	1.3
MSX526-1	1.083	4	6	9	1	0	0	20	1.4
MSZ242-07	1.098	7	5	2	4	0	1	37	1.4
Atlantic	**1.085**	**3**	**5**	**6**	**2**	**3**	**0**	**16**	**1.8**
MSAA260-3	1.080	4	3	4	5	3	0	21	2.0
Snowden	**1.084**	**1**	**5**	**7**	**3**	**3**	**1**	**5**	**2.3**
MSAA498-18	1.086	2	7	4	4	4	2	8	2.3
MSAA217-3	1.091	1	4	9	2	2	2	5	2.3
MSBB079-2	1.083	2	6	4	3	2	3	10	2.3
MSCC058-1	1.086	1	3	7	4	5	0	5	2.5
MSZ120-04	1.082	1	2	9	5	1	2	5	2.5
Lamoka	**1.082**	**1**	**3**	**5**	**6**	**4**	**1**	**5**	**2.6**
MSAA076-6	1.092	0	3	5	9	1	2	0	2.7
MSAA328-4	1.081	1	2	4	7	5	1	5	2.8
MSZ242-13	1.099	0	3	7	3	5	2	0	2.8
MSBB626-11	1.085	2	1	5	7	3	4	7	2.9
MSZ219-13	1.086	0	3	7	7	5	3	0	2.9
MSAA513-1	1.078	0	2	6	5	5	2	0	3.0
MSCC168-1	1.076	2	1	2	5	5	5	10	3.3
MSBB058-1	1.093	0	0	6	5	3	6	0	3.5
MSBB611-3	1.086	0	0	3	8	4	5	0	3.6
MSAA252-7	1.083	0	0	3	8	3	6	0	3.6

SIMULATED BRUISE SAMPLES*

ENTRY	SP GR	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
ADAPTATION TRIAL, TABLESTOCK LINES									
Blackberry	1.066	20	0	0	0	0	0	100	0.0
Queen Anne	1.061	19	1	0	0	0	0	95	0.1
MSZ436-2SPL	1.054	19	1	0	0	0	0	95	0.1
MSCC515-2Y	1.066	18	1	0	0	0	0	95	0.1
MSAA174-1	1.056	17	3	0	0	0	0	85	0.2
MSV443-1PP	1.062	17	3	0	0	0	0	85	0.2
MSX293-1Y	1.066	17	3	0	0	0	0	85	0.2
MSBB351-1	1.059	14	5	0	0	0	0	74	0.3
MSZ109-8PP	1.063	14	5	0	0	0	0	74	0.3
MSX137-6	1.075	18	2	2	0	0	0	82	0.3
MSAA196-1	1.063	14	6	0	0	0	0	70	0.3
MSX193-1Y	1.073	14	6	0	0	0	0	70	0.3
MSV093-1Y	1.067	14	5	1	0	0	0	70	0.4
MSZ268-1Y	1.072	14	5	1	0	0	0	70	0.4
MSZ427-3R	1.055	14	5	1	0	0	0	70	0.4
MSV179-1	1.069	15	3	1	1	0	0	75	0.4
MSX324-1P	1.076	14	4	1	1	0	0	70	0.5
MSCC300-1	1.073	13	4	3	0	0	0	65	0.5
Superior	**1.056**	**12**	**6**	**2**	**0**	**0**	**0**	**60**	**0.5**
Yukon Gold	**1.064**	**13**	**5**	**2**	**1**	**0**	**0**	**63**	**0.5**
MSZ615-2	1.066	14	4	3	0	1	0	68	0.5
MST252-1Y	1.066	12	5	2	1	0	0	60	0.6
MSX324-2R	1.066	12	5	2	1	0	0	60	0.6
MSY111-1	1.089	12	4	4	0	0	0	60	0.6
MSW038-4Y	1.069	15	0	3	1	1	0	75	0.7
MSZ416-8RY	1.056	11	5	2	2	0	0	55	0.8
MSW476-4R	1.073	10	3	5	1	0	0	53	0.8
MSBB213-1SPL	1.078	11	5	1	2	1	0	55	0.9
MSZ590-1	1.061	7	9	1	2	0	1	35	1.1
MSAA120-1	1.071	7	6	4	3	0	0	35	1.2
MSX156-1Y	1.068	5	6	3	3	2	1	25	1.7
MSY507-2	1.076	5	8	2	1	1	3	25	1.7
MSCC302-1	1.076	4	3	8	3	1	1	20	1.9
MSZ551-1	1.075	4	3	6	5	2	0	20	1.9
PRELIMINARY TRIAL, CHIP-PROCESSING LINES									
MSEE022-8	1.077	20	0	0	0	0	0	100	0.0
MSEE052-5	1.070	25	0	0	0	0	0	100	0.0
MSDD497-B	1.056	20	1	0	0	0	0	95	0.0
MSBB107-1	1.068	19	1	0	0	0	0	95	0.1
MSBB634-8	1.071	18	2	0	0	0	0	90	0.1
MSCC725-232	1.068	18	2	0	0	0	0	90	0.1
MSEE038-1	1.057	17	3	0	0	0	0	85	0.2
MSDD530-1	1.065	17	1	1	0	0	0	89	0.2
MSEE137-3	1.077	22	2	1	0	0	0	88	0.2
MSAA085-1	1.071	16	4	0	0	0	0	80	0.2
MSEE063-6	1.076	16	4	0	0	0	0	80	0.2
MSEE154-1	1.059	20	5	0	0	0	0	80	0.2
MSEE180-3P	1.076	16	4	0	0	0	0	80	0.2
MSEE010-3	1.070	16	3	1	0	0	0	80	0.3
Pike	**1.075**	**15**	**5**	**0**	**0**	**0**	**0**	**75**	**0.3**
MSEE151-3	1.078	16	2	0	1	0	0	84	0.3

SIMULATED BRUISE SAMPLES*

ENTRY	SP GR	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSBB623-12	1.070	15	3	2	0	0	0	75	0.4
MSEE074-2	1.073	15	3	2	0	0	0	75	0.4
MSEE131-1	1.077	14	5	1	0	0	0	70	0.4
MSBB190-1	1.068	13	5	1	0	0	0	68	0.4
MSEE157-1	1.077	12	8	0	0	0	0	60	0.4
MSBB651-4	1.071	18	5	0	2	0	0	72	0.4
MSZ219-46	1.074	13	3	3	0	0	0	68	0.5
MSEE033-2	1.071	13	6	2	0	0	0	62	0.5
MSEE190-1	1.073	14	2	3	1	0	0	70	0.6
MSEE141-2	1.079	11	5	3	0	0	0	58	0.6
MSEE031-3	1.078	12	5	2	1	0	0	60	0.6
MSX042-3	1.079	10	7	1	1	0	0	53	0.6
MSEE025-1	1.076	10	8	0	1	1	0	50	0.8
MSEE207-02	1.075	9	7	4	0	0	0	45	0.8
MSAA241-1	1.077	10	7	1	1	0	1	50	0.9
MSBB020-8	1.076	8	7	5	0	0	0	40	0.9
MSEE136-1	1.072	11	8	5	0	1	0	44	0.9
MSBB621-3	1.069	6	12	1	0	1	0	30	0.9
MSBB625-2	1.089	7	9	5	1	0	0	32	1.0
MSBB166-1	1.071	9	6	4	3	0	0	41	1.0
MSBB179-1	1.072	9	4	3	4	0	0	45	1.1
MSBB017-1	1.079	6	7	5	2	0	0	30	1.2
Atlantic	**1.082**	**5**	**10**	**2**	**2**	**1**	**0**	**25**	**1.2**
MSEE149-2	1.084	10	4	2	2	2	1	49	1.3
MSEE101-2	1.083	4	9	5	1	0	1	20	1.4
MSEE151-2	1.075	7	2	7	4	0	0	35	1.4
Snowden	**1.077**	**5**	**5**	**6**	**4**	**0**	**0**	**25**	**1.5**
MSEE149-1	1.075	9	3	1	3	3	1	45	1.6
MSEE018-2	1.092	4	4	3	6	2	1	20	2.1
MSEE171-2	1.082	1	1	7	5	3	3	5	2.9
PRELIMINARY TRIAL, TABLESTOCK LINES									
Paroli	1.054	20	0	0	0	0	0	100	0.0
MSAA342-2	1.065	19	1	0	0	0	0	95	0.1
MSCC314-1	1.065	19	1	0	0	0	0	95	0.1
Nixie	1.065	18	2	0	0	0	0	90	0.1
Golden Globe	1.060	18	2	1	0	0	0	86	0.2
MSCC724-14	1.066	15	5	0	0	0	0	75	0.3
MSBB305-2SPL	1.060	15	4	1	0	0	0	75	0.3
Allora	1.064	17	4	4	0	0	0	68	0.5
Reba	**1.063**	**14**	**3**	**2**	**1**	**0**	**0**	**70**	**0.5**
MSBB371-1YSPL	1.070	9	10	0	0	0	0	47	0.5
Constance	1.060	8	11	1	0	0	0	40	0.7
MSEE085-1	1.075	10	8	1	1	0	0	50	0.7
Melody	1.067	8	9	3	0	0	0	40	0.8
MSEE199-1	1.073	9	5	5	1	0	0	45	0.9
MSEE255-1	1.073	9	4	2	2	2	1	45	1.4
Jacqueline Lee	1.081	2	6	8	3	0	1	10	1.8
PRELIMINARY TRIAL, PIGMENTED LINES									
Dark Red Norland	**1.052**	**19**	**1**	**0**	**0**	**0**	**0**	**95**	**0.1**
MSZ427-1R mini	1.057	19	1	0	0	0	0	95	0.1
MSBB308-2P	1.056	18	2	0	0	0	0	90	0.1
MSEE247-6WP	1.060	18	2	0	0	0	0	90	0.1

SIMULATED BRUISE SAMPLES*

ENTRY	SP GR	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSX443-3P mini	1.074	18	2	0	0	0	0	90	0.1
MSCC542-1P	1.054	17	2	0	0	0	0	89	0.1
Vicki (HZPC)	1.065	18	1	0	0	0	0	95	0.1
MSAA101-1RR	1.081	17	3	0	0	0	0	85	0.2
MSBB250-1PP	1.078	17	3	0	0	0	0	85	0.2
MSCC614-1RYSPL	1.079	18	1	1	0	0	0	90	0.2
MSZ107-6PP	1.075	14	4	0	0	0	0	78	0.2
MSAA157-2PY	1.067	16	3	1	0	0	0	80	0.3
MSAA706-7PP	1.065	16	3	1	0	0	0	80	0.3
MSAA127-7PP	1.053	12	8	0	0	0	0	60	0.4
Fenway Red	1.072	14	3	2	1	0	0	70	0.5
CO99076-6R	1.067	10	6	4	0	0	0	50	0.7
USPB/SFA TRIAL CHECK SAMPLES (Not bruised)									
MSZ063-2	1.080	21	3	1	0	0	0	84	0.2
Lamoka	1.082	14	10	1	0	0	0	56	0.5
CO11023-9W	1.066	15	7	2	1	0	0	60	0.6
Petoskey	1.090	13	7	5	0	0	0	52	0.7
Snowden	1.081	10	12	2	1	0	0	40	0.8
CO11023-2W	1.088	10	10	3	2	0	0	40	0.9
MSZ242-13	1.096	10	7	7	1	0	0	40	1.0
B2869-29	1.083	8	11	4	2	0	0	32	1.0
ND7519-1	1.085	6	13	6	0	0	0	24	1.0
MSW474-1	1.083	10	5	6	4	0	0	40	1.2
NY163	1.081	7	5	10	2	1	0	28	1.4
USPB/SFA TRIAL BRUISE SAMPLES									
MSZ063-2	1.080	5	11	8	1	0	0	20	1.2
ND7519-1	1.085	3	13	6	3	0	0	12	1.4
Lamoka	1.082	3	8	6	8	0	0	12	1.8
NY163	1.081	3	4	8	6	4	0	12	2.2
CO11023-9W	1.066	5	1	8	4	4	3	20	2.4
CO11023-2W	1.088	0	5	8	6	5	1	0	2.6
B2869-29	1.083	2	3	7	3	4	6	8	2.9
Snowden	1.081	0	1	5	9	6	4	0	3.3
Petoskey	1.090	0	4	4	3	8	6	0	3.3
MSW474-1	1.083	0	0	3	9	7	6	0	3.6
MSZ242-13	1.096	0	0	5	5	7	8	0	3.7

* Selected A-size tuber samples were collected at harvest, held at 50 F at least 12 hours,
and placed in a six-sided plywood drum and rotated ten times to produce simulated bruising.
Samples were abrasive-peeled and scored 11/11 & 12/2020.
The table is presented in ascending order of average number of spots per tuber.

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2020 On-Farm Potato Variety Trials

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INTRODUCTION

Our main objectives for on-farm potato variety trials are to: 1) identify promising lines for further testing and evaluation, 2) conduct larger scale commercial agronomic and processing trials through multi-acre block plantings, and 3) use trial data to encourage the commercialization of new varieties in the state of Michigan. We share our results with growers, breeders, and processors across the country to aid in the development of new varieties. In 2020, we conducted 25 on-farm potato variety trials with 11 growers in eight counties.

Processing trial cooperators were: Crawford Farms, Inc. (Montcalm), Hampton Potato Growers (Bay), Lennard Ag. Co. (St. Joseph), Main Farms (Montcalm), Sandyland Farms (Montcalm), Verbrigghe Farms (Delta), and Walther Farms, Inc. (St. Joseph). We also conducted processing trials at the Michigan State University (MSU) Montcalm Research Center (Montcalm). The Potatoes USA/Snacking Nutrition and Convenience International (SNAC Int.) chip trial was conducted at Sandyland Farms (Montcalm).

Fresh market trial cooperators were: Crawford Farms, Inc. (Montcalm), Horkey Bros. (Monroe), Kitchen Farms, Inc. (Antrim), Lennard Ag. Co. (St. Clair), Verbrigghe Farms (Delta), and Walther Farms, Inc. (St. Joseph, Tuscola)

PROCEDURE

A. Processing Variety Trials

We evaluated 52 chip processing varieties in 2020. To evaluate selected processing lines, we used the following check varieties: Altantic, Lamoka, and Snowden. For all trials, we used 10” in-row seed spacing and 34” rows.

The majority of our processing trials were strip trials. These trials consisted of a single 75-100’ strip for each variety of which we harvested and graded a single 23-ft section. For each variety in the Walther Farms, Inc. trials, we planted three, 15-ft long rows and harvested the center row. We also conducted multi-acre block plantings of promising, non-commercialized trials at Sackett Potatoes, Sandyland Farms, Thorlund Bros., Verbrigghe Potato Farms, and Walther Farms. Agronomic production practices for these block plantings varied based on each grower’s production system.

B. Processing Variety Trials

We conducted the Potatoes USA/SNAC Int. Trial for Michigan at Sandyland Farms, LCC (Montcalm County). We planted 11 varieties in 300’ strips and harvested three, 23-ft sections of

row for each variety. Our check varieties were ‘Lamoka’ and ‘Snowden’. For more details on this trial, please reference the 2020 annual report published by Potatoes USA.

C. Fresh Market Trials

Within the fresh market trials, we evaluated 74 primary entries (this does not include entries from Potatoes USA/NFPT trial) which included: 37 russet, 28 red, 30 yellow, 4 novelty, and 11 round white types. To evaluate selected table-stock lines, we used the following check varieties:
Red: Dark Red Norland
Round White: Reba, Superior
Russet: Russet Norkotah, Russet Burbank, Silverton Russet
Yellow: Yukon Gold
We planted all trials with 34” wide rows and 10” in-row seed spacing.

We evaluated the majority of our fresh market trials as strip trials. These trials consisted of a single 60-100’ for each variety of which we harvested and graded a single 23-ft section. We planted the NFPT trial at Walther Farms, Inc. as single 15’ long strips and harvested the entire strip. 2020 was the second year conducting an early generation tablestock variety trial with red skin white flesh potato varieties. This trail was planted and harvested like the NFPT trial, and took place at Walther Farms, Inc. We planted Walther Farms, Inc. trials trial with three, 15-ft rows and harvested the middle row. We also conducted multi-acre block plantings of promising, non-commercialized trials at Crawford Farms and Lennard Ag. Co. Agronomic production practices for these block plantings varied based on each grower’s production system.

RESULTS

A. Processing Variety Trial Results

We recorded general descriptions, pedigrees, and scab ratings for all varieties tested in 2020 (Table 1) and evaluated these varieties based on yield, specific gravity, internal quality, common scab ratings, and maturity (Table 2). Below are six superior processing varieties from 2020.

NY165: This Cornell variety was evaluated at six locations in 2020, including the Box Bin trial. It had the seventh highest US#1 yield of 458 cwt/A and a total yield of 553 cwt/A. The size breakdown was 81% A sized tubers and 15% B sized tubers, average for the trial. It had medium netted skin, and a uniform attractive appearance. The specific gravity at the trial average of 1.079. Internal quality was good, with no tuber defects observed in 2020. It had a common scab rating of 1.2, lower than the trial average, and a stem end defect score of 0.6, lower than the trial average of 1.6. Off the farm chip color was 1.2.

MSW474-1: This Michigan State University variety was evaluated at five locations in 2020. It will be further evaluated in 2021 in storage trials only. It had an above average yield of 422 cwt/A US #1 tubers and a total yield of 540 cwt/A. This variety had 77% A sized tubers and 22% B sized tubers. It has a slightly higher specific gravity of 1.082 than the trial average. No internal defects were observed, and the common scab score was 1.2. This variety had a round, uniform type with medium netted skin. Some sticky stolons were observed in 2020, potentially corresponding to a later vine maturity of 3.8.

MSZ120-04: This variety had the third highest US#1 yield in the 2020 trials when evaluated at five locations. It had 89% US #1 tubers, 9% B sized tubers and a specific gravity of 1.081. This variety had four percent hollow heart and two percent brown center, both around the trial averages. It had a bright appearance, with thin skin and a round type. Off the farm chip color was at the trial average of 1.7, and stem end defect was below the trial average at 0.7. It had a full season vine maturity of 3.8.

NY163: This Cornell variety had some apical purple pigmentation, but it did not affect chip quality. It also had a round type with attractive waxy skin. It was evaluated at six locations in 2020 and will be further evaluated in 2021 to assess its potential as a cold chipper. It had an above average yield of 386 cwt/A US#1 tubers and 16% B sized tubers. Internal quality was good, with only two percent vascular discoloration observed. It had an earlier vine maturity of 2.1, below the trial average of 2.8. Off the farm chip quality was good with an average color of 1.3. The common scab rating of 1.6 was at the trial average.

COOR13270-2: This Colorado State University variety was evaluated at five locations in 2020. It had a total yield of 458 cwt/A and a US#1 yield of 377 cwt/A. The size profile was average for the trial with 81% US#1 tubers. The off the farm chip score was slightly darker than average with a score of 2.2, but chip quality was generally acceptable. Eight percent internal brown spot was observed in 2020, above the trial mean of two percent. There was more common scab observed than the trial average. The appearance was uniform and bright, with round tubers.

MSZ242-13: When it was evaluated at eight locations in 2020, this variety had a total yield of 429 cwt/A and a US#1 yield of 369 cwt/A. This trial had five percent oversize tubers, higher than the trial average of two percent. It had a very high specific gravity of 1.090 and six percent internal brown spot. Common scab was below average, with a rating of 1.2 across all trials. Vine maturity was later than average at 3.5. Tuber type was round to oval, with slight growth crack and sheep nose observed in 2020. It will be further evaluated in 2021 at multiple locations.

B. Potatoes USA/SNAC Int. Chip Trial

In 2020, we conducted the Potatoes USA / SNAC Int. Michigan chip trial at Sandyland Farms, LLC in Montcalm County. We compared yield, size distribution, and specific gravity of nine test varieties to Lamoka and Snowden (Table 3). We also evaluated at-harvest raw tuber quality (Table 4) and sent samples to Herr Foods, Inc. (Nottingham, PA) where potatoes were processed and scored for out of the field chip quality (Table 5). We assessed blackspot bruise susceptibility (Table 6) and pre-harvest panels for each variety (Tables 7A and B).

The varieties with the highest US#1 yields were MSZ242-13, NY163, and Petoskey, with yields ranging from 534 cwt/A to 516 cwt/A. MSZ242-13 also had the highest percent of US #1 tubers at 90%, while B2869-29 had the lowest at 53%. The average specific gravity of the trial was 1.083 (Table 3). CO11023-9W has the highest incidence of internal defects, with 50% hollow heart, 10% vascular discoloration, and 17% internal brown spot. B2869-29 had 17% brown center, much higher than the trial average of 2% (Table 4). Samples collected on October 12th were processed by Herr's Foods, Inc. on October 14th. NY163 was ranked first by Herr's and has a SFA color of 2 and 15.6% external defects. CO11023-2W was also ranked highly, with a SNAC color of 2 and 16.2% total defects. B2869-29 was ranked last with an SFA color of 3,

deep scab lesions, and sugar defects (Table 5). Black spot bruise assessments demonstrated that MSZ063-2, ND7519-1, and Lamoka were most resistant to black spot bruising, while B2869-29 and MSZ242-13 were most susceptible (Table 6).

C. Fresh Market and Variety Trial Results

We recorded general descriptions, pedigrees, and scab ratings for all fresh market varieties evaluated in 2020 (Table 8) and assessed these varieties based on yield, specific gravity, internal quality, common scab ratings, and maturity (Tables 9 and 10). The NFPT and Early Generation Tablestock trials screen potato selections under initial evaluation. In 2020, 48 NFPT-designated russet varieties and an additional 6 russet selections were evaluated (Table 11). Continued evaluation of these varieties are determined based on national performance. In total, 70 red skin potato varieties from Michigan, Colorado State University, and North Dakota State University potato breeding programs were grown in Michigan. Of these, 16 varieties were chosen for continued evaluation in Michigan (Data included in Table 9). They will be grown in 15-foot plots in 2021. Below are top performing russet, yellow, red, white, and novelty fresh pack varieties.

Russets

Reveille Russet: This variety was evaluated at five locations in 2020 and will be planted across multiple locations in 2020. It had an above average US#1 and total yield, 409 and 501 cwt/A, respectively. It had slightly more hollow heart than the trial average, and other internal defects were at or below the trial average. This variety had an attractive appearance and a common scab rating of 0.8. Reveille had a larger size profile, with an average of 18% oversize tubers observed. A wider seed spacing is recommended to decrease tuber size.

W9433-1RUS (Lakeview Russet): This variety had the highest US#1 yield of 495 cwt/A at six locations. It had a light russet skin type and 86% US#1 tubers, higher than the trial average of 76%. This medium maturing variety has a vigorous vine type and had a common scab rating of 1.2. It had a specific gravity of 1.077, slightly above the trial average of 1.075. W9433-1RUS had good internal quality with all defects observed at or below the trial average.

A08433-4sto: This Aberdeen, Idaho variety also had a high yield of 410 cwt/A with 73% US #1 tubers. It had a slightly above average specific gravity of 1.079 and a common scab rating of 1.4. This full season variety had a moderately vigorous vine, and clean internal defects excluding four percent hollow heart. This variety had an oblong to long flattened tuber type. A08433-4sto has multiple disease resistances including PVY, *Verticillium* Wilt, Early Blight, and tuber Late Blight.

CO10085-1RUS: This Colorado State University selection had a high yield of 385 cwt/A US#1 tubers and a total yield of 513 cwt/A. It had a very high specific gravity of 1.087 and good internal quality. This full season variety had a common scab score of 0.7. Moderate alligator hide was observed in these oblong tubers. This variety will be observed at multiple locations in 2021 and minitubers production has begun for future bulk plantings in Michigan.

Yellow Flesh

Columba: This yellow-fleshed variety had the highest total and US#1 trial yield of 519 and 601 cwt/A, respectively. It produced 85% A-sized tubers and had a lower specific gravity of 1.054. Internal quality was very good with only one percent vascular discoloration observed. Columba was an earlier maturing variety with a score of 1.6. This variety had a common scab rating of 0.8, and medium yellow flesh. It had smooth, waxy skin, but did not have a consistently uniform tuber type.

Queen Anne: This variety has a consistent attractive appearance with a smooth skin finish and medium yellow flesh. With a US#1 yield of 275 and total yield of 442 cwt/A, this variety had a smaller size profile with 39% B-sized tubers. It had high ratings for both skin waxiness and yellow flesh color. It had a slightly earlier vine maturity than the trial average. Queen Anne produces uniform, oval shaped tubers with a bright appearance.

Cascada: This selection has an average yield of 469 cwt/A in 2020 with 58% US#1 potatoes. Cascada had a very high total yield of 813 cwt/A with a higher-than-average proportion of B-sized tubers. It had a specific gravity of 1.074, slightly higher than the trial average of 1.067. It had a larger vine type and a full season vine maturity. It had excellent internal quality, with no defects observed. Cascada had bright waxy skin and deep yellow flesh color. This variety displayed scab succeptibility in 2020, with an average score of 2.5, higher than the trial average of 1.2

Paroli: This variety was grown at four locations in 2020 and had a US #1 yield of 412 cwt/A with 81% US #1 tubers. It had a waxy skin and bright appearance, with slightly netted skin. At 1.057, it had a lower-than-average specific gravity, and a common scab rating of 1.1. Paroli had only two percent vascular discoloration and no other internal defects in 2020. This early maturing variety had a larger vine type. This variety will be provided to growers for bulk plantings in 2021 pending seed availability.

Red Skin

NDAF113484B-1: This North Dakota cross selected in Maine was the second highest yielding variety in the 2020 red skin potato trial with a US #1 yield of 424 cwt/A and a total yield of 488 cwt/A. It was evaluated at four locations in 2020 and had 85% US #1 tubers. NDAF113484B-1 had a specific gravity of 1.058, slightly lower than the trial average of 1.067. It had good internal quality with no defects other than one percent vascular discoloration. This mid-season variety had a common scab rating of 0.5 and slight skin flaking. Severe silver scurf was observed in 2021, but tuber skin was deep red and highly uniform.

NDA050237B-1R: This variety had a high US #1 yield of 396 cwt/A and a specific gravity of 1.061. Its internal quality was generally good with low incidence of internal defects. This variety had an oval tuber type with uniform skin color. It had a mid to late season maturity and moderately vigorous vine. Skin color was a deep, attractive red, and was moderately waxy. Slight sticky stolons were observed along with a uniform oval type.

CO99076-6R: This early maturing Colorado variety produced attractive, uniform tubers with deep red skin. It had a US #1 yield of 335 cwt/A, above the trial average of 260 cwt/A. CO99076-6R had a larger size profile with only 10% B size tubers. It had good internal quality with only three percent vascular discoloration and one percent internal brown spot when observed at four locations. Skin waxiness was rated very highly, as was skin color and uniformity when observed at four locations. CO99076-6R is scab susceptible, and had an average scab rating of 2.1, higher than the average score of 0.9 for all other red varieties.

AAC Red Viola: This Agriculture and Agrifoods Canada selection has an attractive tuber type and skin finish but had a slightly higher than average silver scurf rating. It had a below average yield of 232 cwt/A and good internal quality. AAC Red Viola may be less susceptible to common scab then average, as the scab score was 0 when evaluated at one location in 2020. Tubers were round to oval with an attractive uniform skin.

Round White

MSCC302-1: This variety had the third highest yield of all round white varieties in 2020. With 82% US#1 tubers, it had an average size profile. This variety had slight hollow heart, a lower-than-average common scab rating, and was moderately waxy. It had a uniform round tuber type, a bright appearance, and moderate black spot bruising observed in 2020.

Audrey: This variety had an oval type with a bright appearance and slight netting. Some tubers had a pointed appearance, contributing to the slightly higher than average percentage of pickouts. Audrey had good internal quality, at or below the trial average. Vine maturity was slightly earlier than average, and skin waxiness was higher than average when evaluated at four locations.

HZC 01-1356: With an above average total yield and below average US#1 yield, this variety had a smaller size profile and produced more B-sized tubers than average. It had a uniform round tuber type with a bright appearance, but some growth crack was observed. Vascular discoloration was above the trial average, but other internal defects were acceptable. This variety had a more vigorous vine than average as well as an earlier vine maturity.

Novelty

Blackberry: This Michigan State University selection had purple skin and flesh, and a slightly above average yield of 350 cwt/A US #1 tubers. It produced 76% A sized tubers and 19% B sized tubers. Blackberry had no internal defects but was only evaluated at two locations in 2020. The purple skin and flesh were a uniform dark color, but severe silver scurf was observed.

MSV443-1PP: This variety had dark and uniform purple skin and was evaluated at only one location in 2020. It had the highest total yield of novelty varieties at 590 cwt/A and 86% US#1 tubers. It had no internal defects and a common scab rating of 1.0, slightly below the trial average. The skin was netted and less waxy than average.

Table 1. 2020 Chip Processing Variety Descriptions

Entry	Pedigree	2020 Scab Rating*	Characteristics
Atlantic	Wauseon x B5141-6 (Lenape)	3.0	Average yield, early maturing, higher specific gravity, good internal quality, high percentage A-sized tubers.
Lady Liberty (NY152)	B38-14 x Marcy	2.1	High yield potential, average specific gravity, excellent long-term storage chip quality, attractive round shape, earlier vine maturity.
Lamoka (NY139)	NY120 x NY115	1.4	Average yield, mid-season maturity, medium specific gravity, oval to oblong tuber type, low internal defects, long-term chip quality.
Mackinaw (MSX540-4)	Saginaw Chipper x Lamoka	1.0	Above average yield with high specific gravity and high percentage of A-sized tubers, mid-season maturity, long-term chip-processing quality with resistance to PVY and late blight and tolerance to common scab, flattened oval type, netted skin
Petoskey (MSV030-4)	Beacon Chipper x MSG227-2	1.8	Average yield, high specific gravity, uniform round tuber type with heavy netting, good internal quality, earlier vine maturity.
Snowden (W855)	B5141-6 x Wischip	2.3	Average yield, early to mid-season maturity, mid-season storage, reconditions well in storage, medium to high specific gravity.
B2869-29	B0564-8 x B1316-5	3.0	Average yield potential, higher specific gravity, light skin, smaller size profile, smaller vine type.
CO11023-2W	AC03433-1W x Waneta	2.0	Average to above average yield potential, moderate hollow heart, common scab susceptible, mid-season maturity.

(2020 Processing Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
CO11023-9W	AC03433-1W x Waneta	3.2	Lower specific gravity, moderate vascular discoloration, common scab susceptible, bright appearance.
CO11037-5W	BC0894-2W x Nicolet	2.3	Higher incidence of pickouts, good OTF chip quality, oval to oblong type, some misshapen tubers.
COOR13270-2	Winterset x CO02024-9W	3.1	Above average yield, marginal OTF chip quality, mid-season maturity, common scab susceptible
MSAA076-6	MSR127-2 x MSS297-3	1.0	Higher specific gravity, lower yield, less scab susceptible, earlier vine maturity.
MSAA100-1	Snowden x Saginaw Chipper	1.5	High yield and percent #1 tubers, very low specific gravity, larger vine type, earlier vine maturity.
MSAA217-3	Beacon Chipper x Atlantic	2.0	High specific gravity, lower yield, moderate hollow heart, common scab susceptible.
MSAA252-7	NY148 x MSQ089-1	1.5	High yield, more oversized tubers, blocky type, marginal OTF chip color, good internal quality, full season vine maturity.
MSAA260-3	MSQ086-3 x Atlantic	2.5	Average yield, higher specific gravity, moderate hollow heart, earlier vine maturity, common scab susceptible.
MSAA275-3	Snowden x MSS297-3	1.8	Low specific gravity, higher incidence pickouts, low stem end defect, mid-season maturity.

(2020 Processing Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
MSAA328-4	Boulder x MSR169-8Y	1.0	Blocky oval type, high yield, less scab susceptible, smaller vine type.
MSAA373-3	NY148 x McBride	2.0	Flattened round tuber shape, high specific gravity, poor OTF chip color, good internal quality, full season maturity.
MSAA570-3	MSV313-1 x Lamoka	2.5	Less uniform tuber type, good internal quality, earlier vine maturity, marginal OFT chip score.
MSAFB605-4	NY148 x MSV241-2	1.5	Uniform round type, heavy netted skin, good internal quality, high percentage A-sized tubers.
MSAFB609-12	NY148 x MSQ086-3	3.5	Common scab susceptible, mid-season maturity, higher proportion of B-sized tubers, mid-season maturity.
MSAFB635-15	NYH15-5 x MSS297-3	2.0	High specific gravity, smaller uniform tuber type, netted skin, mid-season maturity.
MSAFB635-3	NYH15-5 x MSS297-3	2.5	Good OTF chip quality, common scab susceptible, very early maturity, round type.
MSBB058-1	NY148 x MSR127-2	0.5	Moderately netted skin, flattened round type, very high specific gravity, low common scab incidence.
MSBB079-2	MSS927-1 x MSR127-2	0.5	Compressed tuber type, earlier vine maturity, less common scab susceptibility, higher yield.

(2020 Processing Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
MSBB190-1	MSQ131-A x MSR127-2	1.8	Lower specific gravity, good internal quality, earlier vine maturity, inconsistent appearance.
MSBB610-13	NY148 x MST096-2Y	1.5	Attractive blocky oval appearance, very early maturity, high percentage A-sized tubers.
MSBB614-10	Saginaw Chipper x MSR127-2	0.0	Lower yield, good internal quality, no common scab observed in 2020, full season vine maturity.
MSBB618-9	Saginaw Chipper x Manistee	2.0	Higher incidence of VD and IBS, earlier vine maturity, average yield potential, lower specific gravity.
MSBB635-14	Lady Liberty x MSS297-3	1.0	High yield potential, lower incidence common scab, moderate IBS observed, sticky stolons.
MSV498-1	Snowden x MSQ283-2	0.5	Lower common scab rating, smaller vine type, heavier skin, deeper eyes, average OTF chip quality.
MSW474-1	MSN190-2 x MSP516-A	1.2	Higher yield and specific gravity, good internal quality, round uniform type, netted skin, attractive appearance.
MSX225-02	MSK061-4 x Nicolet	2.0	Higher proportion B-sized tubers, good internal quality, average specific gravity, round to oval type.
MSX526-1	MSR036-5 x Lamoka	1.5	Thin skin, moderate greening, high percentage A-sized tubers, good internal quality.

(2020 Processing Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
MSY156-2	MSK061-4 x Kalkaska	2.0	Small round tubers, below average yield, marginal OFT chip quality, mid to late season maturity.
MSZ063-2	MSR148-4 x McBride	1.5	Round to oval type, slightly flattened shape, bright waxy skin, smaller tuber size profile, good internal quality.
MSZ120-04	Kalkaska x MSQ08603	1.2	Higher yield, average specific gravity, round type with thin skin, less susceptible to common scab.
MSZ194-2	MSQ035-3 x MSU383-A	2.0	Light netted skin, good internal quality, high proportion A-sized tubers, good OTF chip quality.
MSZ242-07	MSR169-8Y x MSU383-A	1.3	Very high specific gravity, good chip color and internal quality, smaller vine type, mid-season maturity.
MSZ242-09	MSU169-8Y x MSU383-A	1.5	Heavier netted skin, less uniform tubers, high specific gravity, good internal quality, marginal OTF chip color.
MSZ242-13	MSR169-8Y x MSU383-A	1.2	Very high specific gravity, round to oval type, medium netted skin, good internal quality, less stem end defect than average.
MSZ269-18	MSU279-1Y x MSR127-2	0.5	Pinkeye observed in 2020, lower specific gravity, less susceptible to common scab, good OTF chip color and stem end defect.

(2020 Processing Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
ND7519-1	ND3828-15 x W1353	2.2	Average yield potential, oval tuber type, good specific gravity, good OTF chip color and stem end defect.
NDAF102629C-4	ND7519-1 x ND7799C-1	1.0	Below average yield and specific gravity, good internal quality, less common scab susceptibility, round type with thin skin.
NDTX1244-3W/Y	AND07358-1Y x ND7192-1	0.0	Smaller size profile with many B-sized tubers, lower specific gravity, earlier vine maturity, light yellow flesh.
NY162 (K31-4)	NYE106-2 x NYE48-2	0.3	Apical anthocyanin pigmentation, oval type, bright appearance, below average yield with smaller tubers, good internal quality and chip color.
NY163 (L7-2)	NYE50-8 x NYE48-2	1.6	Apical anthocyanin pigmentation, good internal quality, earlier maturity, above average yield, average specific gravity.
NY165 (M8-5)	NY148 x NYF48-4	1.2	High yield, lower specific gravity, good OTF chip color and internal quality, uniform type, mid-season maturity.
NY166 (N16-11)	NY140 x E48-2	1.5	Thin bright skin, some pear shaped tubers, most characteristics at trial average.
NYOR14Q9-9	Eva x H25-4	2.0	Above average yield, marginal OTF chip quality, common scab susceptible, flattened oval type.
WAF10664-3	Superior x W6609-3	1.0	Round tubers, deeper eyes, less common scab susceptibility, average yield and specific gravity.

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data provided by Potato Outreach Program. Line descriptions provided by various potato breeding programs and updated by Potato Outreach Program following evaluations at various trial locations throughout Michigan.

Table 2. 2020 Michigan Statewide Chip Processing Potato Variety Trials
Overall Averages- Eight Locations

	CWT/A		PERCENT OF TOTAL[1]							RAW TUBER QUALITY[4] (%)								
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR[2]	OTF CHIP SCORE[3]	HH	VD	IBS	BC	COMMON SCAB RATING[5]	SED SCORE[6]	VINE VIGOR[7]	VINE MATURITY[8]	COMMENTS
MSAA252-7[bc]	524	588	89	5	77	12	6	1.070	2.5	0	0	5	0	1.5	0.4	3.5	5.0	large blocky tubers, sl pinkeye, tr periderm cracking
MSAA100-1[bc]	494	526	94	3	94	0	3	1.062	1.8	5	10	0	0	1.5	0.7	3.8	2.3	heavy netted skin, round, uniform
MSZ120-04[abcde]	493	552	89	9	89	0	2	1.081	1.7	4	0	0	2	1.2	0.7	2.0	3.8	round, thin skin, bright, sl sticky stolons
NYOR14Q9-9[abcde]	470	523	89	9	89	0	2	1.079	2.6	16	12	2	2	2.0	1.4	3.1	3.3	flattened oval type, sl greening, light skin
MSBB635-14[b]	468	533	88	12	88	0	0	1.075	2.0	0	0	20	0	1.0	0.6	3.0	3.5	sticky stolons
Mackinaw[abcdeg]	459	520	88	11	87	0	2	1.087	1.9	0	5	5	0	1.0	0.3	2.5	2.8	med netted skin, points in pos, netted skin
NY165[abcdeg]	458	553	81	15	81	0	4	1.079	1.2	0	0	0	0	1.2	0.6	2.8	3.6	med netted skin, uniform, round to oval, attractive appearance
MSBB079-2[d]	433	494	88	10	88	0	2	1.078	1.5	0	0	0	0	0.5	0.2	2.5	2.0	compressed tuber shape, trace ah
MSAA328-4[d]	428	447	96	3	96	0	1	1.079	1.5	20	10	0	0	1.0	0.2	2.0	3.0	blocky oval type
MSW474-1[bcdef]	422	540	77	22	77	0	1	1.082	1.7	0	0	0	0	1.2	0.4	3.4	3.8	round, uniform, med netted skin, sl sticky stolons, attractive appearance
Lady Liberty[acdeh]	419	469	89	11	87	1	1	1.079	1.1	6	0	0	2	2.1	0.3	2.3	2.6	flat round to oval type, med netted skin
MSBB190-1[bc]	388	468	83	6	81	2	11	1.062	1.8	0	0	0	0	1.8	1.1	3.0	2.5	mod gc, sheep nose, poor appearance and chip quality
NY163[bcdefg]	386	475	80	16	80	0	4	1.080	1.3	0	2	0	0	1.6	0.3	2.8	2.1	apical purple pigmentation, round, attractive, waxy skin
CO11023-2W[cdf]	384	475	81	14	81	0	5	1.081	1.3	26	11	0	0	2.0	0.4	3.0	2.7	round to oval, gc in pos, tr ah
COOR13270-2[abcde]	377	458	81	16	81	0	3	1.080	2.2	0	0	8	0	3.1	0.8	3.2	3.5	round, uniform, bright, sl gc
MSZ242-13[abcdefgj]	369	429	86	9	81	5	5	1.090	1.6	0	0	6	0	1.2	0.3	2.4	3.5	med netted skin, gc, sheep nose, round to oval
Lamoka[cdf]	**367**	**482**	**76**	**17**	**76**	**0**	**7**	**1.079**	**1.7**	**0**	**6**	**1**	**0**	**1.4**	**0.4**	**3.3**	**2.3**	**oval type, bright skin, points in pos**
MSZ194-2[b]	362	395	92	5	92	0	3	1.076	1.0	0	0	0	0	2.0	0.1	2.0	3.5	light netted skin, tr gc
ND7519-1[f]	361	460	78	18	78	0	4	1.085	1.0	0	7	0	0	2.2	0.1	4.0	3.0	trace growth crack and points, moderate pitted scab, oval shape
MSX526-1[cd]	358	397	90	9	90	0	1	1.073	1.8	0	0	0	0	1.5	1.0	3.3	2.3	thin skin, sl greening, sheepnose
CO11023-9W[cdf]	357	422	84	13	84	0	3	1.071	1.7	17	20	6	1	3.2	0.7	2.0	3.0	round shape, bright thin skin
WAF10664-3[de]	354	409	86	12	86	0	2	1.077	1.5	0	10	0	0	1.0	0.7	2.5	1.8	round, inconsistent type, deeper eyes
MSZ063-2[bcdef]	352	463	75	23	75	0	2	1.080	1.7	0	0	1	1	1.5	0.6	2.6	2.9	round to oval type, sl flattened tubers, bright waxy skin
MSAA275-3[bc]	343	447	77	8	77	0	15	1.065	2.0	0	5	5	0	1.8	0.5	2.3	3.5	bottlenecking, knobs, heat sprouting
MSAA260-3[e]	340	371	92	5	92	0	3	1.082	2.5	20	0	0	0	2.5	1.1	2.0	2.0	gc in pos
MSV498-1[e]	337	384	88	9	88	0	3	1.077	1.5	20	10	0	0	0.5	0.4	1.5	2.5	heavier skin, deeper apical eyes, Manistee type
Petoskey[cdef]	334	395	84	12	84	0	4	1.084	2.0	3	0	0	0	1.8	0.8	1.6	2.3	round flattened type, sl sticky stolons, gc in pos
NY162[bc]	330	458	70	20	70	0	10	1.077	1.0	0	0	0	0	0.3	0.3	3.3	2.3	apical purple pigmentation, oval type, bright
CO11037-5W[cd]	328	429	76	10	76	0	14	1.070	1.5	0	5	0	5	2.3	0.4	3.5	3.5	oval to oblong, points and heat knobs in pos
Snowden[acdef]	**328**	**415**	**75**	**24**	**75**	**0**	**1**	**1.081**	**1.6**	**0**	**4**	**0**	**0**	**2.3**	**0.5**	**2.6**	**2.3**	**round shape, darker netted skin**
B2869-29[bf]	325	514	63	36	63	0	1	1.085	1.5	2	0	0	9	3.0	0.5	4.3	3.0	uniform type, mod scab, sl chip blistering
MSAFB635-3[e]	325	373	87	12	87	0	1	1.081	1.5	10	0	0	0	2.5	0.6	3.0	1.0	round, ligher skin type
MSZ242-07[cde]	323	373	87	8	87	0	5	1.094	1.5	0	0	0	0	1.3	0.4	2.2	3.7	oval type, netted skin, gc in pos
Atlantic[b]	**323**	**348**	**93**	**6**	**93**	**0**	**1**	**1.074**	**1.5**	**0**	**0**	**0**	**10**	**3.0**	**0.3**	**2.5**	**1.5**	
NY166[bcdeg]	322	463	69	26	69	0	5	1.077	1.1	0	0	2	0	1.5	0.3	3.1	2.8	oval type, sl flattened tuebrs, bright light skin
MSZ269-18[b]	304	358	85	14	83	2	1	1.072	1.5	0	0	0	10	0.5	0.1	3.0	3.0	pinkeye, gc, possible pvy ntn
MSAFB635-15e	302	409	74	25	74	0	1	1.091	3.0	0	0	0	0	2.0	0.7	2.0	3.0	small uniform type, med netted skin
MSBB618-9[bd]	288	351	81	15	81	0	4	1.062	2.3	0	25	25	5	2.0	0.9	1.5	2.0	sl flattened tubers, bright, tr heat sprouting
MSZ242-09[e]	283	321	88	7	88	0	5	1.087	2.5	0	0	0	0	1.5	0.7	2.0	2.5	heavier netted skin, less uniform, sl ah
MSAFB605-4[e]	282	304	93	6	93	0	1	1.083	1.5	0	0	0	0	1.5	0.6	1.5	3.5	uniform round type, heavy netted skin
MSAFB609-12[e]	281	349	80	20	80	0	0	1.079	1.5	0	0	0	0	3.5	0.6	2.0	3.0	
MSAA076-6[e]	273	332	82	13	82	0	5	1.085	1.5	0	0	10	0	1.0	0.4	2.0	2.5	flat to round, misshapen pos, sl ah
MSAA217-3[e]	257	280	92	7	92	0	1	1.091	1.5	20	0	0	0	2.0	0.7	2.0	3.0	sl pinkeye, med netted skin
MSAA373-3[e]	246	307	80	13	80	0	7	1.091	3.5	0	0	0	0	2.0	0.6	1.5	4.0	flat round tuber type
MSX225-02[e]	239	311	77	23	77	0	0	1.083	1.5	0	10	0	0	2.0	0.4	3.0	3.0	med netted skin, uniform round to oval
MSBB610-13[e]	228	246	93	7	93	0	0	1.077	1.5	0	0	10	0	1.5	0.4	2.0	1.5	nice apperance, blocky oval
MSBB058-1[e]	220	264	83	15	83	0	2	1.092	1.5	0	0	0	0	0.5	0.3	2.0	1.5	med netted skin, flat to round, uniform type
MSY156-2[e]	218	274	80	20	80	0	0	1.078	2.5	0	0	0	0	2.0	0.8	2.5	3.5	small and round, uniform, med netted skin
NDAF102629C-4[abd]	216	328	61	33	61	0	6	1.071	1.2	0	0	0	0	1.0	0.5	3.0	1.3	small and round, tr pointed tubers, mod ah, thin skin
MSAA570-3[e]	210	266	79	16	79	0	5	1.077	2.0	0	0	0	0	2.5	0.7	2.0	2.0	less uniform
NDTX1244-3W/Y[b]	165	287	58	39	58	0	3	1.063	2.0	10	10	10	0	0.0	0.4	4.0	2.0	sticky stolons, bacterial rot, non uniform, poor shape, light yellow flesh
MSBB614-10[b]	89	103	86	14	86	0	0	1.083	2.0	0	0	0	0	0.0	0.2	1.0	4.0	
MEAN	**337**	**407**	**83**	**14**	**82**	**0**	**3**	**1.079**	**1.7**	**3**	**3**	**2**	**1**	**1.6**	**0.6**	**2.6**	**2.8**	

2020 Chip Variety Trial Sites

[a]Crawford Farms
[b]Hampton Potato Growers, Fresh Trial
[c]Lennard Ag. Co., Storage Trial
[d]Main Farms, Storage Trial
[e]MRC Box Bin, Storage Trial
[f]Sandyland Farms, SNAC
[g]Sandyland Farms, Set 1
[h]Verbirgghe Potato Farms
[j]Walther Farms Norkotah Fertility Trial

[1]SIZE

Bs: < 1 7/8"
As: 1 7/8" - 3 1/4"
OV: > 3 1/4"
PO: Pickouts

[2]SPECIFIC GRAVITY

Data not replicated

[3]OUT OF THE FIELD CHIP COLOR SCORE

(SNAC Scale)
Ratings: 1 - 5
1: Excellent
5: Poor

[4]RAW TUBER QUALITY

(percent of tubers out of 10)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[5]COMMON SCAB RATING

0.0: Complete absence of surface or pitted lesions
1.0: Presence of surface lesions
2.0: Pitted lesions on tubers, though coverage is low
3.0: Pitted lesions common on tubers
4.0: Pitted lesions severe on tubers
5.0: More than 50% of tuber surface area covered in pitted lesions

[6]SED (STEM END DEFECT) SCORE

0: No stem end defect
1: Trace stem end defect
2: Slight stem end defect
3: Moderate stem end defect
4: Severe stem end defect
5: Extreme stem end defect

[7]VINE VIGOR RATING

Date: Variable
Rating 1-5
1: Slow emergence
5: Early emergence (vigorous vines, some flowering)

[8]VINE MATURITY RATING

Date: Variable
Rating 1-5
1: Early (vines completely dead)
5: Late (vigorous vines, some flowering)

Table 3. Yield , Size Distribution*, Specific Gravity								
	Yield (cwt/A)		Percent Size Distribution					
Entry	US#1	TOTAL	US#1	Small	Mid-Size	Large	Culls	Specific Gravity
MSZ242-13	485[a]	534	90	8	90	0	2	1.096
NY163	481[a]	560	86	13	86	0	1	1.081
Petoskey	460[ab]	516	89	9	89	0	2	1.090
CO11023-9W	447[ab]	520	86	13	86	0	1	1.066
Snowden	**419[bc]**	**515**	**81**	**18**	**81**	**0**	**1**	**1.081**
CO11023-2W	404[bcd]	510	79	19	79	0	2	1.088
MSW474-1	379[cd]	546	69	30	69	0	1	1.083
Lamoka	**372[cd]**	**478**	**78**	**21**	**78**	**0**	**1**	**1.082**
ND7519-1	361[cd]	460	78	18	78	0	4	1.085
MSZ063-2	350[d]	512	68	31	68	0	1	1.080
B2869-29	263[e]	495	53	45	53	0	2	1.083
MEAN	**402**	**513**	**78**	**20**	**78**	**0**	**2**	**1.083**
ANOVA p-value	**<.0001**	0.5240	**<.0001**	**<.0001**	**<.0001**	-	**0.0002**	**<.0001**
LSD	**60.1**	-	**5.0**	**5.1**	**5.0**	-	**1.2**	**0.004**

*small <1 7/8"; mid-size 1 7/8"-3 1/4"; large >3 1/4"

Table 4. At-Harvest Tuber Quality. Sandyland Farms, Howard City, Michigan.				
	Raw Tuber Quality[1] (%)			
Entry	HH	VD	IBS	BC
MSZ242-13	3	0	0	0
NY163	0	0	0	0
Petoskey	10	0	0	0
CO11023-9W	50	10	17	3
Snowden	**0**	**0**	**0**	**0**
CO11023-2W	17	13	0	0
MSW474-1	0	0	0	0
Lamoka	**0**	**7**	**3**	**0**
ND7519-1	0	7	0	0
MSZ063-2	0	0	7	3
B2869-29	3	0	0	17
MEAN	**8**	**3**	**2**	**2**
ANOVA P-value	**<0.0001**	0.0255	0.0575	**0.0026**
LSD	**11.4**	-	-	**7.2**

[1]Internal Defects. HH = hollow heart, VD = vascular discoloration, IBS = internal brown spot, BC = brown center.

Table 5. Post-Harvest Chip Quality[1] for the 2020 SNAC Trial at Sandyland Farms						
		SNAC[2]	Specific	Percent Chip Defects[3]		
Rank	Entry	Color	Gravity	Internal	External	Total
1	NY163	2.0	1.075	0.0	15.6	15.6
2	CO11023-2W	2.0	1.075	1.3	14.9	16.2
3	**Snowden**	**2.5**	**1.074**	**4.3**	**6.9**	**11.2**
4	MSZ063-2	2.0	1.076	4.1	8.2	12.3
5	**Lamoka**	**3.0**	**1.068**	**20.6**	**0.0**	**20.6**
6	MSZ242-13	2.0	1.085	0.0	7.2	7.2
7	MSW474-1	2.0	1.074	0.0	15.4	15.4
8	Petoskey	3.0	1.077	11.0	1.4	12.4
9	ND7519-1	2.0	1.073	8.4	12.2	20.6
10	CO11023-9W	3.0	1.060	15.2	18.4	33.6
11	B2869-29	3.0	1.068	8.4	19.4	27.8

[1] Samples collected October 6th and processed by Herr Foods, Inc., Nottingham, PA on October 14th, 2020.

[2] SNAC Color: 1 = lightest, 5 = darkest

[3] Percent Chip Defects are a percentage by weight of the total sample; comprised of undesirable color, greening, internal defects and external defects

Lines are sorted by Herr's ranking: 1(best) to 11 (worst)

Table 6. Black Spot Bruise Test for the 2020 SNAC Trial at Sandyland Farms																
	A. Check Samples[1]									B. Simulated Bruise Samples[2]									
	# of Bruises Per Tuber						Total	Percent Bruise	Average Bruises Per	# of Bruises Per Tuber						Total	Percent Bruise	Average Bruises Per
Entry	0	1	2	3	4	5	Tubers	Free	Tuber	0	1	2	3	4	5	Tubers	Free	Tuber
MSZ063-2	21	3	1	0	0	0	25	84	0.2	5	11	8	1	0	0	25	20	1.2
ND7519-1	6	13	6	0	0	0	25	24	1.0	3	13	6	3	0	0	25	12	1.4
Lamoka	**14**	**10**	**1**	**0**	**0**	**0**	**25**	**56**	**0.5**	**3**	**8**	**6**	**8**	**0**	**0**	**25**	**12**	**1.8**
NY163	7	5	10	2	1	0	25	28	1.4	3	4	8	6	4	0	25	12	2.2
CO11023-9W	15	7	2	1	0	0	25	60	0.6	5	1	8	4	4	3	25	20	2.4
CO11023-2W	10	10	3	2	0	0	25	40	0.9	0	5	8	6	5	1	25	0	2.6
B2869-29	8	11	4	2	0	0	25	32	1.0	2	3	7	3	4	6	25	8	2.9
Snowden	**10**	**12**	**2**	**1**	**0**	**0**	**25**	**40**	**0.8**	**0**	**1**	**5**	**9**	**6**	**4**	**25**	**0**	**3.3**
Petoskey	13	7	5	0	0	0	25	52	0.7	0	4	4	3	8	6	25	0	3.3
MSW474-1	10	5	6	4	0	0	25	40	1.2	0	0	3	9	7	6	25	0	3.6
MSZ242-13	10	7	7	1	0	0	25	40	1.0	0	0	5	5	7	8	25	0	3.7
																		2.6

[1] Tuber samples collected at harvest and held at room temperature for later abrasive peeling and scoring.

[2] Tuber samples collected at harvest, held at 50ºF for 12 hours, then placed in a 6 sided plywood drum and rotated 10 times to produce simulated bruising. They were then held at room temperature for later abrasive peeling and scoring.

Table 7A. Pre-Harvest Panel for the 2020 SNAC Trial at Sandyland Farms, Taken on 8/14 and 8/20/2020

Entry	Specific Gravity	Glucose[1] %	Sucrose[2] Rating	Canopy Rating[3]	Canopy Uniform.[4]	Number of Hills	Number of Stems	Average[5] Tuber Weight
MSZ242-13	1.101	0.048	1.522	100	100	3	17	2.82
NY163	1.100	0.006	0.636	75	75	5	12	3.32
Petoskey	1.112	0.011	1.511	100	100	5	20	2.43
CO11023-9W*	1.071	0.005	0.372	75	100	4	6	2.78
Snowden	**1.100**	**0.006**	**0.555**	**75**	**75**	**3**	**16**	**3.20**
CO11023-2W	1.102	0.007	1.135	100	100	3	16	2.61
MSW474-1*	1.085	0.004	0.557	100	100	3	18	2.70
Lamoka*	**1.085**	**0.003**	**0.780**	**100**	**100**	**4**	**11**	**3.74**
ND7519-1*	1.090	0.004	1.026	75	100	4	18	3.23
MSZ063-2	1.096	0.009	0.894	100	100	3	15	2.60
B2869-29	1.093	0.019	1.361	75	75	4	16	1.74

Table 7B. Pre-Harvest Panel for the 2020 SNAC Trial at Sandyland Farms, Taken on 8/31/2020

Entry	Specific Gravity	Glucose[1] %	Sucrose[2] Rating	Canopy Rating[3]	Canopy Uniform.[4]	Number of Hills	Number of Stems	Average[5] Tuber Weight
MSZ242-13	1.091	0.005	0.499	75	75	6	15	4.26
NY163	1.091	0.005	0.172	75	100	4	11	4.08
Petoskey	1.086	0.012	0.679	75	75	5	16	4.26
CO11023-9W	1.078	0.008	0.273	50	75	4	10	2.99
Snowden	**1.090**	**0.008**	**0.370**	**75**	**75**	**4**	**19**	**4.26**
CO11023-2W	1.092	0.005	0.578	75	100	4	21	2.60
MSW474-1	1.088	0.006	0.443	75	75	4	29	2.50
Lamoka	**1.087**	**0.005**	**0.495**	**75**	**75**	**4**	**11**	**3.31**
ND7519-1	1.090	0.009	0.725	75	75	4	17	3.50
MSZ063-2	1.085	0.007	0.791	75	75	3	9	2.63
B2869-29	1.092	0.009	0.641	75	75	3	24	2.47

1 Percent Glucose is the percent of glucose by weight in a given amount of fresh tuber tissue.

2 Sucrose Rating is the percent of sucrose by weight in a given amount of fresh tuber tissue X10.

3 The Canopy Rating is a percent rating of green foliage (0 is all brown, dead foliage, 100 is green, vigorous foliage).

4 The Canopy Uniformity is a percentage of how uniform the foliage health is at the date of observation.

5 The Average Tuber Weight is the total tuber weight collected, divided by the number of tubers reported in ounces.

* These varieties were sampled on 8/20/20, not 8/14/20

Table 8. 2020 Russet and Tablestock Variety Descriptions

Russet Variety Descriptions

Entry	Pedigree	2020 Scab Rating*	Characteristics
Alverstone Russet	Cre 92-200 x Innovator	2.5	Light russet skin, some bottlenecking and knobs, average yield, high specific gravity, larger vine type, mid-season maturity.
Campagna	Peribonka x NY112	0.2	High yield and percentage A-sized tubers, moderate hollow heart, mid-season maturity, darker russet skin.
Clearwater Russet (AOA95154-1)	Bannock Russet x A89152-4	0.8	Low yield, split of B and A-sized tubers, higher specific gravity, good internal quality, smaller vine type.
Dakota Russet	Marcy x AH66-4	1.5	Silverton Russet type and appearance, good internal quality, oblong blocky tubers, lower yield.
GoldRush Russet (ND1538-1Rus)	ND450-3Rus x Lemhi Russet	0.0	Medium maturity, oblong-blocky to long tubers, bright white flesh, common scab resistance, average yield potential, earlier vine maturity.
Pacific Russet (VO168-3)	NDA8694-3 x Century Russet	2.8	Inconsistent type, lower specific gravity, average yield potential, attractive skin color, oblong tubers.
Peribonka	La Patate Lac-St-Jean	0.3	Lower specific gravity, larger vine with earlier maturity, lower specific gravity, average yield.
Plover Russet (W9133-1RUS)	ND4093-4 x CO82142-4	2.1	Larger tuber size profile with many oversize tubers, lower specific gravity, mid-season maturity.

(2020 Russet Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
Ranger Russet (A7411-2)	Butte x A6595-3	3.0	Tubular type, darker skin, common scab susceptible, high specific gravity, higher proportion B-sized tubers, slight vascular discoloration observed in 2020.
Reveille Russet (ATX91137-1Rus)	Bannock Russet x A83343-12	0.8	Excellent yield potential, common scab tolerant, early bulking, nice uniform dark russeted skin with good general tuber appearance, occasional misshapen tubers observed, long dormancy, some prominent eyes observed.
Russet Burbank	Unknown	2.5	Oblong type, lower yield, many misshapen pickouts, smaller size profile, good internal quality.
Russet Norkotah	ND9526-4Rus x ND9687-5Rus	1.3	Average yield, earlier maturity, long to oblong tubers, heavy russet skin, low specific gravity, moderate hollow heart.
Silverton Russet (AC83064-6)	A76147-2 x A7875-5	0.8	High yield, oblong to long blocky tuber type, medium netted russet skin, masks PVY, medium to low specific gravity, PVY, Sencor & Linuron susceptibility, moderate hollow heart, lower specific gravity.
SunSet Russet (TX13590-9RUS)	ND9687-3Ru x ND9852-1Ru	1.8	Average yield, severe hollow heart, dark russet skin, non-uniform type, mid-season maturity.
Umatilla Russet (AO82611-7)	Butte x A77268-4	0.5	Small tuber profile, 37% B-sized tubers in 2020, average specific gravity, earlier maturity, smaller vine type.

(2020 Russet Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
Vanguard (TX08352-5RUS)	TXA549-1Ru x AOTX98137-1Ru	0.2	Nice slightly blocky shape, medium size profile, medium vine vigor with early maturity, semi-erect vines, lower specific gravity.
A07769-4	PA01N32-1 x Premier Russet	2.5	Average yield potential, good internal quality, large vine type, full season maturity, oval to oblong type.
A08433-4STO	A02611-1 x AOND95249-1	1.4	Flattened oblong tuber shape with medium russet skin, resistant to shatter bruise, tuber late blight, and common scab, high yield potential, full season maturity.
A09086-1LB	Palisade Russet x AC96052-1RU	2.8	Higher yield potential, smaller size profile, higher specific gravity, good internal quality, marginal appearance in 2020.
A09119-4LB	A00472-20LB x Premier Russet	1.7	Non-uniform type, lighter russet skin, average yield potential, higher specific gravity, moderate vascular discoloration, significant alligator hide.
A10071-1	Targhee Russet x AO02183-2	2.4	Higher percentage B-sized tubers, larger vine type, mid season maturity, darker russet skin, blocky oblong type.
A11188-1	A98345-1 x A98196-5	2.3	Higher yield potential, larger tuber size profile with many oversize tubers, full season maturity, oblong type.
A11326-1	A06030-8T x AO96365-2	2.0	Higher yield potential, very high specific gravity, severe hollow heart, full season maturity.

(2020 Russet Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
A11737-1LB	A96814-65LB x A05084-11	1.7	Non-uniform tuber type, good internal quality, average yield potential, tubular appearance, moderate alligator hide.
A12114-7	A06665-10LB x A01025-4	2.3	Low yield potential with more B-sized tubers than average, marginal appearance, mid-season maturity.
AF5707-1	A93575-4 x Dakota Trailblazer	2.3	Smaller size profile, average specific gravity, larger vine type, oblong to long type.
AO06191-1 (Rainier Russet)	A99134-1 x Canela Russet	0.1	Lower yield, moderate hollow heart, early to mid-season vine maturity, dark skin, prominent eyes, blocky type.
AOR07781-5	PA92A08-17 x PALB03035-6	0.0	Good specific gravity, moderate hollow heart, mid-season maturity, dark russet skin, oblong type, slight alligator hide.
AOR11217-3	A01010-3 x NDA070929B-3	0.9	Lower yield, more B-sized tubers than average, earlier maturity, netted skin, long tubular type.
ATX13018-2RUS	A06015-13TE x A06084-1TE	2.5	Very low yield, unacceptable gravity, mid-season maturity, poor appearance.
CO09205-2RUS	Clearwater Russet x	1.3	Below average yield with smaller size profile, moderate hollow heart, lower specific gravity, medium russet skin, uniform type.
CO10085-1RUS	AC03364-5RU x Silverton Russet	0.7	High yield potential, high specific gravity, good internal quality, full season maturity, flattened oblong type.

(2020 Russet Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
CO99076-3RUS		0.4	Average yield potential, less succeptible to common scab, earlier season maturity, lower specific gravity.
COAF11018-10	AC00395-2RY x AC00395-2RY	0.0	Average yield, slight hollow heart, no common scab observed in 2020, earlier vine maturity, long tubular type with heavy russet skin.
COOR9205-2RUS		1.0	Lower yield, higher proportion B-sized tubers, unacceptable specific gravity, moderate brown center, misshapen pickouts.
COTX15271-1RUS	A03921-2 x Mercury Russet	0.5	Lower yield, moderate vascular discoloration, growth crack observed, mid to full season maturity.
MN13142-32		0.8	Smaller size profile with more B-sized tubers, moderate hollow heart, high specific gravity, earlier vine maturity, long tubular type.
W13027-46RUS	Plover Russet x Canela	2.0	Average yield, moderate hollow heart, larger vine type, mid-season vine maturity, lower specific gravity.
W14002-2RUS	CO05189-2RUS x Russet Norkotah	0.8	Below average yield and specific gravity, earlier vine maturity, long tuber type, misshapen pickouts.
W14094-13RUS	Russet Norkotah x Canela	0.2	Attractive shape and appearance, blocky type, mid-season maturity, below average yield.

(2020 Russet Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
W9433-1RUS (Lakeview Russet)	Calwhite x A96023-6	1.2	High yield, larger tuber size profile, light russet skin, uniform and blocky type, larger vine type.

* Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data provided by Potato Outreach Program. Line descriptions provided by potato breeding programs and updated by Potato Outreach Program following evaluations at trial locations throughout Michigan.

2020 Yellow Flesh Variety Descriptions

Entry	Pedigree	2020 Scab Rating*	Characteristics
Allora	Apart x Borwina	1.1	Average yield and specific gravity, earlier vine maturity, waxy skin, bright appearance, oval type, slight netting.
Anouk	Ampera x AR95-1073	1.3	Even split of A and B-sized tubers, smaller type, netted skin, round shape.
Cascada	Real Potatoes	2.5	Higher yield and specific gravity, very waxy skin, dark yellow flesh color, oval to oblong type.
Columba	HZPC	0.8	Higher yield, lower specific gravity, very early vine maturity, non-uniform appearance.
Connect	Solanum International	1.6	Average yield, larger vine type, moderate netting, flat oval type.
Constance	Marabel x AR93-1243	1.5	Lower yield, earlier vine maturity, oval type, slight alligator hide, smaller size profile.
Golden Globe	Norkia America	1.0	Higher yield, earlier vine maturity, very waxy, round type with smooth skin.
Jennifer	HZPC	3.5	High yield potential, oblong to long type, waxy skin.
Lucera	Real Potaotes	1.0	Lower #1 yield but high total yield due to mostly B-sized tubers, earlier maturity, oblong to long type.
Maggie	HZPC	1.1	Below average yield and specific gravity, darker yellow flesh, slight netting and heat sprouts.

Table of Contents

(2020 Yellow Flesh Varieties Cont.)

Entry	Pedigree	2020 Scab Score*	Characteristics
Melody	Solanum International	1.1	Oval type, bright appearance, trace growth crack, good internal quality, mid-season maturity.
Nixie	Real Potatoes	2.3	Small tuber size, bright skin, excellent internal quality, above average specific gravity.
Paroli	Norika	1.1	Attractive waxy skin, larger vine type, good internal quality, above average yield potential, lower specific gravity.
Queen Anne	Solanum International	1.9	Oval to oblong shape, yellow flesh, yellow skin, shallow eyes, medium to high scab resistance, PVY resistance and resistance to Ro1 and Ro4 nematodes, attractive appearance, waxy skin.
Tacoma	Norika America	1.2	Oblong type with netted skin, darker yellow flesh, average yield and specific gravity.
Tyson	HZPC	1.1	Higher yield, slight internal brown spot, mid-season vine maturity, round type with netted skin, bright appearance.
Yukon Gold	Norgleam x W5279-4	2.1	Slightly above average yields, earlier maturity, oval shaped with yellow-white skin and light-yellow flesh, common scab susceptible.
CO11250-1W/Y	CO99045-1W/Y x POR02PG25-6	0.3	Higher specific gravity, good internal quality, pink splash around eyes, oblong type.

(2020 Yellow Flesh Varieties Cont.)

Entry	Pedigree	2020 Scab Score*	Characteristics
MSCC515-2Y	MSM288-2Y x McBride	1.0	Round uniform tuber type with shallow eyes, moderate vascular discoloration.
MSV093-1Y	McBride x MSP408-14Y	0.8	Above average yield, good internal quality, rough netted skin, deep apical ends
MSW038-4Y	MSI005-20Y x MSM288-2Y	1.5	Round uniform type, slight growth cracks, good internal quality, smaller tuber size profile.
MSZ268-1Y	MSU278-1Y x Pike	0.2	Heavily netted skin, round type, moderate vascular discoloration, higher proportion A-sized tubers.
MSZ615-2	Sieglinde x MSL211-3	1.3	High yield, earlier vine maturity, flattened round type, netted skin, moderate hollow heart.
Nectar	Real Potatoes	2.1	Average yield potential, full season vine maturity, flattened oval type, pink splash around eyes.
W15240-2Y	NW64-6 x W9576-11Y	1.6	Smaller tuber size profile, lower specific gravity, mid-season vine maturity, oval type, uniform appearance, buff skin.

* Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data provided by Potato Outreach Program. Line descriptions provided by potato breeding programs and updated by Potato Outreach Program following evaluations at trial locations throughout Michigan.

2020 Red Skin Variety Descriptions

Entry	Pedigree	2020 Scab Rating*	Characteristics
Blushing Belle	La Patate Lac-St-Jean	0.2	Smaller tuber size profile, lower specific gravity, good internal quality, inconsistent red skin color.
Dark Red Norland	Redkote x ND626	0.8	Broadly adapted, moderate to above average yields, early season maturity, smooth, oblong, slightly flattened tubers, common scab tolerant.
Fenway Red	HZPC	1.1	High yield and specific gravity, good internal quality, bright appearance with round tubers, moderate silver scurf.
Norland RP	Redkote x ND626	0.6	A selection of Dark Red Norland, similar type, appearance, and agronomic traits, moderate silver scurf.
Ricarda	SunRain	0.9	Higher yield, moderate vascular discoloration, uniform waxy red skin, moderate silver scurf.
Roko	Alwara x MA81-0536	1.0	Uniform lighter red skin, oval tuber shape, moderate internal brown spot, average specific gravity, above average yield potential.
Vicki	HZPC	0.6	Above average yield, good internal quality, uniform skin color, mid-season maturity.
AAC Red Viola	AAF Canada	0.0	Attractive and uniform round to oval tubers, some misshapen pickouts, potential scab tolerance, mid-season maturity.

Table of Contents

(2020 Red Skin Varieties Cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
CO14040-3R	CSU	0.0	Average yield and specific gravity, earlier vine maturity, smaller tuber size profile, round and uniform tubers.
CO14074-1R	CSU	0.0	Slight alligator hide and pointed tubers, dark red, uniform skin, moderate silver scurf.
CO14105-1R	CSU	1.5	Uniform skin color, mid-season vine maturity, high proportion A-sized tubers, low specific gravity.
CO99076-6R	AC91848-1 x Rio Colorado	2.1	Above average yield, below average specific gravity, good internal quality, highly uniform dark red skin color, slight growth crack, waxy skin.
MSW343-2R	MSQ440-2 x NDTX4172-5R	1.0	High yield, very low specific gravity, moderate vascular discoloration, deep eyes, sticky stolons, marginal appearance.
MSX324-2R	MSN105-1 x Colonial Purple	0.9	Lighter red skin color, slight alligator hide, above average yield, slight internal defects, growth crack.
MSZ427-3R	MSQ440-2 x NDTX4271-5R	0.5	Flattened round tuber type, earlier vine maturity, uniform lighter red skin.
NDA050237B-1R	ND028678-1RY x ND028770B-4R	0.8	Above average yield, full season maturity, uniform oval type, slight sticky stolons, moderate silver scurf.

(2020 Red Skin Varieties Cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
NDAF113484B-1	ND060570B-1R x ND8555-8R	0.5	Attractive, uniform dark red skin, uniform round type, severe silver scurf, mid-season maturity.
NDTX4784-7R	Dakota Rose x ND2050-1R	2.0	Attractive dark red skin, severe silver scurf, blocky type, lower specific gravity, larger tuber size profile.

* Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data provided by Potato Outreach Program. Line descriptions provided by various potato breeding programs and updated by Potato Outreach Program following evaluations at various trial locations throughout Michigan.

2020 Round White Variety Descriptions

Entry	Pedigree	2020 Scab Rating*	Characteristics
Algonquin (NY141)	R6-5 x NY115	1.2	Blocky oval type, less uniform, earlier vine maturity, slight internal brown spot.
Audrey	HZPC	1.2	Oval type, slight points, moderate skin netting, bright appearance, earlier vine maturity, lower specific gravity.
Envol	F68123 x Simcoe	2.1	Flat blocky type, misshapen pickouts, good internal quality, lower yield, very early maturity.
Reba (NY 87)	Monona x Allegany	1.0	High yield, bright tuber appearance, medium specific gravity, resistance to golden nematode Ro1, common scab, verticillium wilt, and early blight, susceptible to late blight and PVY, larger type.
Superior	USDA96-56 x M59.44	0.8	Early maturity, round to oblong tubers, deep eyes, resistant to net necrosis and common scab, susceptible to verticillium wilt, pressure bruise issues in long-term storage, dark netted skin.
HZC 07-1356	HZPC	1.6	Moderate vascular discoloration, uniform round type, bright appearance, slight growth crack, high total yield.
MSAA120-1	MSM182-1 x MSW126-1	2.8	Large blocky type with marginal appearance, full season maturity, buff skin, moderate hollow heart, high yield.
MSAA174-1	MSU161-1 x MSQ440-2	1.0	Bright appearance, oval type, waxy skin, moderate vascular discoloration, lower yield and specific gravity.

(2020 Round White Varieties cont.)

Entry	Pedigree	2020 Scab Rating*	Characteristics
MSAA196-1	MSW151-1 x MSQ440-2	0.5	Flattened oval type, trace growth cracks, very waxy skin, good internal quality, below average yield and specific gravity.
MSBB351-1	MSS483-1 x MSQ440-2	0.8	Pink splash around eyes, buff skin, very low specific gravity, slight hollow heart, average yield.
MSCC300-1	MST500-1 x MSL211-3	2.0	Flattened tubers, trace growth crack, bright, moderately waxy skin, severe hollow heart, average yield.
MSCC302-1	MST500-1 x MSQ086-3	0.8	Uniform round type, moderate black spot bruise, high specific gravity, moderate hollow heart.
NDAF102629C-4	ND7519-1 x ND7799C-1	2.0	Buff skin, round tubers, slight vascular discoloration, above average yield, higher specific gravity, full season maturity.

* Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data provided by Potato Outreach Program. Line descriptions provided by various potato breeding programs and updated by Potato Outreach Program following evaluations at various trial locations throughout Michigan.

2020 Novelty Variety Descriptions

Entry	Pedigree	2020 Scab Rating*	Characteristics
Blackberry (MSV109-10PP)	COMN07-W112BGA x MSU200-5PP	0.0	Severe silver scurf, very dark red/purple skin color, good internal quality, average yield potential, mid-season maturity.
MSV443-1PP	MSU200-5PP x NDTX4271-5R	1.0	Mid to full season maturity, moderate silver scurf, slight netted skin, dark purple skin color, recessed stem ends, good internal quality, highest novelty yield.
MSV443-6P	MSU200-5PP x NDTX4271-5R	1.0	Round type, some deep apical eyes, moderate alligator hide, very dark, uniform skin.
MSZ413-6P	Colonial Purple x MSU200-5PP	0.0	Small uniform tubers, sticky stolons, buff skin, less silver scurf, split of B and A-sized tubers.

* Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data provided by Potato Outreach Program. Line descriptions provided by potato breeding programs and updated by Potato Outreach Program following evaluations at trial locations throughout Michigan.

Table 9. 2020 Michigan Statewide Russet Potato Variety Trials
Overall Averages- Eight Locations

LINE	CWT/A		PERCENT OF TOTAL[1]					SP GR[2]	RAW TUBER QUALITY[3] (%)				COMMON SCAB RATING[4]	VINE VIGOR[5]	VINE MATURITY[6]	COMMENTS
	US#1	TOTAL	US#1	Bs	As	OV	PO		HH	VD	IBS	BC				
W9433-1RUS[abdgej]	495	575	86	7	62	24	7	1.077	5	6	6	0	1.2	3.3	3.4	light russet skin, uniform, blocky
Campagna[dg]	490	663	74	9	67	7	17	1.072	17	5	0	0	0.2	3.6	2.8	med to dark russet skin, misshapen pos
A08433-4sto[abceg]	410	542	73	18	67	6	9	1.079	4	0	0	0	1.4	3.0	4.1	flattened oblong to long type, med russet skin
A11326-1[degh]	410	504	81	14	71	10	5	1.089	60	1	0	0	2.0	3.5	4.3	light to med russet skin, blocky, misshapen and knobs
A11188-1[g]	410	473	86	7	60	26	7	1.072	0	3	0	0	2.3	2.7	4.2	mod ah, oblong type, sig ah
Silverton Russet[abdegj]	**409**	**501**	80	**12**	**59**	**21**	**8**	**1.072**	**12**	**3**	**2**	**3**	**0.8**	**3.0**	**3.6**	**sl ah, oblong type, misshapen and knobs in pos**
Reveille Russet[bdgej]	401	495	79	12	61	18	9	1.069	16	3	1	0	0.8	2.7	2.9	med russet skin, prominent eyes, knobs in pos
Plover Russet[abdegj]	395	465	79	17	56	23	4	1.067	4	0	2	0	2.1	3.1	2.7	med russet skin, mod pinkeye and ah
CO10085-1RUS[adg]	385	513	74	16	70	4	10	1.087	3	3	0	0	0.7	3.5	4.1	mod ah, sl flattened, oblong
COAF11018-10[hi]	359	440	82	12	78	4	6	1.079	10	0	0	0	0.0	2.8	2.5	long, tubular, heavy russet, nice appearance
Goldrush[dj]	359	466	77	14	64	13	9	1.078	10	0	0	0	0.0	3.8	2.0	dark russet skin
SunSet Russet[abdefg]	358	454	76	11	59	17	13	1.074	36	6	3	0	1.8	3.0	3.0	dark russet skin, non uniform type, bottlenecking, knobs
A09086-1LB[abdeghj]	354	490	71	24	65	6	5	1.082	3	3	4	0	2.8	3.8	3.3	flat oblong type, marginal appearance
A11737-1LB[g]	348	461	75	18	74	1	7	1.083	0	0	0	0	1.7	2.8	3.5	mod ah, non uniform type, tubular
A09119-4LB[g]	341	408	83	12	75	8	5	1.086	0	10	3	0	1.7	3.7	3.5	non uniform type, light russet skin, sig ah
AOR07781-5[abdegj]	335	439	74	13	62	12	13	1.083	11	0	0	2	0.0	4.5	2.8	dark russet skin, oblong, sl ah, deeper eyes
A10071-1[adegh]	332	448	71	22	65	6	7	1.078	1	0	0	0	2.4	4.3	3.0	dark russet skin, blocky, oblong, sl ah
Alverstone Russet[abcefgj]	329	516	63	31	61	2	6	1.082	0	4	0	0	2.5	3.8	3.4	light russet skin, bottlenecking, knobs in pos
Peribonka[g]	324	487	67	3	52	15	30	1.073	0	0	3	0	0.3	4.0	2.3	knobs, points, misshapen pos, tr ah
Russet Norkotah[abdegj]	**313**	**412**	**74**	**18**	**65**	**9**	**8**	**1.071**	**17**	**1**	**0**	**0**	**1.3**	**2.9**	**2.2**	**mod pink eye, heavy russet skin, blocky**
Pacific Russet[abdfgj]	312	390	78	19	70	8	3	1.059	0	4	0	0	2.8	3.2	1.7	oblong blocky type, attractive skin
AF5707-1[hi]	311	459	68	27	65	3	5	1.076	10	0	0	0	2.3	3.5	3.3	oblong to long type
Vanguard[abcegj]	309	420	71	23	68	3	6	1.063	0	0	0	0	0.2	3.1	1.4	non uniform russet skin, sl ah, attractive size profile
W13027-46RUS[eg]	305	376	80	10	62	18	10	1.067	15	0	0	0	2.0	3.8	2.9	
MN13142-32[abcefg]	293	459	62	32	61	1	6	1.084	18	1	0	0	0.8	2.3	2.5	long tubuar type, smooth shape, sl pink eye
CO09205-2RUS[adegj]	292	426	65	24	61	4	11	1.074	25	0	0	1	1.3	3.0	2.7	med russet skin, uniform, bottlenecking in pos
A07769-4[eg]	288	368	78	14	69	9	8	1.075	2	7	0	0	2.5	3.7	3.2	med russet skin, mod ah, oval to oblong, blocky
COTX15271-1RUS[e]	287	436	63	20	55	8	17	1.071	0	20	0	0	0.5	2.5	3.5	med rus, gc and misshapen pos
W14094-13RUS[ag]	285	381	75	15	61	14	10	1.074	2	3	3	2	0.2	2.5	2.7	attractive shape and appearance, blocky
W14002-2RUS[ag]	270	396	64	18	56	8	18	1.063	0	5	0	0	0.8	2.1	1.9	long type, knobs, bottlenecking, ah and gc
COOR9205-2RUS[b]	256	389	66	25	64	2	9	1.056	10	0	0	20	1.0	3.5	3.0	med russet skin, misshapen pos
AO06191-1[abcegj]	252	324	76	14	58	18	10	1.076	23	2	0	1	0.1	2.2	2.7	dark russet skin, blocky, prominent eyes
Dakota Russet[fg]	245	315	76	18	68	8	6	1.082	8	0	0	0	1.5	2.0	3.2	mod ah, med russet skin, oblong blocky type
AOR11217-3[abdefgj]	243	375	64	29	59	5	7	1.081	9	5	3	0	0.9	3.2	2.2	heavy netted skin, long tubular type, sl ah, attractive
Russet Burbank[h]	**232**	**444**	**49**	**38**	**47**	**2**	**13**	**1.071**	**0**	**0**	**0**	**5**	**2.5**	**3.3**	**3.8**	**tubular, bottlenecking and second growth in pos**
Ranger Russet[fgh]	209	396	50	41	50	0	9	1.083	0	10	0	0	3.0	3.1	3.4	tubular, med russet skin, mod knobs
A12114-7[eh]	189	294	64	29	62	2	7	1.081	0	5	0	0	2.3	3.5	3.5	med russet skin, marginal apperance
CO99076-3RUS[abdegj]	144	309	45	38	40	5	17	1.067	3	1	2	0	0.4	2.6	2.3	knobs and gc in pos, tubular type, marginal appearance
Umatilla Russet[f]	142	287	50	37	50	0	13	1.078	0	0	0	0	0.5	2.0	2.0	heavy eyebrows, med russet
Clearwater Russet[fg]	119	274	44	50	43	1	6	1.081	0	5	0	0	0.8	1.4	2.9	smaller size profile, points and pears in pos
ATX13018-2RUS[e]	93	179	52	47	52	0	1	1.045	0	10	10	0	2.5	3.0	3.0	poor appearance
MEAN	**308**	**426**	**70**	**21**	**61**	**9**	**9**	**1.075**	**8**	**3**	**1**	**1**	**1.3**	**3.1**	**3.0**	

2020 RUSSET VARIETY TRIAL SITES

[a]Crawford Farms
[b]Horkey Farms
[c]Kitchen Farms Mini Bulk Trial
[d]Kitchen Farms Strip Trial
[e]Lennard Ag. Co.
[f]MRC Box Bin
[g]Walther Farms Norkotah Fertility Trial
[h]Walther Farms NFPT Trial
[i]Walther Farms NFPT Add Ons Trial
[j]Verbrigghe Farms

[1]SIZE

Russets
Bs: < 4 oz
As: 4 - 10 oz
OV: > 10 oz
PO: Pickouts

[2]SPECIFIC GRAVITY

Data not replicated

[6]VINE MATURITY RATING

Date: Variable
Rating 1-5
1: Early (vines completely dead)
5: Late (vigorous vines, some flowering)

[3]RAW TUBER QUALITY

(percent of tubers out of 10)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[4]COMMON SCAB RATING

0.0: Complete absence of surface or pitted lesions
1.0: Presence of surface lesions
2.0: Pitted lesions on tubers, though coverage is low
3.0: Pitted lesions common on tubers
4.0: Pitted lesions severe on tubers
5.0: More than 50% of tuber surface area covered in pitted lesions

[5]VINE VIGOR RATING

Date: Variable
Rating 1-5
1: Slow emergence
5: Early emergence (vigorous vine, some flowering)

Table 10. 2020 Tablestock Potato Variety Trial
Overall Averages - Eight Locations

	LINE	CWT/A		PERCENT OF TOTAL[1]					SP GR[2]	RAW TUBER QUALITY[4] (%)				COMMON SCAB	VINE VIGOR[7]	VINE MATURITY[8]	YELLOW FLESH		RED SKIN				COMMENTS
		US#1	TOTAL	US#1	Bs	As	OV	PO		HH	VD	IBS	BC				WAXINESS[7]	FLESH COLOR[8]	WAXINESS[7]	SKIN COLOR[9]	UNIFORMITY[10]	SILVER SCURF[11]	
YELLOW SKIN TYPE	Columba[abcg]	519	601	85	11	85	0	4	1.054	0	1	0	0	0.8	3.8	1.6	3.6	2.6					non unIFrom, tr heat sprouts, tr ah, points, oval
	MSZ615-2[abd]	487	534	91	7	91	0	2	1.065	10	7	7	0	1.3	3.5	2.7	1.8	2.5					flattened round type, netted
	Cascada[d]	469	813	58	38	58	0	4	1.074	0	0	0	0	2.5	4.5	4.0	4.5	5.0					oval to oblong, bright, sl netted
	Golden Globe[abceg]	420	542	76	18	76	0	6	1.063	2	4	2	0	1.0	3.8	2.3	4.1	2.3					round, mooth, bright, uniform, sl netting, tr knobs
	MSCC515-2Y[dh]	419	471	89	7	89	0	4	1.073	0	15	0	0	1.0	3.3	3.5	2.5	2.3					round uniform type, netted, shallow eyes
	Paroli[abcg]	412	504	81	10	81	0	9	1.057	0	2	0	0	1.1	4.0	1.2	3.6	3.3					oblong type, attractive appearance, uniform, sl netting
	Tyson[abcg]	404	477	84	11	84	0	5	1.071	0	3	10	0	1.1	3.8	2.8	3.3	2.1					sl netted skin, round, tr sheep nose, bright appearance
	Jennifer[b]	401	564	71	22	71	0	7	1.060	0	0	10	0	3.5	3.5	2.5	4.5	1.0					bright, oblong to long type
	CO11250-1W/Y[gbd]	397	576	68	30	68	0	2	1.085	0	0	3	0	0.3	4.5	3.0	2.5	2.6					pink spl around eyes, oblong, netted
	MSFF247-2Y[f]	394	469	84	13	84	0	3	1.070	0	0	0	0	2.0	3.5	2.5	3.5	2.0					bright skin finish
	Connect[abdg]	386	601	65	21	65	0	14	1.070	0	9	10	0	1.6	4.0	4.1	2.5	2.7					mod netting, flat oval type, sl points
	Yukon Gold[abdg]	**383**	**425**	**90**	**4**	**89**	**1**	**6**	**1.078**	**8**	**0**	**8**	**1**	**2.1**	**3.5**	**2.3**	**2.9**	**2.6**					**round blocky type, misshapen pos, pink spl around eyes**
	W15240-2Y[bdg]	381	501	75	23	75	0	2	1.060	0	0	4	0	1.6	3.8	2.7	2.8	2.7					oval type, uniform, sl netting, buff skin
	Nectar[abcg]	354	557	63	33	63	0	4	1.075	5	10	3	3	2.1	3.6	4.2	2.3	2.2					sl flattened oval type, pink splash around eyes, pears in pos
	MSV093-1Y[abdh]	349	406	86	4	82	4	10	1.067	8	0	0	0	0.8	2.8	3.8	1.9	2.9					large blocky type, deep eyes, light netted skin
	Nixie[abdeg]	349	527	66	28	66	0	6	1.073	0	0	0	0	2.3	3.4	3.2	3.5	3.8					sl netted skin, oval to oblong type
	Melody[abg]	344	458	74	20	74	0	6	1.067	3	0	3	0	1.1	3.3	3.6	3.4	2.7					oval type, bright appearance, tr gc
	Allora[abceg]	339	438	75	15	73	2	10	1.066	0	0	0	0	1.1	3.2	2.2	3.7	2.9					bright, oval, sl netting, sl pears in pos
	Tacoma[adg]	323	444	72	19	72	0	9	1.066	0	6	0	0	1.2	3.2	3.0	2.7	3.9					oblong, netted skin, points
	MSW038-4Y[abdg]	320	418	74	21	74	0	5	1.069	0	0	0	3	1.5		3.4	2.1	3.0					round, uniform, sl gc, netted skin
	Constance[abcg]	298	455	66	29	66	0	5	1.065	0	0	5	0	1.5	3.8	2.6	3.0	3.3					oval, attractive, sl ah, sl pears, bright
	Maggie[abceg]	290	383	74	24	74	0	2	1.050	0	0	0	0	1.1	3.1	1.2	3.1	3.9					smaller round type, sl netting, tr heat sprouts
	Queen Anne[abdeg]	275	442	60	39	59	1	1	1.056	0	0	0	0	1.9	2.8	2.5	4.2	4.0					oblong type, buff skin, nice appearance
	MSZ268-1Y[g]	247	268	92	6	92	0	2	1.071	0	20	0	0	0.2	1.8	4.7	3.2	1.7					round, uniform, heavy netted skin, sl ah
	MSFF069-1Y[f]	211	223	94	6	94	0	0	1.066	0	0	0	0	1.0	2.0	2.0	2.0	2.0					oval, sl netting
	MSFF055-1Y[f]	201	252	79	21	79	0	0	1.072	0	0	0	0	0.5	1.5	2.5	3.5	2.5					sl netting, attractive shape
	Tessa[f]	183	226	81	17	81	0	2	1.074	0	0	0	0	2.0	1.5	4.0	2.5	2.5					uniform, oblong
	Anouk[g]	173	371	47	50	47	0	3	1.068	7	0	0	0	1.3	2.8	3.8	3.3	2.0					smaller type, netted skin, round
	Tokio[f]	84	172	49	49	49	0	2	1.081	0	0	0	0	1.5	1.5	4.5	3.0	3.5					sl pigmentation in vascular ring
	Lucera[a]	66	503	13	79	13	0	8	1.067	0	0	0	0	1.0	3.0	2.5	3.0	3.5					oblong to long tubers, misshapen pos
	Mary Ann[f]	54	118	46	50	46	0	4	1.071					2.0	1.0	4.5	4.0	2.5					smooth oval type, bright appearance
	MEAN	320	443	72	23	72	0	5	1.068	1	3	2	0	1.4	3.1	3.0	3.1	2.8					
RED SKIN TYPE	Fenway Red[abcg]	505	605	83	13	83	0	4	1.072	0	3	3	0	1.1	4.2	2.9			3.0	2.7	3.4	2.9	bright apperance, round, sl netting
	NDAF113484B-1[abdg]	424	488	85	10	85	0	5	1.058	0	1	0	0	0.5	3.1	2.7			3.5	4.4	4.8	3.8	attractive skin color, uniform round type, severe silver scurf
	MSW343-2R[abdg]	417	479	87	11	87	0	2	1.054	0	20	0	0	1.0	2.3	3.0			3.0	2.9	3.7	1.3	deep eyes, sl sticky stolons, poor appearance
	NDA050237B-1R[abdg]	396	482	78	19	78	0	3	1.061	3	3	5	0	0.8	3.3	3.9			3.2	4.9	4.5	2.6	uniform oval type, sl sticky stolons, nice skin color
	Roko[abdh]	389	562	69	21	69	0	10	1.070	0	0	28	0	1.0	3.4	4.0			3.4	1.8	4.4	2.0	
	ND1394-5RY[f]	358	400	89	8	89	0	3	1.074	0	0	0	0	1.5	3.0	2.5		2.0	3.0	4.0	5.0	3.5	light yellow flesh
	Vicki[abcg]	349	490	72	20	72	0	8	1.067	0	0	0	0	0.6	3.1	3.3			2.6	1.8	4.1	2.2	
	Dark Red Norland[abdg]	**342**	**421**	**80**	**16**	**80**	**0**	**4**	**1.059**	**0**	**0**	**0**	**0**	**0.8**	**3.6**	**1.7**			**3.3**	**3.1**	**1.8**	**4.3**	**oval type, inconsistent skin color and finish, mod scurf**
	MSFF225-04R[f]	341	387	88	9	88	0	3	1.065					0.0	2.5	2.0			2.0	3.0	3.0	2.5	
	CO99076-6R[abcg]	335	391	85	10	85	0	5	1.070	0	3	1	0	2.1	2.9	2.3			4.4	5.0	4.6	2.2	uniform round type, nice skin color, sl gc
	Norland RP[abdeg]	322	391	78	19	76	2	3	1.061	0	4	0	0	0.6	3.4	1.8			3.0	4.2	3.6	3.2	
	MSZ427-3R[g]	320	363	88	10	88	0	2	1.063	0	0	0	0	0.5	2.0	2.5			2.5	2.8	4.3	2.7	flattened round type
	Ricarda[dg]	319	421	75	18	75	0	7	1.066	0	12	0	0	0.9	4.3	3.6			4.4	2.1	4.4	1.9	
	MSX324-2R[abdg]	307	392	78	15	78	0	7	1.072	0	3	3	3	0.9	3.3	2.5			3.7	3.5	3.8	3.4	sl ah, gc in pos, lighter skin color
	AAC Red Viola[g]	275	352	84	16	78	6	0	1.073	0	0	0	0	0.0	2.5	2.7			2.3	4.2	4.3	2.8	round to oval type, pear shapes, uniform, attractive
	CO14105-1R*[g]	267	333	80	18	80	0	2	1.058	0	0	0	0	1.5	2.3	2.7			2.0	4.0	4.2	2.7	uniform skin color
	Canadian Rose[h]	263	300	88	6	88	0	6	1.068	0	40	0	0	1.0	1.5	3.0			2.5	4.5	5.0	3.0	round to oval type, attractive skin color
	NDTX4784-7R[h]	227	247	92	5	83	9	3	1.059	0	0	0	0	2.0	1.5	3.5			2.5	4.5	4.5	4.5	dark red skin color, sl ah, blocky
	MSFF304-2R[f]	224	314	71	27	71	0	2	1.077	0	0	0	0	1.0	2.0	3.0			3.5	1.0	5.0	1.0	lighter pink skin
	CO15205-4R[f]	222	289	77	14	77	0	9	1.074	0	0	0	0	2.0	1.0	2.5			5.0	4.5	5.0	4.5	attractive shape and skin color
	CO14074-1R*[g]	198	268	74	19	74	0	7	1.072	0	0	0	0	0.0	1.8	3.3			3.0	5.0	5.0	3.0	sl ah, points in pos
	ND1466CB-1R[f]	196	239	82	11	82	0	7	1.072	0	0	0	0	1.5	1.5	2.5			4.0	5.0	4.5	1.5	sl gc
	CO15121-3R[f]	126	167	76	20	76	0	4	1.071	0	30	0	0	1.0	1.5	1.5			3.5	5.0	4.0	3.0	pink pigmentation in vasc ring, sl sticky stolons
	Blushing Belle[g]	121	315	38	25	38	0	37	1.060	0	0	0	0	0.2	3.0	3.5			2.2	1.3	3.2	1.2	misshapen pos, bottlenecks, inconsistent skin color
	CO14040-3R*[g]	116	272	42	57	42	0	1	1.074	0	3	0	0	0.0	2.6	1.5			2.5	3.5	3.3	2.7	very small, unfirm, round, uniform
	CO14048-2R[f]	88	137	64	31	64	0	5	1.062	0	0	0	0	2.0	1.5	2.5			4.5	4.5	4.0	0.5	attractive shape and skin finish
	MSFF138-04R[f]	37	66	57	39	57	0	4	1.080					1.0	1.0	3.0			1.0	4.0	4.5	0.5	
	ND13292B-3R[f]	28	44	63	29	63	0	8	1.067					0.0	1.0	2.0			4.0	4.5	3.0	2.5	
	ND1466CB-2[f]	14	31	46	43	46	0	11	1.063					0.0	2.0	1.0			2.5	3.5	3.0	4.5	attractive color and type
	MEAN	260	333	75	19	74	1	6	1.067	0	5	2	0	0.9	2.4	2.6			3.1	3.6	4.1	2.6	
ROUND WHITE TYPE	**Reba[bd]**	**624**	**656**	**95**	**4**	**94**	**1**	**1**	**1.069**	**10**	**10**	**5**	**0**	**2.3**	**4.0**	**2.8**	**2.0**						**large type**
	MSAA120-1[bd]	515	555	93	5	91	2	2	1.064	25	0	0	0	2.8	3.0	4.0	1.0						large, blocky, netted, marginal appearance
	MSCC302-1[abd]	458	551	82	17	82	0	1	1.078	13	0	0	0	0.8	3.3	3.0	2.8						uniform round type, bright, mod BSB
	NDAF102629C-4[d]	452	506	89	10	89	0	1	1.074	0	10	0	0	2.0	5.0	2.5	1.0						netting, patches of ah, misshapen pos
	MSCC300-1[bd]	423	543	79	11	78	1	10	1.069	40	5	0	0	2.0	3.0	4.3	3.5						flat, tr gc, bright appearance
	Algonquin[bdg]	418	492	86	8	86	0	6	1.073	0	0	10	0	1.2	4.2	2.3	2.7						blocky oval type, non uniform, misshapen pos
	Superior[bd]	**415**	**521**	**80**	**13**	**80**	**0**	**7**	**1.069**	**0**	**20**	**0**	**0**	**0.5**	**4.8**	**1.3**	**1.5**						**netted round type, misshapen pos**
	Audrey[abcg]	413	527	77	13	77	0	10	1.063	0	3	3	0	1.2	3.6	2.3	3.6						oval type, points in pos, mod netting, bright
	HZC 01-1356[abcg]	407	525	77	20	77	0	3	1.066	0	13	3	0	1.6	3.3	2.1	3.3						uniform round type, bright, sl gc
	MSBB351-1[bd]	403	450	90	5	89	1	5	1.052	10	0	0	0	0.8	3.0	3.0	1.8						pink spl around eyes, sheep nose, points in pos
	MSAA196-1[d]	369	473	78	15	78	0	7	1.067	0	0	0	0	0.5	2.5	3.5	4.5						flat, oval, bright skin, tr gc
	MSAA174-1[ad]	328	390	81	12	81	0	7	1.061	0	15	10	5	1.0	2.8	2.8	3.8						sl ah, bright appearance, oval tyype
	Envol[abceg]	283	342	82	13	76	6	5	1.067	0	0	0	0	2.1	4.3	1.0	3.1						flat blocky type, pink eye or PVY, sl gc and knobs in pos
	MEAN	424	502	84	11	83	1	5	1.067	8	6	2	0	1.4	3.6	2.7	2.7						

	MSV443-1PP[d]	590	685	86	14	86	0	0	1.063	0	0	0	0	1.0	3.5	2.0			1.0	5.0	5.0	5.0	netted skin, less bright
NOVELTY	MSV443-6P[a]	443	525	84	15	84	0	1	1.070	0	0	0	0	1.0	2.5	2.5			4.5	5.0	4.5	3.5	mod ah, round type, sl deep apical eyes, lumps
TYPE	Blackberry[ad]	350	449	76	19	76	0	5	1.068	0	0	0	0	0.0	2.5	3.3			3.8	5.0	5.0	4.5	severe scurf, uniform round type
	MSZ413-6P[a]	121	244	50	48	50	0	2	1.066	0	0	0	0	0.0	2.5	2.5			1.5	5.0	5.0	1.0	tr ah, sticky stolons, uniform skin, small uniform tubers
	MEAN	376	476	74	24	74	0	2	1.067	0	0	0	0	0.5	2.8	2.6			2.7	5.0	4.9	3.5	
	TRIAL MEAN	**318**	**413**	**75**	**20**	**75**	**0**	**5**	**1.067**	**2**	**4**	**2**	**0**	**1.2**	**2.9**	**2.8**	**3.0**	**2.8**	**3.0**	**3.8**	**4.2**	**2.7**	

[1]SIZE
Non-russet tablestock
Bs: < 1 7/8"
As: 1 7/8" - 3 1/4"
OV: > 3 1/4"
PO: Pickouts

[2]SPECIFIC GRAVITY
Data not replicated

[3]RAW TUBER QUALITY
(percent of tubers out of 10)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[4]COMMON SCAB RATING
0.0: Complete absence of surface or pitted lesions
1.0: Presence of surface lesions
2.0: Pitted lesions on tubers, though coverage is low
3.0: Pitted lesions common on tubers
4.0: Pitted lesions severe on tubers
5.0: More than 50% of tuber surface area covered in pitted lesions

[5]VINE VIGOR RATING
Date: Variable
Rating 1-5
1: Slow emergence
5: Early emergence

[6]VINE MATURITY RATING
Date: Variable
Rating 1-5
1: Early (vines completely dead)
5: Late (vigorous vines, some flowering)

[7]WAXINESS RATING
1: Heavy netting, buff
5: Waxy, smooth

[8]FLESH COLOR
1: White
5: Dark yellow

2020 TABLESTOCK VARIETY TRIAL SITES
[a]Crawford Farms, Montcalm County
[b]Horkey Brothers, Monroe County
[c]Kitchen Farms Mini Bulk, Antrim County
[d]Kitchen Farms, Antrim County
[e]Verbrigghe Potato Farms, Delta County
[f]Walther Farms Early Generation Selection, Tuscola County
[g]Walther Farms Replicated, Tuscola County
[h]Walther Farms, Tuscola County

[9]SKIN COLOR
1: Light pink
5: Dark red

[10]UNIFORMITY OF SKIN COLOR
1: Highly variable, non-uniform
5: Highly uniform, color throughout

[11]SILVER SCURF
0: No incidence of silver scurf
5: High incidence of silver scurf

Table 11. 2020 Russet Potato Variety Trial
NFPT and Added Lines

Planting: 5/8/20 Vine Kill: 8/26/20 Harvest: 9/29/20

GDD_{40}: 3319

	CWT/A		PERCENT OF TOTAL[1]						RAW TUBER QUALITY[3] (%)				COMMON SCAB	VINE	VINE	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR[2]	HH	VD	IBS	BC	RATING[4]	VIGOR[5]	MATURITY[6]	COMMENTS
AF5736-16	514	560	92	5	71	21	3	1.090	20	40	0	0	1.0	3.0	4.5	med to heavy russet, blocky, oblong, nice appearance
A12305-2adg	510	584	87	4	61	26	9	1.077	0	0	0	0	2.0	3.0	3.0	long, tubular, dark russet skin
CO11009-3RUS	493	530	93	6	88	5	1	1.088	60	0	0	0	2.0	4.0	2.0	
A12327-5VR	476	588	81	11	67	14	8	1.082	0	0	0	0	0.5	3.5	4.0	heavy russet skin, oval to oblong type
AFA5661-8	473	533	89	8	69	20	3	1.079	0	70	0	0	2.5	3.0	5.0	med russet skin, sticky stolons, ah
ND14110B-3RUS	470	560	84	13	73	11	3	1.079	0	0	0	0	3.0	3.5	3.0	oval to oblong, med russet skin, flat, blocky
AF5731-11	453	522	88	4	80	8	8	1.098	0	10	0	0	1.5	2.5	2.0	med russet skin, blocky, oblong
AF5770-7	450	530	85	9	67	18	6	1.086	0	0	0	10	2.0	3.0	4.5	mod ah, points, pears, less uniform
W13A11229-1RUS	440	539	82	14	82	0	4	1.087	0	0	0	0	0.5	3.0	3.0	
AAF10596-1	410	514	80	14	73	7	6	1.080	0	0	0	0	3.5	4.0	3.0	long, tubular, poor appearance, severe pitted scab
CO12246-1RUS	403	497	81	16	73	8	3	1.073	0	20	40	0	1.0	4.0	4.0	med russet skin, nice appearance
A12076-4sto	393	489	81	16	77	4	3	1.093	0	0	20	0	1.5	4.0	3.5	med russet skin, oblong type, sl ah
COAF11018-10	385	455	84	13	78	6	3	1.082	10	0	0	0	0.0	3.0	2.5	long, tubular, heavy russet, nice appearance
A10508-2LB	378	445	85	4	65	20	11	1.078	40	0	0	0	0.0	3.5	1.5	mod ah, knobs in pos
ND1412Y-5RUS	373	465	81	9	66	15	10	1.081	0	10	0	0	3.0	3.0	2.5	lt russet skin, blocky, poor appearance
Russet Burbank	**367**	**638**	**57**	**26**	**57**	**0**	**17**	**1.075**	**0**	**0**	**0**	**0**	**2.0**	**3.5**	**4.5**	**mod bottlenecking**
A13038-3	364	460	79	8	69	10	13	1.079	20	0	0	0	2.0	2.0	5.0	tubular, knobs, eyebrows, mod ah
A10020-3sto	360	502	72	22	68	4	6	1.088	0	20	0	0	2.0	2.5	1.5	heavy russet skin, long type, mod eyebrows
AOR13064-2	357	443	81	11	69	12	8	1.080	0	10	0	0	3.0	3.5	3.0	med russet skin, oblong blocky tubers
AOR10129-1	351	459	77	20	71	6	3	1.083	0	0	0	0	2.5	4.0	3.5	oblong, med russet skin
AF5711-2	348	427	82	8	46	36	10	1.080	0	0	0	0	2.5	3.0	3.0	blocky, oblong, misshapen and knobby pos
AF5741-6	346	415	83	14	76	7	3	1.061	0	20	0	0	2.0	4.0	4.0	lt russet skin, marginal appearance
A09136-9LB	344	455	75	14	68	7	11	1.087	20	0	10	0	3.0	4.5	3.0	med russet skin, misshapen pos
A12304-1sto	333	522	64	33	64	0	3	1.087	0	0	0	0	1.5	3.5	2.0	smaller flat oblong type, uniform appearance
A11326-1	333	400	83	15	70	13	2	1.088	50	0	0	0	2.5	3.0	4.0	lt russet skin, blocky, oblong, marginal appearance
NDAF113476CB-3	325	423	77	12	67	10	11	1.087	0	10	0	0	0.0	3.5	2.0	heavy russet skin, blocky, less uniform, tr pinkeye
A12308-4VR	324	440	74	18	69	5	8	1.083	0	0	0	0	1.0	3.0	4.0	flat oblong, med russet skin
AF5707-1	322	450	71	26	69	2	3	1.078	10	0	0	0	2.5	3.5	2.5	blocky oblong to long type, med russet
A13036-1	301	366	82	11	54	28	7	1.080	20	40	0	0	0.0	4.0	4.5	flattened oval to blocky type
AOR10654-11	287	370	77	10	62	15	13	1.083	10	20	0	0	2.0	4.0	5.0	med russet skin, knobs and gc in pos
ND13213B-1RUS	284	422	67	27	67	0	6	1.067	0	10	0	0	2.0	2.5	3.5	long type, bottlenecking, sl gc
A09086-1LB	283	456	62	34	57	5	4	1.084	10	10	0	0	4.0	3.5	4.5	lt russet skin
A10071-1	282	391	73	19	67	6	8	1.078	0	0	0	0	2.0	4.0	2.0	dark russet skin, oblong, eyebrows, knobs, points
Ranger Russet	278	482	58	31	58	0	11	1.083	0	20	0	0	3.0	3.0	2.5	tubular, knobs, bottlenecking
AF5735-8	273	394	69	20	63	6	11	1.069	0	0	0	0	2.0	3.0	3.0	long and tubular, less uniform
A10007-3	268	321	83	11	58	25	6	1.064	0	20	0	0	2.0	3.0	4.0	blocky, tubular, med russet skin
AOR11027-4	263	392	67	10	54	13	23	1.090	10	0	10	0	0.0	4.0	3.0	blocky oblong type, darker skin
A12115-16sto	260	591	44	51	44	0	5	1.072	0	30	0	0	3.5	4.0	5.0	long, tubular, light russet skin
CO12378-1RUS	255	381	67	25	64	3	8	1.081	80	10	0	0	0.0	4.5	3.5	sl ah, dark russet skin, less uniform
A12314-1sto	253	352	72	17	63	9	11	1.079	0	0	0	0	2.0	3.0	2.5	mod ah, tubular, med skin
CO12152-1RUS	243	389	62	38	62	0	0	1.090	0	0	10	0	1.5	2.5	3.0	sl ah
AF5750-16	242	501	48	35	48	0	17	1.080	0	0	0	0	2.0	3.5	3.0	long type, med russet, bottlenecking and points
A09022-4	212	318	66	30	66	0	4	1.075	0	20	0	0	2.0	4.0	4.0	apical anthocyanin pigmentation , lt russet skin
A08292-1LB	201	413	49	37	49	0	14	1.083	0	0	0	0	1.0	2.5	3.5	med russet skin, bottlenecking, points
A12304-4sto	193	407	47	31	43	4	22	1.072	0	10	0	0	2.0	3.5	3.5	long tubular type, light russet skin, knobs
A12114-7	179	265	67	29	67	0	4	1.082	0	0	0	0	2.0	3.0	3.0	small, med russet skin, marginal
AOR10093-11	147	302	48	35	48	0	17	1.076	0	0	0	0	0.0	3.0	3.5	ah, apical gc
A10635-2VR	78	368	21	63	21	0	16	1.078	0	0	0	0	2.5	3.0	4.5	tubular, small size, bottlenecking

WAF13027-2*		450	514	88	7	82	6	5	1.070	0	0	0	0	0.5	4.0	4.0	dark russet skin, blocky type, attractive appearance
AF6073-5*		389	546	71	27	64	7	2	1.074	0	0	20	0	3.0	4.0	3.0	pinkeye and prominent eyes
AF6086-7*		387	506	76	20	72	4	4	1.080	70	0	0	0	2.0	3.0	3.0	med russet skin, oblong, inconsistent shape, eyebrows
COAF13066-1*		361	488	74	13	67	7	13	1.089	0	10	0	0	0.0	3.0	4.5	flat blocky type, med russet skin, deeper eyes
COAF11018-10*		333	425	78	13	77	1	9	1.077	10	0	0	0	0.0	2.5	2.5	sl ah
AF5707-1*		299	467	65	28	61	4	7	1.074	10	0	0	0	2.0	3.5	4.0	flat, oblong, dark russet skin
	MEAN	**335**	**457**	**73**	**19**	**65**	**8**	**8**	**1.080**	**8**	**8**	**2**	**0**	**1.7**	**3.4**	**3.4**	

[1]SIZE

Russets
Bs: < 4 oz
As: 4 - 10 oz
OV: > 10 oz
PO: Pickouts

[2]SPECIFIC GRAVITY

Data not replicated

[3]RAW TUBER QUALITY

(percent of tubers out of 10)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[4]COMMON SCAB RATING

0.0: Complete absence of surface or pitted lesions
1.0: Presence of surface lesions
2.0: Pitted lesions on tubers, though coverage is low
3.0: Pitted lesions common on tubers
4.0: Pitted lesions severe on tubers
5.0: More than 50% of tuber surface area covered in pitted lesions

[5]VINE VIGOR RATING

Date:6/18/20
Rating 1-5
1: Slow emergence
5: Early emergence (vigorous vine, some flowering)

[6]VINE MATURITY RATING

Date: 8/18/20
Rating 1-5
1: Early (vines completely dead)
5: Late (vigorous vines, some flowering)

FIELD DATA

Planting Date	5/8/20
Vine Kill Date	8/26/20
Harvest Date	9/29/20
Days (planting to vine kill)	110
Days (planting to harvest)	145
GDD_{40} MAWN Station	Constantine
GDD_{40} (planting to vine kill)	3319
Seed Spacing	10"

* Denotes NFPT Add On variety

Evaluating New Potato Varieties for Herbicide Sensitivity-2020 MPIC Research Report

Erin Burns
Assistant Professor-Weed Science
Department of Plant, Soil, and Microbial Sciences
Michigan State University

The potato research team at MSU is continually striving to introduce new potato varieties that have improved agronomic, storability, and processing qualities compared to standard commercial varieties. In recent years, varieties like Silverton Russet have been introduced to the US commercial potato industry with susceptibility to commonly used broadleaf herbicides. In the commercialization process, many growers have experienced yield losses, and therefore significant economic loss, which results in slow variety adoption or even rejection. Many times the developer of new varieties is not aware of all potential weaknesses of a variety and is unable to warn growers of potential management concerns like herbicide sensitivities. To protect the commercial potato industry in Michigan from these unforeseen impacts, the Michigan State University Weed Science and Potato Outreach Programs propose that all potato varieties nearing commercialization be screened for sensitivity to commonly used herbicide treatments. Therefore, objective one of this research was to identify varietal sensitivity to commercially used herbicides prior to release. The following list of advanced chip and russets varieties are nearing commercialization in Michigan: Lady Liberty, Mackinaw, Petoskey, Reveille, and Vanguard. These varieties were compared to the check varieties Atlantic, Lamoka, Snowden, Russet Norkotah, and Russet Silverton.

Due to COVID restrictions, the planned field study was converted to a greenhouse study. The greenhouse study followed a randomized complete block design with three herbicide treatments and 10 potato varieties. Herbicides were applied using a greenhouse research sprayer when potatoes reached 12 inches tall. Herbicide treatments were matrix (1 oz/A), metribuzin (0.33 lb/A), and matrix plus Metribuzin tank mixed at the above rates. Herbicide injury ratings were taken 7, 14, and 21 days after treatment. Tubers were separated from plants, counted, and weighed 42 days after treatment. To access photos from this study visit: https://michiganstate-my.sharepoint.com/:p:/g/personal/burnser5_msu_edu/Efkmz7b3KZJKv4WcVr323hkB3jL1HHaKp51j_i9UI7otuw?e=PZZUBo.

Overall, potato varieties varied in their sensitivity to postemergence herbicides. Results from this greenhouse study should be validated in the field during 2021 as weather conditions greatly affect herbicide metabolism in potatoes. The Michigan Potato Industry Commission supported this research.

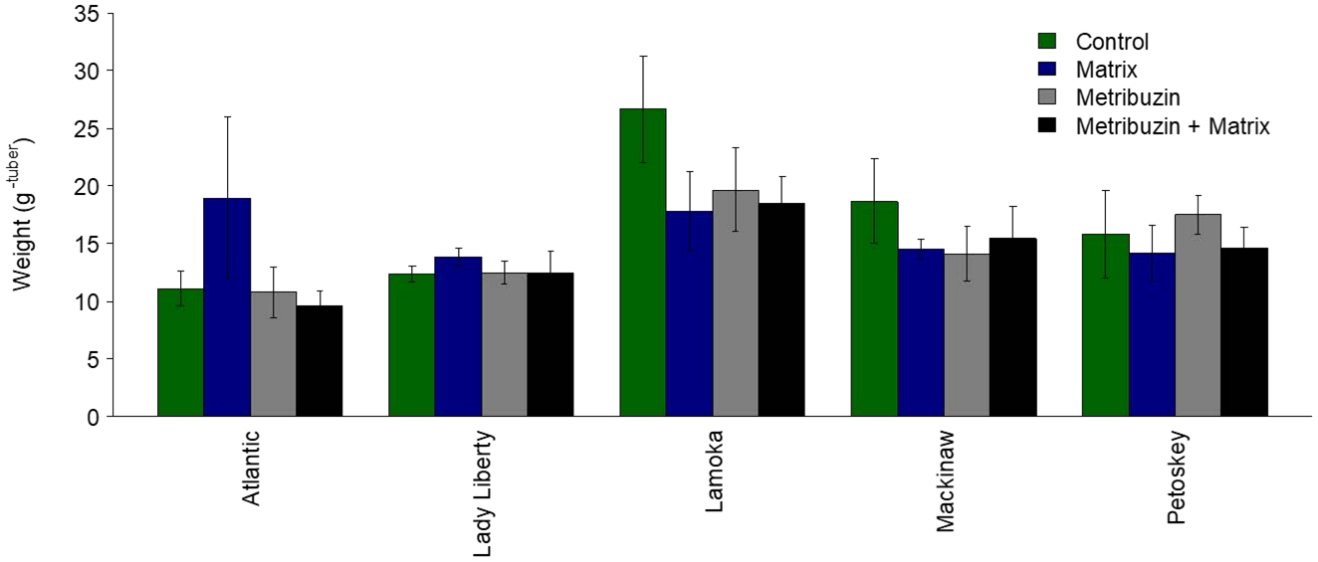


Figure 1. Mean tuber weight (g) from 2020 greenhouse screen.

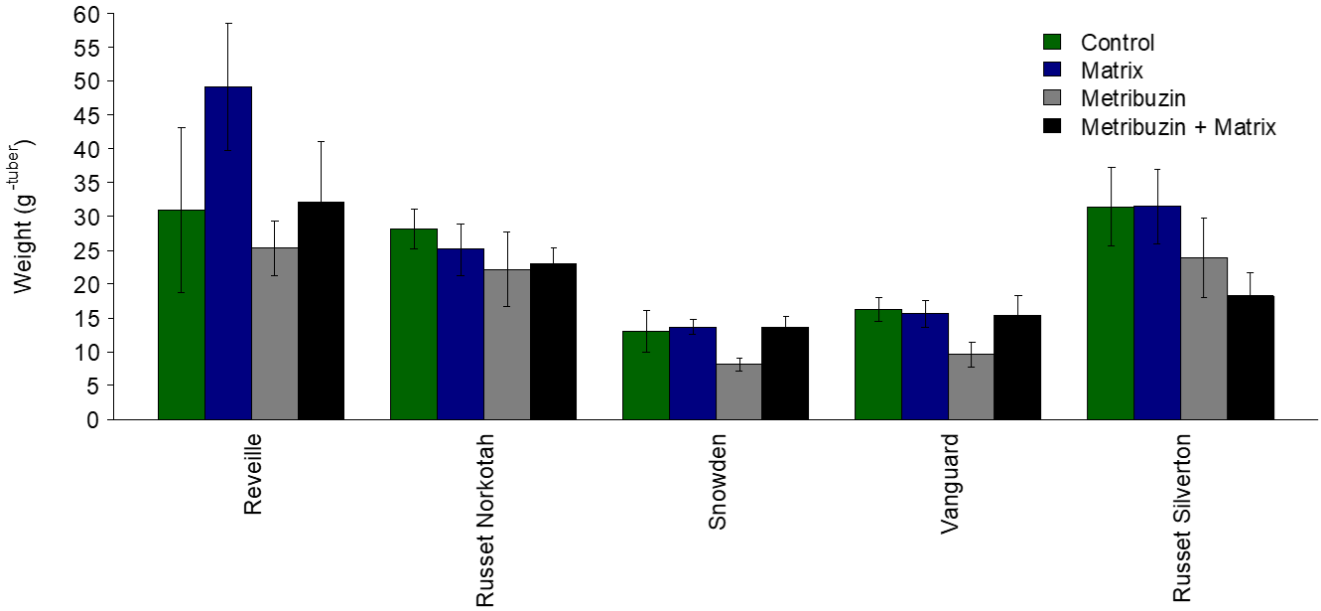


Figure 2. Mean tuber weight (g) from 2020 greenhouse screen.

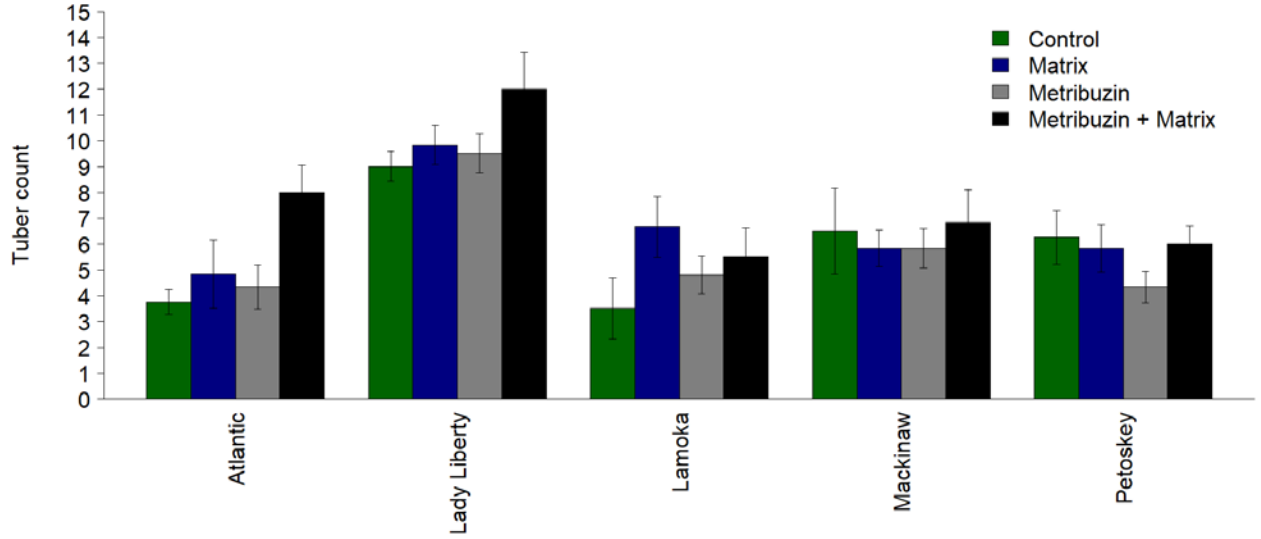


Figure 3. Mean tuber count from 2020 greenhouse screen.

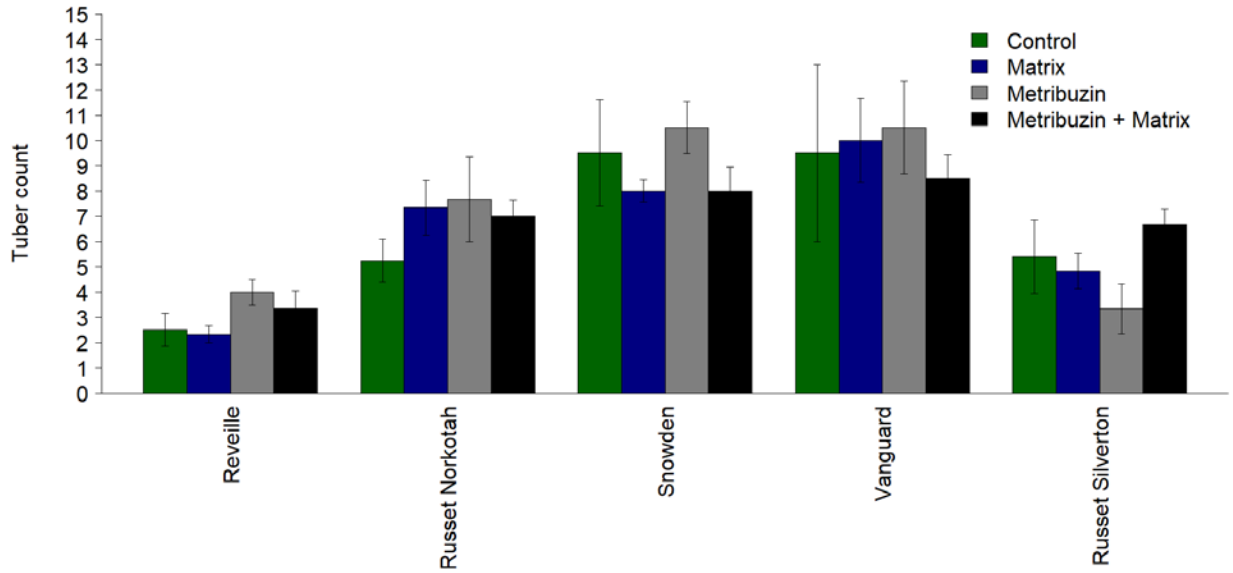


Figure 4. Mean tuber count from 2020 greenhouse screen.

Layering soil residual herbicides for troublesome weed control in potatoes-2020 MPIC Research Report

Erin Burns
Assistant Professor-Weed Science
Department of Plant, Soil, and Microbial Sciences
Michigan State University

Many troublesome weeds (horseweed/marestail, common waterhemp, palmer amaranth, common lambsquarters, and foxtails) in MI are shifting emergence patterns from a single early flush in the spring to extended emergence throughout the summer, therefore outlasting pre-emergence residual herbicide activity. Later emerging weeds can not only have yield impacts, but also be a harvest nuisance. Layering a residual soil-applied herbicide along with the post-emergence herbicide pass is one way to maintain a barrier to weeds emerging later in the growing season. Therefore, objective two was to evaluate layering different group 14 (examples Tuscany/Reflex) and 15 (examples Outlook/Dual) herbicides at two timings for season long weed control. Overall, results suggest both group 14 and 15 herbicides provide residual control and layering dual postemergence will improve season long weed control. Data is presented in the table below. The Michigan Potato Industry Commission supported this research.

Layering residuals for palmer amaranth control in potato

Study Dir.: Burns, Hart
Trial ID: P02-20 Conducted: Walther Farms Investigator: Erin Burns

Planting Date: Apr-24-2020
Variety: FL1867 **Population:**
Soil Type: SL sandy loam
Plot Size: 10 X 20 FT
Row Spacing: 34 IN
No. of Reps: 4
% OM: 2.2
pH: 6.3
Study Design: Randomized Complete Block (RCB)

Tillage/Previous Crops:
Fertilizer:

Crop and Weed Description

Weed	Code	Common Name	Scientific Name
1	ANGR	mainly foxtail species	Annual grasses
2	CHEAL	Common lambsquarters	Chenopodium album
3	AMAPA	Palmer amaranth	Amaranthus palmeri
4	AMBEL	Common ragweed	Ambrosia artemisiifolia
5	ABUTH	velvetleaf	Abutilon theophrasti

Crop	Code	Common Name
1	SOLTU	Potato

Application Description

	A	B
Application Timing:	PRE	POST
Date Treated:	May-21-2020	Jun-15-2020
Time Treated:	12:00 PM	10:30 AM
% Cloud Cover:	80	5
Air Temp., Unit:	70 F	61 F
% Relative Humidity:	35.6	51.6
Wind Speed/Unit/Dir:	4.3 MPH W	4.2 MPH SW
Soil Temp, Unit:	70 F	65 F
Leaf Moist/Dew Presence (Y/N):	N	N
Soil Moist:	4	3

Crop Stage at Each Application

	A	B
Crop 1 Name:	SOLTU	SOLTU
Height:		24 IN
Stage:		

Weed Stage at Each Application

	A	B
Weed 1 Name:	ANGR	ANGR
Height:		4.5 IN
Stage:		7 L
Weed 2 Name:	CHEAL	CHEAL
Height:		2.5 IN
Stage:		12 L
Weed 3 Name:	AMAPA	AMAPA
Height:		1.5 IN
Stage:		6 L
Weed 4 Name:	AMBEL	AMBEL
Height:		3 IN
Stage:		8 L
Weed 5 Name:	ABUTH	ABUTH
Height:		3 IN
Stage:		6 L

Application Equipment

Appl	Sprayer Type	Ground Speed	Nozzle Type	Nozzle Size	Nozzle Height	Nozzle Spacing	Boom Width	Spray Volume	Carrier	Operation Pressure
A	BKPK	3.0 MPH	AIXR	11003	22 "	20 "	100 "	19 GAL/AC	WATER	32 PSI
B	BKPK	3.0 MPH	AIXR	11003	26 "	20 "	100 "	19 GAL/AC	WATER	32 PSI

Comments:

Table of Contents

Michigan State University

Layering residuals for palmer amaranth control in potato

Trial ID: P02-20 Location: Walther Farms Trial Year: 2020
Protocol ID: P02-20 Investigator (Creator): Erin Burns
Project ID: Study Director: Burns, Hart
Sponsor Contact:

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	C SOLTU	ANGR	CHEAL	AMAPA	AMBEL	ABUTH	C SOLTU	ANGR
Pest Code												
Crop Type, Code												
Rating Date					Jun-15-2020	Jun-15-2020	Jun-15-2020	Jun-15-2020	Jun-15-2020	Jun-15-2020	Jul-17-2020	Jul-17-2020
Rating Type					Injury	Control	Control	Control	Control	Control	Injury	Control
Rating Unit					Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Trt-Eval Interval					0 DA-B	0 DA-B	0 DA-B	0 DA-B	0 DA-B	0 DA-B	32 DA-B	32 DA-B
1	Dual II Magnum	1.33	pt/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
1	Lorox DF	2	lb/a	A								
1	Dual II Magnum	1.33	pt/a	B								
2	Dual II Magnum	1.33	pt/a	A	0.0	99.5	100.0	100.0	100.0	100.0	0.0	99.5
2	Lorox DF	2	lb/a	A								
3	Reflex	1	pt/a	A	0.0	87.5	100.0	100.0	100.0	100.0	0.0	87.5
3	Lorox DF	2	lb/a	A								
3	Matrix	1.5	oz/a	A								
3	Dual II Magnum	1.33	pt/a	B								
4	Reflex	1	pt/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
4	Lorox DF	2	lb/a	A								
4	Matrix	1.5	oz/a	A								
5	Untreated				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Valor SX	1.5	oz/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
6	Matrix	1.5	oz/a	A								
6	Dual II Magnum	1.33	pt/a	B								
7	Valor SX	1.5	oz/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
7	Matrix	1.5	oz/a	A								
8	Zidua SC	2.5	fl oz/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
8	Lorox DF	2	lb/a	A								
8	Dual II Magnum	1.33	pt/a	B								
9	Zidua SC	2.5	fl oz/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
9	Lorox DF	2	lb/a	A								
10	Dual II Magnum	2	pt/a	A	0.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0
10	Lorox DF	2	lb/a	A								
LSD P=.05					.	11.50	.	.	.	.	.	11.50
Standard Deviation					0.00	7.92	0.00	0.00	0.00	0.00	0.00	7.92
CV					0.0	8.93	0.0	0.0	0.0	0.0	0.0	8.93

Could not calculate LSD (% mean diff) for columns 1,3,4,5,6,7,9,10,11,12 because error mean square = 0.

Table of Contents

Michigan State University

Layering residuals for palmer amaranth control in potato

Trial ID: P02-20 Location: Walther Farms Trial Year: 2020
Protocol ID: P02-20 Investigator (Creator): Erin Burns
Project ID: Study Director: Burns, Hart
Sponsor Contact:

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	CHEAL	AMAPA	AMBEL	ABUTH
	Pest Code				CHEAL	AMAPA	AMBEL	ABUTH
	Crop Type, Code							
	Rating Date				Jul-17-2020	Jul-17-2020	Jul-17-2020	Jul-17-2020
	Rating Type				Control	Control	Control	Control
	Rating Unit				Percent	Percent	Percent	Percent
	Trt-Eval Interval				32 DA-B	32 DA-B	32 DA-B	32 DA-B
1	Dual II Magnum	1.33	pt/a	A	100.0	100.0	100.0	100.0
1	Lorox DF	2	lb/a	A				
1	Dual II Magnum	1.33	pt/a	B				
2	Dual II Magnum	1.33	pt/a	A	100.0	100.0	100.0	100.0
2	Lorox DF	2	lb/a	A				
3	Reflex	1	pt/a	A	100.0	100.0	100.0	100.0
3	Lorox DF	2	lb/a	A				
3	Matrix	1.5	oz/a	A				
3	Dual II Magnum	1.33	pt/a	B				
4	Reflex	1	pt/a	A	100.0	100.0	100.0	100.0
4	Lorox DF	2	lb/a	A				
4	Matrix	1.5	oz/a	A				
5	Untreated				0.0	0.0	0.0	0.0
6	Valor SX	1.5	oz/a	A	100.0	100.0	100.0	100.0
6	Matrix	1.5	oz/a	A				
6	Dual II Magnum	1.33	pt/a	B				
7	Valor SX	1.5	oz/a	A	100.0	100.0	100.0	100.0
7	Matrix	1.5	oz/a	A				
8	Zidua SC	2.5	fl oz/a	A	100.0	100.0	100.0	100.0
8	Lorox DF	2	lb/a	A				
8	Dual II Magnum	1.33	pt/a	B				
9	Zidua SC	2.5	fl oz/a	A	100.0	100.0	100.0	100.0
9	Lorox DF	2	lb/a	A				
10	Dual II Magnum	2	pt/a	A	100.0	100.0	100.0	100.0
10	Lorox DF	2	lb/a	A				
	LSD P=.05				.	.	.	.
	Standard Deviation				0.00	0.00	0.00	0.00
	CV				0.0	0.0	0.0	0.0

Could not calculate LSD (% mean diff) for columns 1,3,4,5,6,7,9,10,11,12 because error mean square = 0.

Table of Contents

Developing Yield Maps in Potatoes Using Thermal Imagery to Understand How In-Season Spatial Variation of Growth Affects Tuber Development and Yield (1st Year – Report)

Michigan Potato Industry Commission Report

Bruno Basso, PhD.
University Foundation Professor
Department of Earth & Environmental Sciences
Michigan State University

Rationale

Historical productivity is an important component of understanding trends of spatial and temporal variability throughout the agricultural landscapes of Michigan. Visualizing this productivity with yield maps for every crop in the rotation reveals parts of the field where yield varies or remains consistent. Maestrini and Basso (2018) found that these spatial trends can be described through an analysis of these historical yields over time. These yield stability maps (YSMs) are useful tools for the designing of site-specific management, where resources are more efficiently applied. It is important to consider how each crop in the rotation affects overall productivity and how that impacts the whole system. The availability of these maps has been limited to grain crops (e.g., corn, soybean, wheat) due to the applicability of yield monitors within grain combines. However, the importance of including specialty crops like potatoes in these analyses is valuable in discerning potato yield trends over the course of more than a single growing season. Yield monitors affixed to potato harvesters are rare, however data analyzed by the Basso Digital Agronomy Lab from the past three seasons confirms their similarity with grain monitors. For farms without the possibility of yield monitors on their potato harvester, discerning these trends can be visualized by using remotely sensed imagery. Satellites, planes, and unmanned aerial vehicles (UAVs) carry cameras and sensors that capture the plant's reflectance of sunlight across many spectral wavelengths. Using known relationships based on reflectance, plant health is quantified and measured, revealing the similar patterns found from grain yield monitors. Reflectance in the thermal band has shown to be of particular importance, because an analysis of a composite of these images reveals a major similarity with historical productivity as described in these YSMs.

Objectives

The primary objective of this proposal was to test the ability of remotely sensed imagery to create maps of yield productivity in potato fields using thermal reflectance. Thermal stability maps (TSMs) were created from fields in rotation with potatoes during the 2020 growing season.

Methodology

Commercial potato fields from the 2020 growing season in Montcalm county were used in this analysis (Table 1). The fields were managed by Main Farms located in Trufant, MI. Irrigation was provided by center pivots throughout the season. Specific images taken while the irrigator was running were removed from the analysis to ensure a consistent reflectance of sunlight with each image throughout the year. To create the thermal stability maps, all the image raster datasets are normalized by using the following equation:

$$Normalized\ Raster_{Yr} = (Raster_{Yr} - \mu Raster_{Yr})\ x\ \frac{100}{\mu Raster_{Yr}}$$

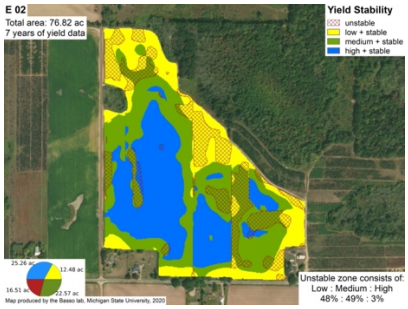
The thermal stability map is a composite of these images over the growing season that separates regions of the field into four categories based on their reflectance of temperature: Cold + stable, medium + stable, hot + stable, and unstable. The stable categories represent consistent zones of cold, hot, and a middle temperature in between the two. In these cold zones, plants reflect lower temperatures because they have adequate water and transpiration is happening at a normal rate. The medium temperature zones are contained within the small gap between the cold and hot zones. The hot zones are areas where the plants are warmer because they do not have an adequate supply of water. These plants are running a "fever". Finally, the unstable zones are where the temperature fluctuates more than one standard deviation from the mean for that particular field. Here, temperatures are colder when more water is present and hotter when water is not available. These zones are generally found near the field edges, in areas that are less likely to receive supplemental irrigation from pivots located closer to the center of the field.

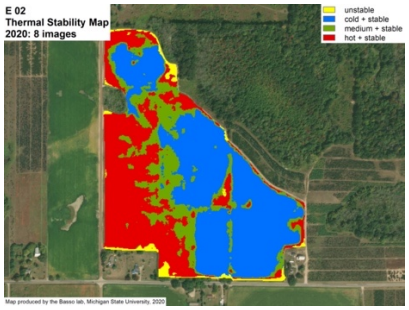
Field	Field Acreage	Thermal Stability Map	Yield Stability Map	2020 Potato Yield Monitor
E2	76.82	Yes	Yes	Yes
R07	155.06	Yes	Yes	Yes
R12	73.37	Yes	Yes	Yes
M6	17.52	Yes	Yes	No
M7	18.41	Yes	Yes	No
M8	86.27	Yes	Yes	No
P18	110.34	Yes	Yes	No

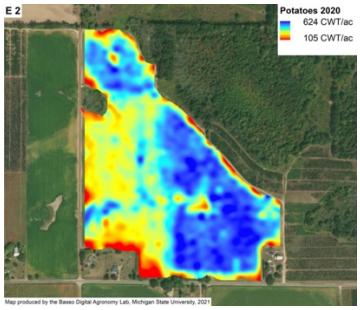
Table 1. Fields monitored in 2020, their acreage, and the geospatial data available for this project.

A total of 10 images were collected throughout the season for each field, however, 2 images were removed from the thermal stability analysis due to the irrigator running while the image was taken. Images collected while the water is running creates an unfair bias in the thermal stability map creation. Yield stability maps for these seven fields were created using previous historical yield data. Finally, potato yield monitor data were available for three of the seven fields.

Results







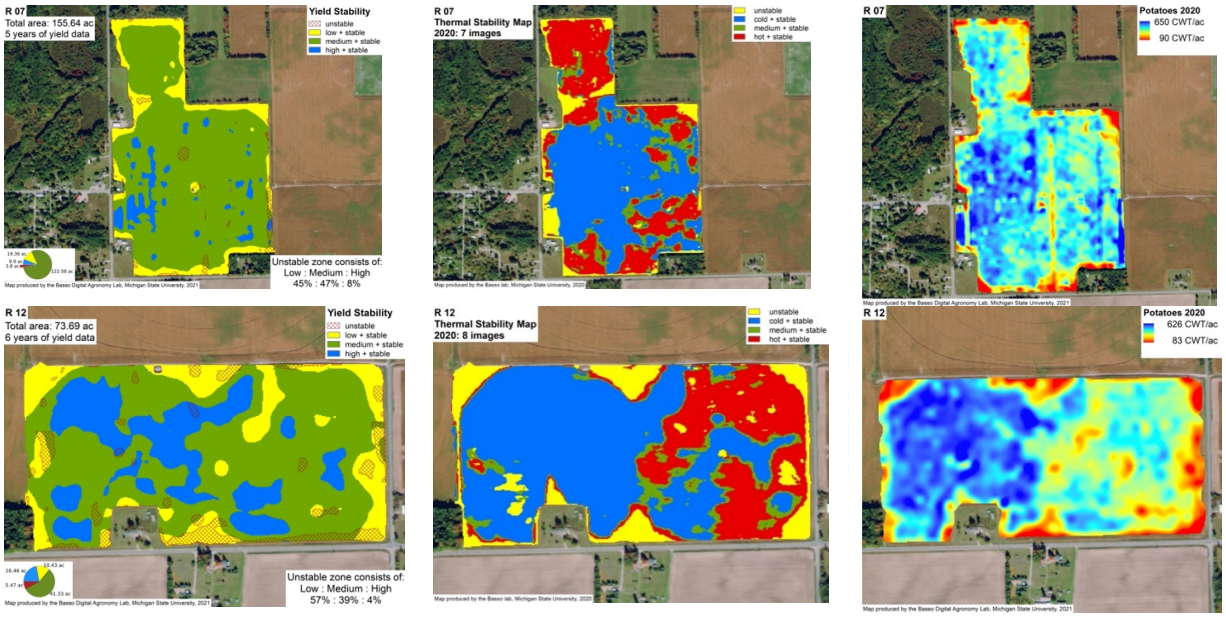
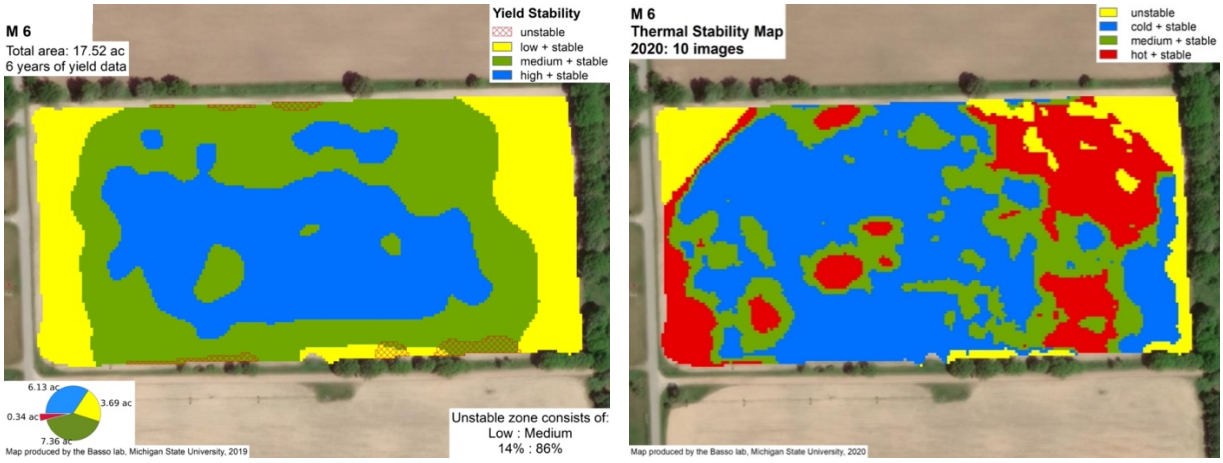


Figure 1. Yield stability 5-7 (left) years of grain yield data, thermal stability (center), and potato yield data (right) for 2020 growing season.

Initial visual analysis of the fields with yield data (E2, R7, R12) shows similar trends across each field (Figure 1). Yield stability maps made from historical grain yield data, thermal stability maps in 2020, and 2020 potato yield monitor data are visually correlated. Spatial patterns of higher yields (dark blue) visible in the potato yield monitor are associated with cold + stable zones in the thermal stability map. The trends of lower yield (yellows, reds) appear in areas of hot + stable zones. The thermal stability maps from the potato fields (Figure 1, center) are an effective indicator of yield (Figure 1, right) given that the imagery were taken over the course of the potatoes' growing season. These yield stability maps (Figure 1, left) were made from 7, 5, and 6 years (fields E2, R7, and R12) of grain yield data and potato yields were not included.



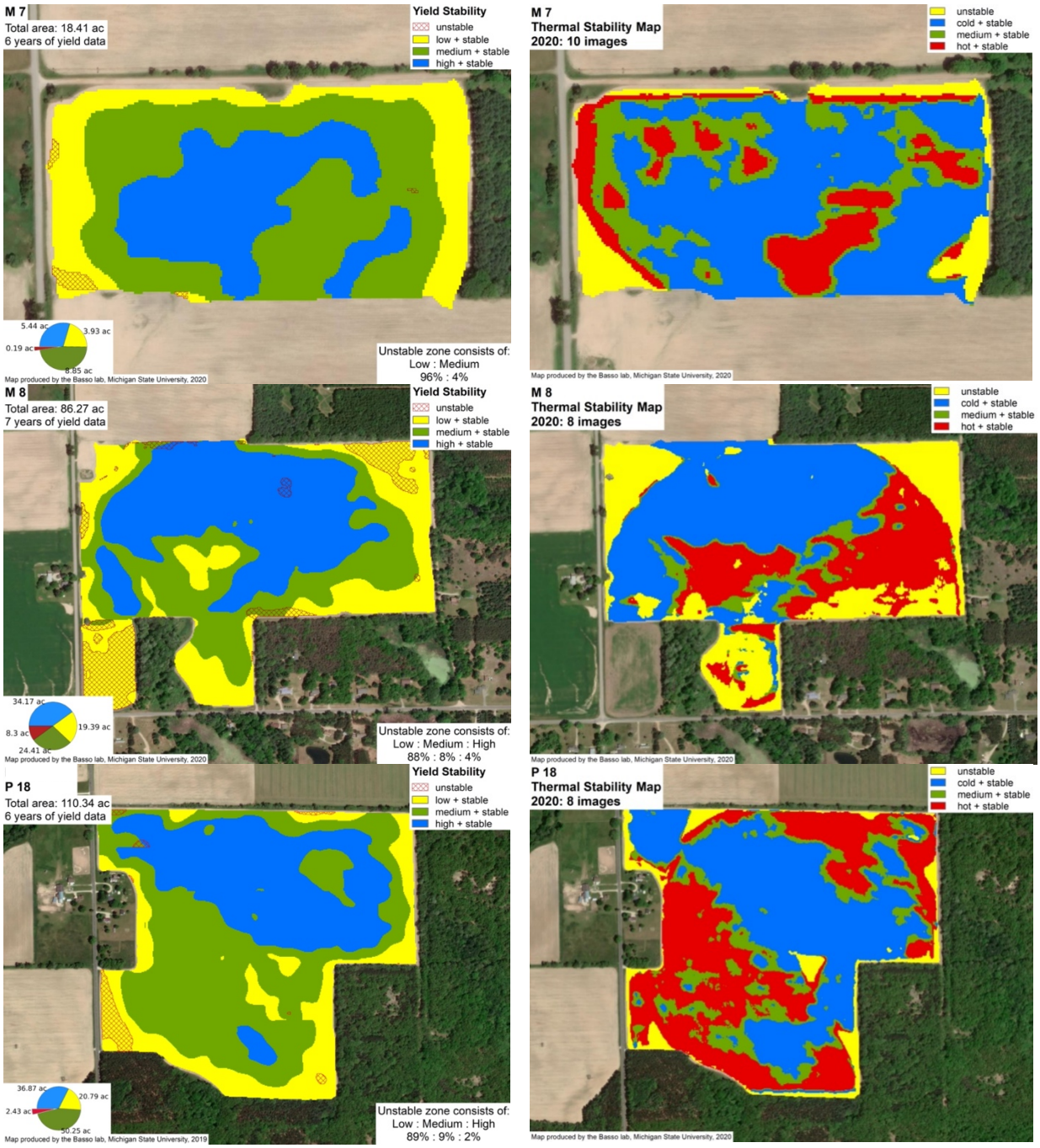
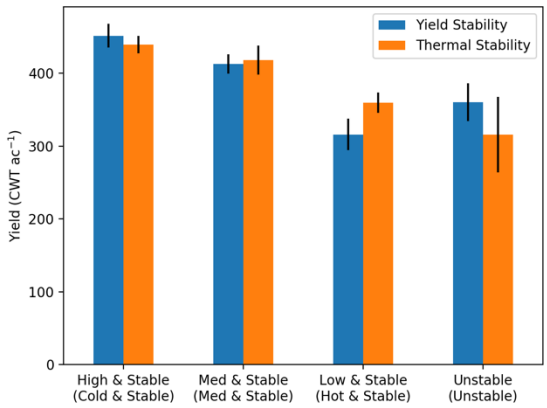


Figure 2. Four fields in 2020 potato production where yield stability (left) and thermal stability (right) maps were available. There were no potato yield monitor data for these fields.

Fields without yield data (M6, M7, M8, and P18) show very consistent trends between the yield and thermal stability map (Figure 2). Areas of cold + stable predominantly remain in the same locations as the high + stable zones. Likewise, areas of lower yielding zones, like medium + and low + stable zones are found in hot + stable zones. The trends recognized in Figure 1 from the fields that contained yield data lead us to surmise that these fields had higher potato yields in the areas of cold + stable and lower yields in the hot + stable zones.



		Thermal Stability				
		Cold and Stable	Medium and Stable	Hot and Stable	Unstable	Total %
Yield Stability	High and Stable	**25.58%**	0.00%	0.70%	0.00%	**26.28%**
	Medium and Stable	**40.87%**	6.41%	**18.91%**	0.00%	**66.19%**
	Low and Stable	0.61%	3.89%	3.89%	0.00%	4.50%
	Unstable	1.13%	1.40%	1.40%	0.51%	3.04%
		68.18%	6.41%	**24.90%**	0.51%	100%

Figure 3. Yield analysis of yields at one potato field (left) and frequency distribution of thermal and yield stability pixel values in the same field (right).

A robust analysis of yield, thermal stability, and yield stability based on pixel values shows how these components are linked to one another. In Figure 3 (left), yields in each zone of both yield and thermal stability were similar. As expected, the highest yields were found in the high + stable yielding zones and the cold + stable thermal zones. The hot + stable yields were almost identical to those in the unstable yield zones and likewise for the unstable thermal zones and low + stable yielding zones. The frequency table (right) shows that 66.45% of the pixels from the thermal stability map were found in the high + and medium + stable yielding zones. Conversely, the hot + stable pixels made up about 24.90% of the thermal stability map. Most of these pixels were found in the medium + and low + stable yielding zones.

Conclusions

Understanding trends of spatial variability in every field is crucial for site-specific management to be effective. In potato production, it is important to note that supplemental irrigation does not create a spatially equal benefit to the plants throughout the season. Some parts of the field remain warmer and reflect lower yields despite the impression that they have been irrigated equally. Discerning yield trends is possible without the possession of high-quality yield monitor data in potatoes. Thermal remotely sensed imagery has shown to be a valuable indicator of spatial trends in yield variability. Further incorporation of thermal imagery will assist farmers in recognizing the variability within their production and can benefit their management strategies.

References

Maestrini and Basso. 2018. Drivers of within-field spatial and temporal variability of crop yield across the US Midwest. *Scientific Reports*, 8 (1), 2045-2322.

Effect of Biological Soil Amendments on Soil Nutrient Content and Beneficial Microbial Communities and Its Influence on Potato Early Die Complex

Marisol Quintanilla, Luisa Parrado, Emilie Cole
[1]Michigan State University, Department of Entomology, Applied Nematology Lab

Introduction

Potato Early Die is a disease caused by the association between the root-lesion nematode *Pratylenchus penetrans* and the soil-borne fungus *Verticillium dahliae.* Both pathogens have a wide host range, including potatoes, where the main symptoms are chlorosis, necrosis and wilting, which results in yield losses between 30-50%. The management of the disease is done by the use of nematicides like Vydate (oxamyl) or fungicides like Elatus (azoxystrobin, benzovindiflupyr) however they are not always effective for PED management and can be detrimental to soil health. Therefore, the Applied Nematology has begun evaluating new management strategies. Organic soil amendments like manures and compost have been widely use for its benefits on soil health like the increase of organic matter, yet the use of these organic materials for pest management is innovative. During 2018, the first studies were conducted, and it was found that poultry manure and a compost blend made from poultry and cattle manure, were effective in decreasing *P. penetrans* populations. Following, during 2020 new field studies were conducted evaluating the effectiveness of integrating these organic soil amendments with biocontrol agents on Potato Early Die severity and incidence.

The initially proposed objectives were as follows: 1) Determine the antagonistic potential of microbial communities found in poultry manure and the compost blend, 2) Establish if poultry manure and the compost blend are increasing soil health and influencing PED incidence and severity, 3) Evaluate the effect of *P. lilacinum* when combined with poultry manure and the compost blend on PED incidence and severity, 4) Evaluate the potential of Brassica spp. vegetable material for the biocontrol of PED and 5) Evaluate the effect of Vydate when combined with the compost blend on PED. However, due to the on-going Covid-19 pandemic that started in March of 2020, only goal 2, 3, 4 and 5 were carried on, with several modifications as a result of the very strict restrictions.

Methodology

On May 4, 2020, a field trial was set-up at Three Rivers, MI on and was planted with Russet Norkotah on May 5. Plots were 12 x 25ft with 4 rows with 5ft space between plots. In each plot there was around 120 plants and we evaluated 10 treatments with 6 replicates each, for a total of 60 plots arranged in a randomized block design (see below).

Note: Each color and pattern correspond to a different treatment, which were marked in the field with flags

The treatments evaluated were combinations of organic soil amendments, chemical nematicide and biological control agents that are available in the market for nematode management. The treatments, rate, application method and application time are listed in Table 1.

Table 1. Treatments evaluated during summer field season 2020

Treatment Code	Treatment Name	Rate	Application Method	Application Time
Unt	Untreated	-	-	-
SeedTr	CruiserMaxx	0.27 fl oz	Seed Treatment	Pre-Planting
PM	Poultry manure	1.25 tons/A	Incorporated. 4-6" deep	Pre-Planting
LAB	Layer Ash Blend	1.25 tons/A	Incorporated. 4-6" deep	Pre-Planting
Vyd	Vydate	2.5 L/Ha	In-furrow	At-Planting
PM + Vyd	Poultry Manure + Vydate	1.25 tons/A 2.5 L/Ha	Incorporated. 4-6" deep In-furrow	Pre-Planting At-Planting
PM + MC	Poultry Manure + MeloCon	1.25 tons/A 6 lb./A	Incorporated. 4-6" deep In-furrow	Pre-Planting At-Planting
LAB + MC	Layer Ash Blend + MeloCon	1.25 tons/A 6 lb./A	Incorporated. 4-6" deep In-furrow	Pre-Planting At-Planting
HC + MC	Nursery Mix + MeloCon	1.25 tons/A 6 lb./A	Incorporated. 4-6" deep In-furrow	Pre-Planting At-Planting
DN + MC	Double Nickel + MeloCon	2.13 L/A 6 lb./A	In-furrow	At-Planting

Measurements were taken at multiple points during the growing season starting with soil sampling on May 4 (prior to treatment application) for initial *P. penetrans* and *V. dahliae* populations in soil. On June 4, we took 30-day post treatment application soil samples for the same purpose. Later in June 23, we took plant heigh measurements to see the impact of treatments of plant growth. On July 13 we again took soil samples for nematode and fungi density in soil as well as stem samples for *V. dahliae* incidence *in-planta* and additionally, we recorded disease incidence and severity. We also took root samples for *P. penetrans* incidence; however, we could not collect data from the roots due to processing error. On July 28 and August 11, we recorded disease incidence and collected root samples for *P. penetrans* incidence as well as potato stems for *V. dahliae* incidence.

Lastly, on September 18 we took our at-harvest soil samples for both nematode and fungi population density and also harvested one row of each plot. Back in the Agronomy barn, we graded our potatoes to obtain our yields and we also inspect 10 tubers per plot for defects like vascular discoloration, hollow heart, brown center, internal brown spots and potato scab.

Results

Reduction of P. penetrans pressure in soil after one month of treatment application

There was a significant decrease of *P. penetrans* pressure in soil between May 4 and June 4 (p-value<0.001) (See figure 1). Most interestingly, after one-month, nematode populations within the poultry manure treated plots (PM) decreased to zero.

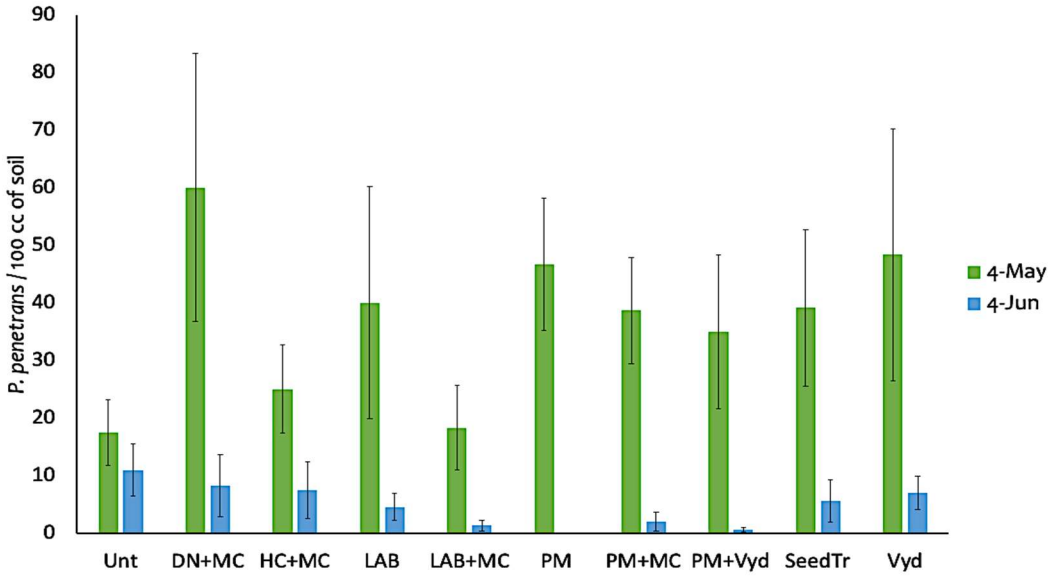


Figure 1. Mean ± SEM P. penetrans density in soil. Green bars represent May 4 and blue bars June 4.

Reduction of V. dahliae propagule density in soil after one month of treatment application

There was a significant reduction of *V. dahliae* propagule density in soil after one month of treatment (p-value<0.0001), but there was no significant difference among treatments. However, numerically, the greatest reduction was on plots treated with poultry manure (PM) + MeloCon (66%) (Figure 2).

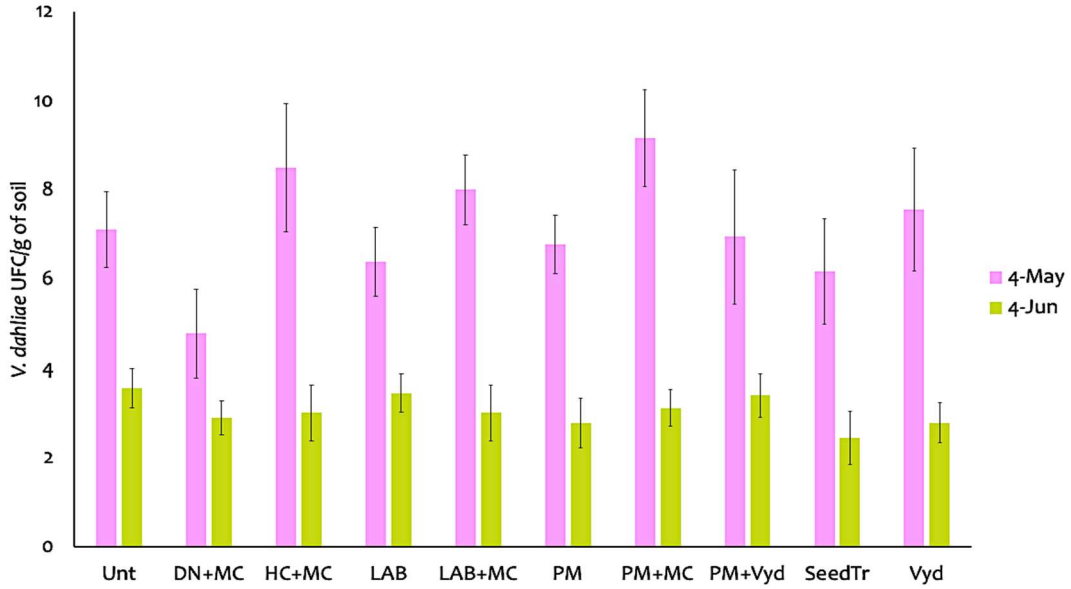


Figure 2. Mean ± SEM *V. dahliae* density in soil. Pink bars represent May 4 and green bars June 4.

Increase of V. dahliae incidence

Contrary to the decrease of propagule density in soil by June 4, between July13 and August 11 there was a significant increase of *V. dahliae* incidence in stems (p-value<0.0001). There were no significant differences between treatments but numerically, the greatest increase of infection was in potato plants that we treated with Vydate (70%) (Figure 3). The decrease of *V. dahliae* propagules in the soil and increase of Verticillium wilt in the plants can be attributed to the germination of the microsclerotia which subsequently infected the plants. What is key, is that none of the treatments tested, significantly decreased Verticillium incidence and therefore did not protect the plants from infection.

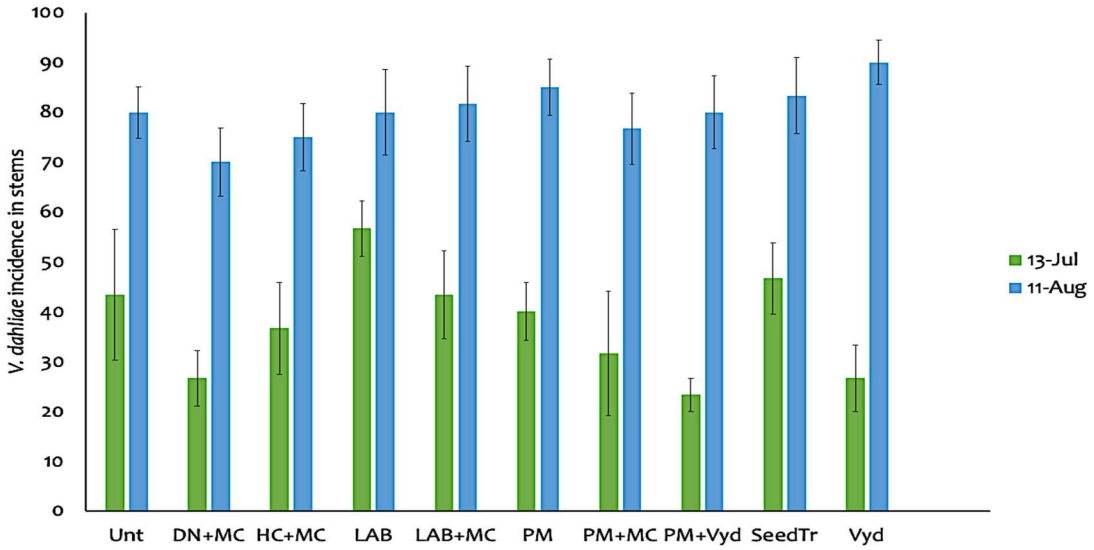


Figure 3. Mean ± SEM *V. dahliae* incidence in stems. Green bars represent July 13 and blue bars August 11.

Low incidence of P. penetrans in roots from potato plants treated with poultry manure plus Vydate

There was a significant difference between the number of *P. penetrans* recovered from potato roots treated with poultry manure plus Vydate (PM +Vyd) and the untreated control (p=0.023), however, there was no significant difference between the other treatments (Figure 4).

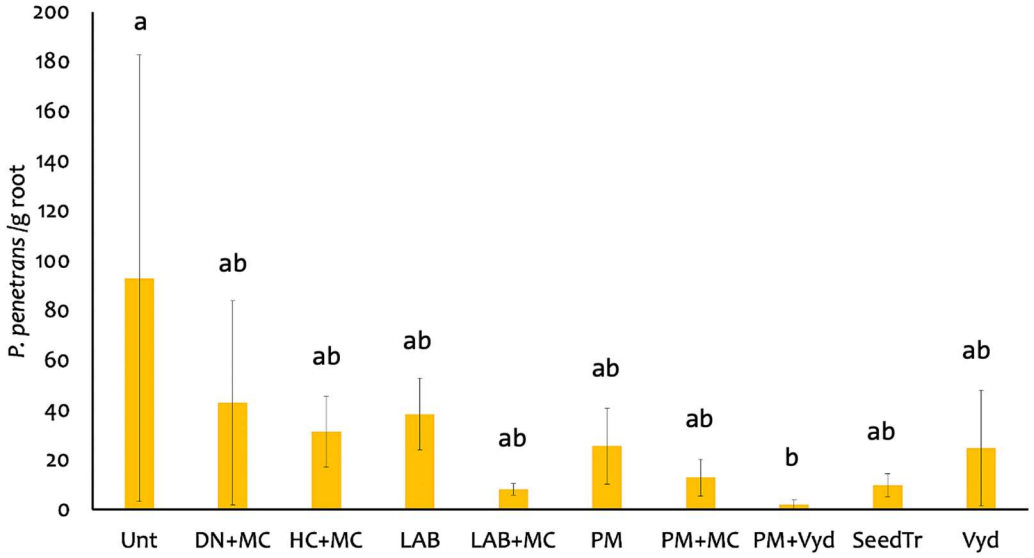


Figure 4. Mean ± SEM P. penetrans incidence in roots. On August 11. Tukey HSD, α=0.05.

Increase of PED severity and decrease of the treatment percentage of control

Severity increased significantly from July 11 to August 11 (p-value<0.0001) (Figure 5) which correlates with the high incidence of *V. dahliae* in stems (Figure 3) as well as the decrease of treatment percentage of control through time (Figure 6). Although there was no significant difference between treatments, numerically, LAB + MeloCon had the highest percentage of control throughout (63.6%).

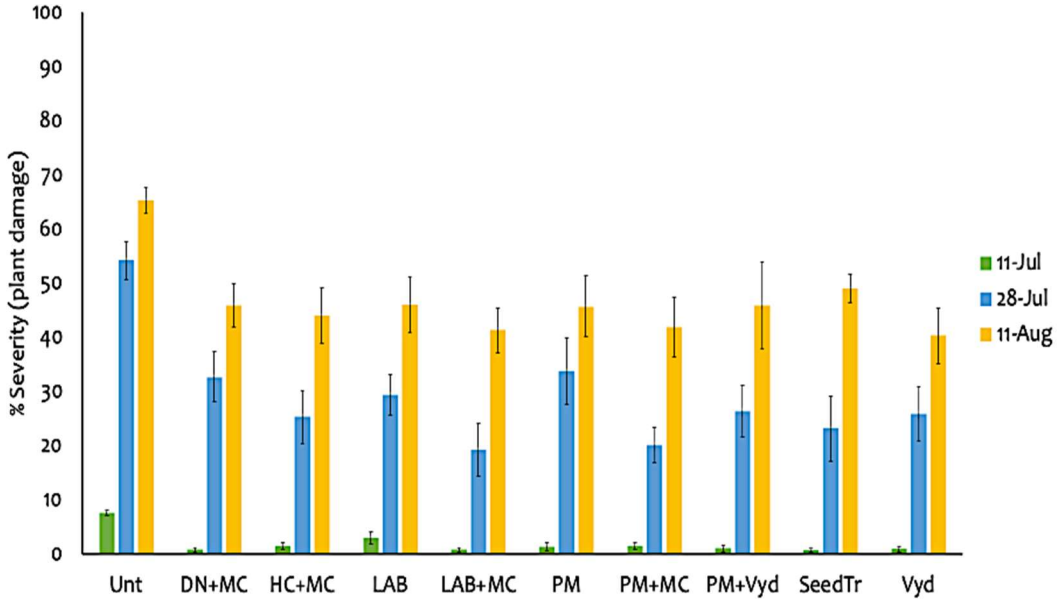


Figure 5. Mean ± SEM disease progress from July 11 to August 11 (severity). Green bars represent July 11, blue bars July 28 and yellow bars August 11.

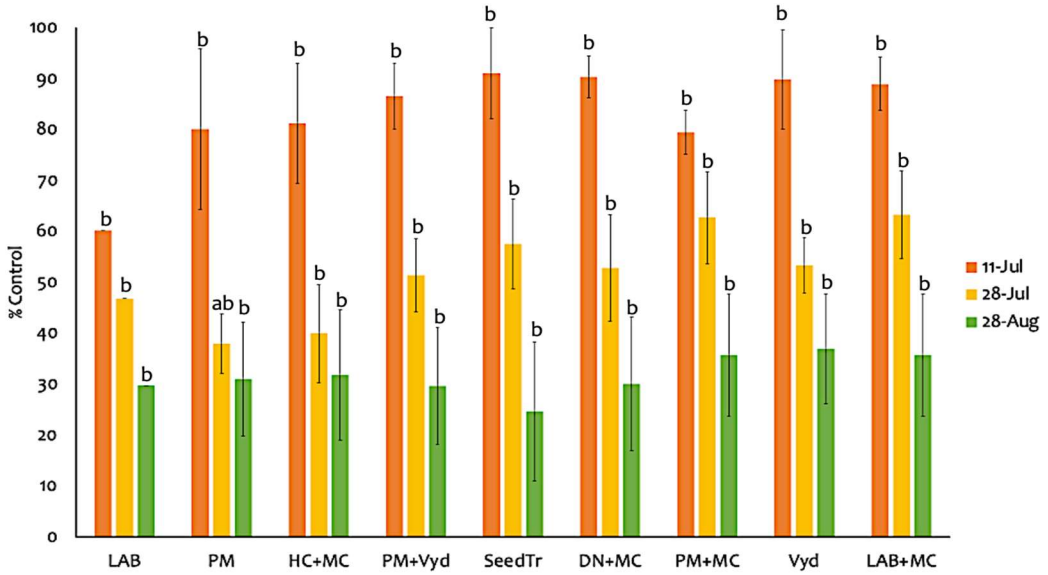


Figure 6. Mean ± SEM % of control from July 11 to August 11 (severity~treatment). Orange bars represent July 11, yellow bars July 28 and green bars August 11.

Tuber yield

Total tuber yield ranged between 362 and 403 cwt/acre while the highest yield was from plots treated with LAB and the lowest yield was from plots that were not treated (Figure 7), so numerically, there was an increase of 41 cwt/acre when plots are treated with LAB. Nonetheless, no significant differences were observed between treatments.

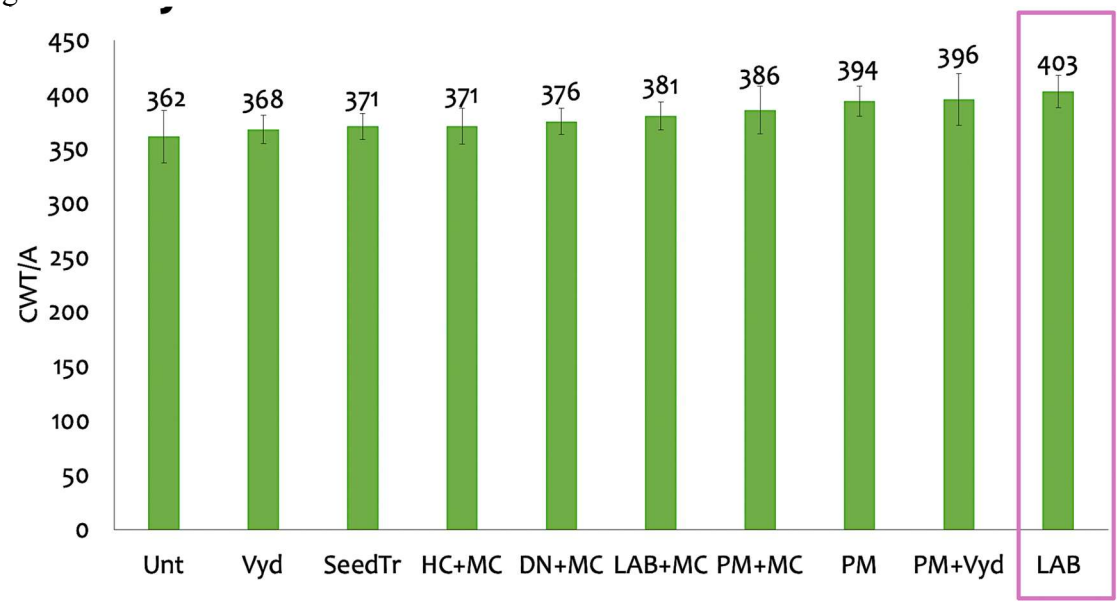


Figure 7. Mean ± SEM potato tuber yield.

Tuber quality: internal defects

Interestingly, the lowest vascular discoloration (which is related to *V. dahliae*) proportion was in tubers from the LAB + MeloCon plots (11%; p=0.15) (Figure 8).

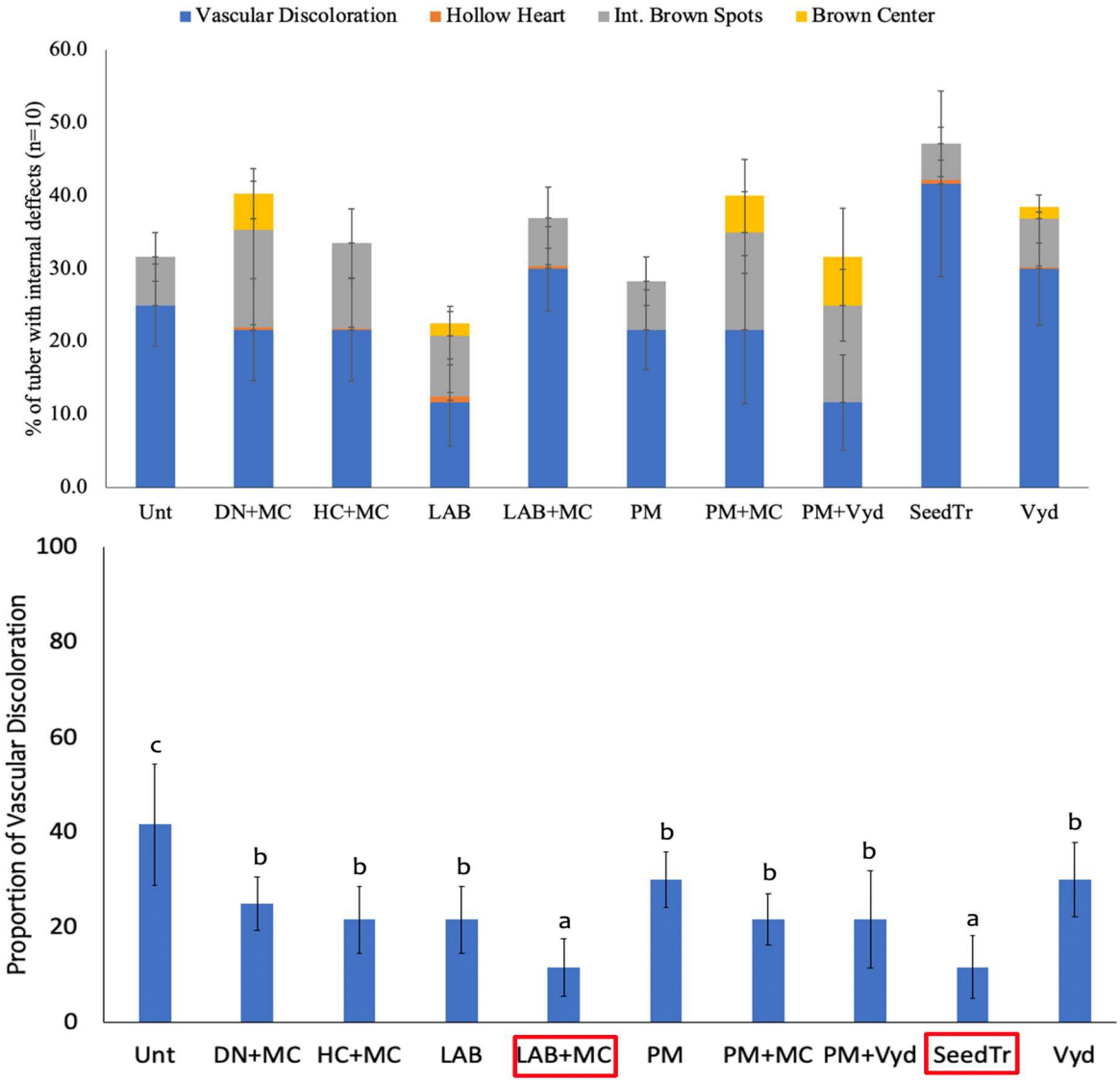


Figure 8. Mean ± SEM. A. percentage of tubers with internal defects like VD= vascular discoloration, HH= hollow heart, IBS= internal brown spots and BC= brown center. B. proportion of tubers with vascular discoloration. Tukey HSD, α=0.05.

Conclusions

Our results allow us to conclude that for a second year, poultry manure decreased *P. penetrans* population density in soil as well as it had the lowest incidence of the nematode in potato roots, meaning that it qualifies as a nematicide product. Regarding, *V. dahliae* stem infection significantly increased in a month. Suggesting that perhaps prior that point in time, a second application of treatments is necessary. Our results also suggest that *P. lilacinum* (MeloCon) in

combination with organic soil amendments like LAB or poultry manure, is effective in suppressing PED but on the contrary, *B. amyloliquefaciencs* (Double Nickel) didn't stand out on controlling PED under field conditions. Nonetheless, more research is required to develop a strategy to manage *V. dahliae*, with this in the future we would be able to provide an integrated management program for the PED complex.

Note: Is important to mentioned that we are in the process of counting our remaining soil samples for nematode pressure as well as the screening of *V. dahliae* microsclerotia in soil.

Acknowledgments

We would like to thank the Michigan Potato Industry Commission for funding this project. We also thank Walther's Farms for providing us with the land and field maintenance and Chris Long's crew for providing help with planting and harvesting.

Survey of postharvest disease in Michigan potato storages, 2020

Emma Schlachter, Chris Bloomingdale, Damen Kurzer, Trina Zavislan, Ray Hammerschmidt, Chris Long, Jaime F. Willbur; Michigan State University, Department of Plant, Soil and Microbial Sciences

Potatoes are stored after harvest to meet year-round market demands. However postharvest losses caused by shrinkage and disease can result in significant economic loss. Approximately 22.3 million cwt (11%) was lost in the 2019/20 storage season between September and June, with an estimated value of $219.4 million (USDA-NASS 2020). This project was performed to quantify disease incidence and severity in tubers at harvest and after a commercial storage period. Information on prevalent diseases and their impact on potato tubers postharvest will be used to develop management strategies. Diseases of concern include bacterial soft rot (*Pectobacterium* spp. and *Dickeya* spp.), Fusarium dry rot (*Fusarium* spp.), leak (*Pythium ultimum*), and late blight (*Phytophthora infestans*).

Materials and Methods

In 2019, approximately 50 tubers were obtained from 12 potato fields in six Michigan counties. At-harvest assessment was performed October to November 2019 ($N = 679$ tubers) and post-storage assessment was performed July to October 2020 ($N = 676$ tubers). At-harvest samples were held at 39°F until processed immediately after harvest (at-harvest samples). Postharvest samples were placed in the Michigan Potato Industry Commission Potato Demonstration Storage Facility in standard storage conditions at 48°F from harvest (September to October 2019) until processing (July to September 2020) and observed at four time points for disease progression and weight loss. During assessment, tubers were weighed and destructively sampled. Tubers were cut and examined externally and internally for abiotic damage as well as signs and symptoms of disease. Putative pathogens were identified based on defining morphological characteristics including colony appearance, hyphae, presence of reproductive structures, and pigmentation.

Results and Conclusions

At-harvest survey results found symptoms and signs of disease in 95% assessed tubers ($N = 682$) with blemish diseases including scab (*Streptomyces spp.*), black dot (*Colletotrichum coccodes*), black scurf (*Rhizoctonia solani*), and silver scurf (*Helminthosporium solani*) most prevalent. Rot diseases including bacterial soft rot (*Pectobacterium* and *Dickeya spp.*), Fusarium dry rot (*Fusarium* spp.), and leak (*Pythium* spp.) were also present. Putative pathogens were recovered from 84% of at-harvest sampled tubers and include the following genera: *Fusarium, Rhizoctonia, Pythium, Alternaria, Pectobacterium, Dickeya, Colletotrichum, Streptomyces, Geotrichum, Phytophthora*.

Post-storage sampling identified symptoms and signs of disease in 99% assessed tubers ($N = 673$). Blemish diseases including scab, black dot, black scurf, and silver scurf were detected on 79% of tubers; rot diseases were also detected including Fusarium dry rot (7%), and leak (<1%). Putative pathogens were recovered from 90% post-storage sampled tubers (Table 1).

Correlations between abiotic and biotic damage will be calculated to identify damage that increases susceptibility to disease. At-harvest and post-storage data will be analyzed to monitor disease development in storage. During 2020-2021 storage season, the efficacy of Sanidate, a peroxyacetic acid based fungicide, will be investigated in management of Fusarium dry rot, leak, pink rot, and bacterial soft rot. Newly commercialized and advanced potato chip processing lines will be assessed for postharvest disease resistance to these four diseases as well.

Acknowledgements: We would like to thank the grower cooperators who participated in this survey for their continued support in furthering our research. Funding is provided by the Michigan Potato Industry Commission, MSU Extension, MSU AgBioResearch, the Michigan Department of Agriculture and Rural Development - MPIC Specialty Crop Block Grant, and the USDA National Institute of Food and Agriculture, Hatch project 1020281.

Table 1. Frequencies (%) of pathogens recovered from 2018 and 2019 samples

Pathogen Genera	2018	2019	
		At-Harvest	Post-Harvest
Number of tubers	*N* = 368	*N* = 570	*N* = 610
Fusarium	29.8	24,4	23.0
Pectobacterium	24.6	-	-
Rhizoctonia	19.3	24.0	25.0
Pythium	5.3	16.7	15.0
Phytophthora	5.3	-	-
Geotrichum	3.5	-	-
Colletotrichum	3.5	7.2	12.0
Dickeya	3.5	-	-
Streptomyces	3.5	-	1.0
Alternaria	1.8	15.0	24.0

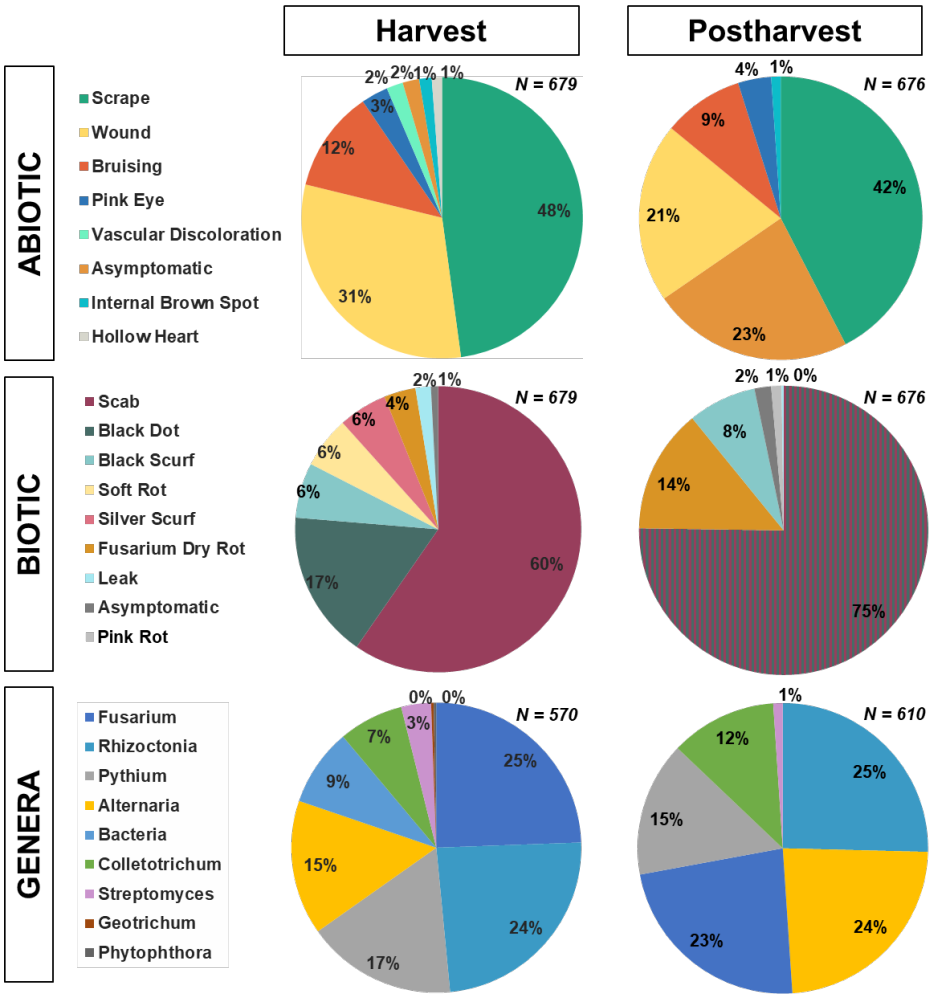


Figure 1 (left). Relative frequencies (%) of biotic damage and physiological disorders, biotic signs and symptoms of disease, and known pathogenic genera isolated from tubers during at-harvest and postharvest destructive sampling (*N* = total number of tubers evaluated, or organisms isolated). Vertical fill lines represent observed blemish diseases, excluding black scurf, in postharvest samples.

Diagnostic optimization of viral detection and characterization for the Michigan seed potato certification program, 2020

Mio Satoh-Cruz[1], Stefanie Rhodes[2], Jeff Axford[3], Elizabeth Dorman[2] and Jaime Willbur[1]; [1]Michigan State University, Dept. Plant, Soil and Microbial Science, Potato and Sugar Beet Pathology; [2]Michigan Department of Agriculture and Rural Development, Pesticide and Plant Pest Management Division, Plant Pathology; [3]Michigan Seed Potato Association

Potato virus Y (PVY) is a major concern throughout the US, including the North Central region, and is one of the primary diseases monitored and tested for in the seed certification process. Cost-effective and efficient detection of PVY in early generation potato seed lots will help prevent infected material from entering the production chain and will prevent unnecessary yield and profit loss. Since 2018, Michigan Department of Agriculture and Rural Development (MDARD) and MSU Potato and Sugar Beet Pathology (PSBP) have been collaborating to increase handling capacity, efficiency and optimizing the viral detection and diagnostic protocols used in winter testing. Through this work we continue to: 1) investigate improved detection options to identify accurate, timely, and cost-effective methods for use in the Michigan seed potato certification and 2) monitor PVY strain prevalence in Michigan seed potatoes. The results of this work will help develop standard protocols for high-throughput, in-state tuber testing.

Materials & Methods:
Tuber testing methods, which do not require breaking tuber dormancy to sample from resulting sprouts or plantlets, were investigated. General (Mackenzie et al. 2015) and multiplex (Lorenzen et al. 2006, 2010; Chikh-Ali et al. 2013) reverse-transcriptase (RT) high-fidelity polymerase chain reaction (PCR) protocols were compared to existing plantlet assays involving enzyme-linked immunosorbent assay (ELISA). In 2019, four samples of tubers were taken from a single seed potato lot with high levels of visual foliar symptoms of PVY in the field (4.9%). Samples were divided into 10-tuber subsamples and subjected to the following tests: 1) dormant tuber (RT-PCR), 2) standard Michigan grow out with leaflets (ELISA), 3) dormant tuber (RT-PCR) and standard grow out (ELISA), and 4) standard Hawaii grow out with leaflets (ELISA). Sensitivity, accuracy, and agreement of the various methods, as well as cost of each test, were compared with existing methods.

In 2020, samples of 400 tubers were collected from seed lots with three levels of visual foliar symptoms of PVY in the field. We investigated high (0.9%), medium (0.23%) and low incidence (0.01%) lots and conducted RT-PCR tuber testing. All of the tubers were tested then planted and grown out for standard leaflet ELISA. Subsets of positive samples will be subject to PVY strain confirmation by RT-PCR.

Results & Conclusions:
In 2019, both dormant tuber and standard grow out methods identified high levels of PVY (12.9-100%) in in a visually high-incidence lot (Table 1). In treatment 3, where the tubers and leaflet grow outs of the same plants were tested using different methods, 30.1 and 16.4% PVY was detected, respectively. The majority of tested samples were positive for PVY^{N-Wi} (Figure 1). Overall, all tested methods validated high-incidence visual inspection results (4.9%) and would result in rejection of this lot for certification.

In 2020, more than 90% of tested samples were positive for the PVY strain N:Wi, however, N:O, NTN, and O strains were also present (Figure 1). Dormant tuber methods validated summer and winter visual inspection results for the high-PVY lot (Table 2). However, our methods detected higher levels of PVY in the low and medium lots than estimated from the summer field inspections (though more similar to the winter visual). This could be due to in-field spread, variety differences, strains differences (Figure 1), or variety by strain interactions. Overall, our results suggest that PVY^{N-Wi} is the prevalent strain in Michigan, and dormant tuber testing is a viable and informative option for our seed certification program.

Table 1. Comparison of ELISA and RT-PCR results from a seed lot assessed at 4.9% visually positive for PVY in the field. Results are based on positive PVY detections (%) using dormant tuber and standard leaflet grow out methods in 2019 (N=number of 10-tuber subsamples tested).

#	Test method	N	ELISA (%)	RT-PCR (%)
1	Dormant tuber	32	-	**12.9**
2	Leaflet grow out	14	**23.2**	**38.9**
3	Dormant tuber and leaflet grow out	36	- **16.4**	**30.1** **>27.8**[a]
4	Hawaii leaflet grow out – tested in MI	53	**18.3**	-
5	Hawaii leaflet grow out – tested in HI	56	**15.8**	-

[a] All 10-tuber subsamples tested positive in this sample. Result adjusted to better reflect actual PVY incidence.

Table 2. Comparison of ELISA and RT-PCR results from seed lots assessed for high, medium, and low incidence based on field inspections. Results are based on positive PVY detections (%) using dormant tuber and standard leaflet grow out methods in 2020 (N=number of 10-tuber subsamples tested).

Sample	Gas	N	Visual Summer (Jun-Jul)	Visual Winter (Jan)	Dormant Tuber RT-PCR[a] (Oct-Nov)	Leaflet ELISA Greenhouse[a] (Jan)	Leaflet ELISA Field – Florida (Jan)
High	-	24	0.90	>25.0	**>27.2**[b]	**29.6**	-
High	+	24	0.90	>25.0	**>27.2**[b]	**22.4**	-
Medium	+	40	0.23	4.40	**6.70**	**5.62**	**3.98**
Low	+	40	0.01	0.45[c]	**1.61**	**1.12**	**1.84**

[a] Dormant tuber RT-PCR and leaflet ELISA greenhouse results from the same 10-tuber subsamples.
[b] All 10-tuber subsamples tested positive in this sample. Result given for greater than 23 out of 24 subsamples to better reflect actual PVY incidence.
[c] Symptoms were very mild in the field and actual PVY incidence was suspected to be higher than 0.45%.

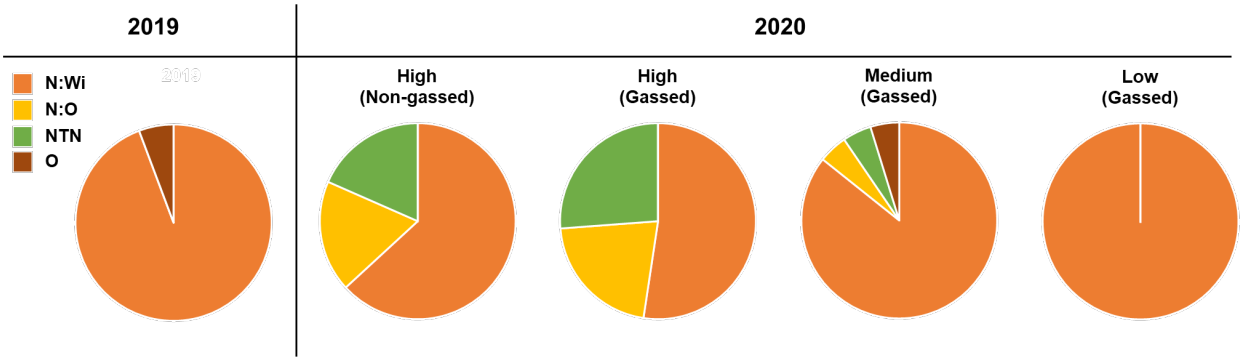


Figure 1. PVY strains present in seed certification pathology experiments conducted in 2019 and 2020.

Evaluation of foliar fungicide timing to manage white mold of potato in Michigan, 2020.

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Montcalm Research Center (MRC): A foliar fungicide timing trial was established at MRC in Lakeview, MI and managed by the Potato and Sugar Beet Pathology program (Bloomingdale and Willbur). The trial objective was to determine the most effective timing of fungicide applications for managing white mold in potato. A randomized complete block design, with four replicates, was used. Potato seed were cut from US#1 'Lamoka' tubers and allowed to suberize before planting. The trial was hand-planted 12 Jun. Plots were four rows wide (34-in. row spacing) by 20 ft long and a 10-in seed spacing was used. Standard grower practices were followed to manage non-target pests. Fluazinam applications (8 fl oz/A) were made 30 Jul (full bloom) and 13 Aug (14-d post-bloom); treatments of full bloom, post-bloom, and full followed by post-bloom applications were compared to a grower standard control. A CO_2 powered backpack sprayer, equipped with two TJ 8004XR flat fan nozzles and operating at a boom pressure of 38 psi, was used to apply fungicides at 20 gal/A. To control for late blight, weekly chlorothalonil applications (1.5 pt/A) were initiated 22 Jul and applied until vine kill 31 Aug. Apothecia and disease data were collected 20 Jul and 13 Aug. Ten stems were arbitrarily rated from the center two rows of plots and assigned a disease severity (0-3). The severity ratings were: 0 = no disease to 3 = infection girdling mainstem, resulting in wilting and/or death. The ratings were used to calculate a percent disease incidence (DI) and average disease severity of symptomatic plants (DS; 0-3). Disease index (DX) was calculated from the following equation: DX = DI x DS/3. The center two rows of plots were harvested 24 Sep, potatoes were washed then specific gravity and internal defects determined. Due to a technical failure, tuber size and yield data were lost and were not available for these analyses. A generalized linear mixed model procedure was used to conduct the ANOVA and mean separations at α=0.05.

Mean DI values from the final rating ranged between 32.5 and 43.8% and DX values ranged between 10.8 and 17.1%. There were no differences among mean DI ($P > 0.05$) or mean DX ($P > 0.05$) values of various timings (Table 1). Specific gravities ranged from 1.080 to 1.082 and were also not different among tested fungicide programs ($P > 0.05$). As a result of the low white mold pressure observed in this location, no differences among the fluazinam timings were detected. Nutrient management programs to promote canopy and disease development, as well as alternate locations with naturally elevated levels of white mold pressure, will be considered for future trials.

Table 1. White mold and specific gravity observations in treatments tested in small-plot research at the Montcalm Research Center in Lakeview, MI in 2020.

No.	Treatment, Rate[z], and Timing[y]	DI (%)[x]	DX (%)	Specific Gravity
1[w]	Grower standard treated control	35.0	12.5	1.082
2	Omega 500F (8 fl oz) full bloom	43.8	17.1	1.080
3	Omega 500F (8 fl oz) 14-d post-bloom	33.8	11.3	1.081
4	Omega 500F (8 fl oz) full bloom + 14-d post-bloom	32.5	10.8	1.081

[z] All rates, unless otherwise specified, are listed as a measure of product per acre, and all tank mixes contained MasterLock at a rate of 0.25 % v/v.

[y] Applications were made on the following dates: full bloom = 30 Jul and 14-d post-bloom = 13 Aug.

[x] Column values followed by the same letter were not significantly different based on Fisher's Protected LSD (α=0.05); if no letter, then the effect was not significant.

[w] Treated control.

Dale Johnson Farm, Sagola, MI: A foliar fungicide timing trial was established on the Dale Johnson Potato Farm in Sagola, MI and managed by the grower with guidance from MSU Extension (DeDecker). The trial objective was to determine the most effective timing of fungicide applications for managing white mold in potato. A completely randomized design with three replicates was used. A commercial potato field with a history of white mold was selected for the trial and planted to the variety Silverton using standard grower practices. Plots were 36 rows wide (34-in. row spacing), running the length of the field, to accommodate the grower's self-propelled sprayer. Standard grower practices were followed to manage non-target pests. A John Deere R4038 sprayer, equipped with air-induction flat fan nozzles, was used to apply fungicides at 40 gal/A. To control for late blight, weekly chlorothalonil applications (Bravo Ultrex at 1.25 lbs/A) were made until vine kill. Fluazinam applications (8 fl oz/A) were made 20 Jul (full bloom) and 3 Aug (14-d post-bloom) as a tank mix with chlorothalonil. Treatments of full bloom and 14-d post-bloom were compared to the grower's standard treated control (chlorothalonil only). Apothecia and disease data were collected 20 Jul and 27 Aug, respectively. No apothecia were observed at the full bloom timing. Fifty stems were later rated (5 subsamples of 10 stems each) from the center twelve rows of each plot and assigned a disease severity (0-3). The severity ratings were: 0 = no disease to 3 = infection girdling mainstem, resulting in wilting and/or death. The ratings were used to calculate a percent disease incidence (DI) and average disease severity of symptomatic plants (DS; 0-3). Disease index (DX) was calculated from the following equation: DX = DI x DS/3. A generalized linear mixed model procedure was used to conduct the ANOVA and mean separations at α=0.05.

DI values from the final rating ranged between 30.0 and 72.0% and DX values ranged between 12.7 and 38.7%. There were significant differences among mean DI (P = 0.0006) and mean DX (P = 0.01) values of the treatments (Table 2). These results suggest that later fungicide applications may be helpful in managing potato white mold, particularly in longer flowering varieties. Possible confounding factors in this study included a) that our full bloom application was slightly early (1-2 days), and b) a wind event that removed many blossoms between the full bloom and post bloom applications.

Table 2. White mold observations in treatments tested on-farm in Sagola, MI in 2020.

No.	Treatment, Rate[z], and Timing[y]	DI (%)[x]	DX (%)
1[w]	Grower standard treated control	72.0 a	38.7 a
2	Omega 500F (8 fl oz) full bloom	50.0 b	25.1 b
3	Omega 500F (8 fl oz) 14-d post-bloom	30.0 c	12.7 c

[z] All rates, unless otherwise specified, are listed as a measure of product per acre, and all tank mixes contained MasterLock at a rate of 0.25 % v/v.
[y] Applications were made on the following dates: full bloom = 20 Jul and 14-d post-bloom = 3 Aug.
[x] Column values followed by the same letter were not significantly different based on Student–Newman–Keuls multiple comparisons test (α=0.05); if no letter, then the effect was not significant.
[w] Treated control.

2019-2020 MICHIGAN POTATO DEMONSTRATION STORAGE ANNUAL REPORT MICHIGAN POTATO INDUSTRY COMMISSION

Chris Long, Coordinator, Trina Zavislan, and Damen Kurzer

Introduction and Acknowledgements

Round white potato production for chip processing continues to lead the potato market in Michigan. Michigan growers continually look for promising new round white varieties that meet necessary production and processing criteria. There are many variety trials underway in Michigan that are evaluating chipping varieties for yield, solids, disease resistance, desired tuber size profile and chipping quality with the hope of exhibiting the positive attributes of these lines to growers and processors. Extended storage chip quality and storability are of high importance in round white potato production. Therefore, any new chip processing varieties with commercialization potential will have storage profiles developed. Examining new varieties for long-term storage and processing quality keeps the Michigan chip industry at the leading edge of the snack food industry. The information in this report allows the industry to make informed decisions about the value of adopting these varieties into commercial production.

The Michigan Potato Industry Commission (MPIC) Potato Demonstration Storage Facility currently consists of two structures. The first building, the Dr. B. F. (Burt) Cargill Building, constructed in 1999, allows the Michigan potato industry to generate storage and chip quality data on newly identified chip processing clones. This information helps to establish the commercial potential of new varieties. This demonstration storage facility utilizes six, 550 cwt. bulk bins (bins 1-6) that have independent ventilation systems. The Ben Kudwa Building, built in 2008, has three independently ventilated, 600 cwt. bulk bins. The first of these bulk bins, bin 7, was converted to box bin storage that holds 36, 10 cwt. box bins to provide storage profiles on early generation potato varieties. The box bin is an entry point into storage profiling that allows the industry to learn about a varieties' physical and chemical storability before advancing to the bulk bin level. A variety is evaluated for 4-6 years before entering box bin testing. In the variety development process, little information has been collected about a varieties' physical storability or chemical storage profile prior to being included in the box bin trial. A storage profile consists of bi-weekly sampling of potatoes to obtain: sucrose and

glucose levels, chip color and defect values. In addition, we evaluate each variety for weight loss or shrinkage and pressure bruise. With this information, we can create the storage profile of a variety, providing the industry with a clearer picture of where a line can or cannot be utilized in the snack food industry. The Michigan potato industry hopes to use these storage profiles to improve in areas such as long-term storage quality, deliverability of product and, ultimately, sustained market share.

The two remaining 600 cwt. bulk bins in the second structure are used to evaluate the post-harvest physiology of potatoes. The facility can be used to evaluate storage pathology or sprout inhibitor products. The Michigan industry recognizes the importance of controlling disease and sprout development in storage and is committed to doing research in these areas.

This sixteenth annual Demonstration Storage Report contains the results of the storage work conducted in the facility during the 2019-2020 storage season. Section I, “2019-2020 New Chip Processing Variety Box Bin Report”, contains the results and highlights from our 10 cwt. box bin study. Section II, “2019-2020 Bulk Bin (500 cwt. bin) Report”, shows bulk bin results, including information from commercial processors regarding these new varieties.

The storage facility, and the work done within it, is directed by the MPIC Storage and Handling Committee and Michigan State University (MSU) faculty. The funding and financial support for this facility, and the research conducted within it, is largely derived from the MPIC. The committee occasionally receives support for a given project from private and/or public interests.

We wish to acknowledge all the support and investment we receive to operate and conduct storage research. First, we express our gratitude for the partnership we enjoy between the MPIC and Michigan State University. Thank you to the MPIC Storage & Handling Committee for their investment of time, guiding the decisions and direction of the facility. Brian Sackett, Sackett Potatoes; Todd Young, and Chase Young, Sandyland Farms; Jeff Thorlund, Thorlund Brothers Farm; and Karl Ritchie and Brice Stine of Walther Farms for provided the material to fill the bulk bins this year; and without their willingness to be involved, we could not have accomplished our objectives. Equal in importance are the processors who invested in this research. They are Mitch Keeney, Jim Fitzgerald and Jack Corriere of UTZ Quality Foods, Inc.,

Hanover, PA; Gene Herr and Ellis Cole of Herr Foods, and Al Lee and Phil Gusmano of Better Made Snack Foods, Detroit, MI. It has been a great pleasure to work with all of you. Special thanks to Butch Riley (Gun Valley Ag. & Industrial Services, Inc.) for his annual investment in the sprout treatment of the storage facility. We would also like to acknowledge a long list of additional contributors who invested much time to help foster a quality storage program: Dr. Dave Douches and the MSU Potato Breeding and Genetics Program, Todd Forbush (Techmark, Inc), Mathew Klein (Farm Manager, MSU Montcalm Research Center), and Tim and Matt Wilkes (Potato Services of Michigan). All played a role in making this facility useful to the Michigan potato industry.

Overview of the 2019 Production Season

The overall 6-month average maximum and minimum temperatures during the 2019 growing season in central Michigan approximately average compared to the 15-year average temperatures (Table 1). Temperatures were slightly cooler than average between April and June, and slightly warmer than average in July. Extreme heat events were also average in 2019 (Table 2), with 5 hours over 2 days exceeding 90ºF during the entire summer, lower than it has been in the past three years. High nighttime temperatures (over 70ºF) were also average with 105 hours over 20 days.

Rainfall for April through September was 22.07 inches, 4.47 inches above the 15-year average (Table 3). May and September were rainier than average, each month had more than two inches additional rainfall than the 15-year average. The remaining months had more typical precipitation in line with the 15-year averages.

Table 1. The 15-year summary of average maximum and minimum temperatures (°F) during the growing season at the Montcalm Research Center.*

	April		May		June		July		August		September		6-Month Average	
Year	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2005	62	36	65	41	82	60	82	58	81	58	77	51	75	51
2006	62	36	61	46	78	54	83	61	80	58	68	48	72	51
2007	53	33	73	47	82	54	81	56	80	58	76	50	74	50
2008	61	37	67	40	77	56	80	58	80	54	73	50	73	49
2009	56	34	67	45	76	54	75	53	76	56	74	49	71	49
2010	64	38	70	49	77	57	83	62	82	61	69	50	74	53
2011	53	34	68	48	77	56	85	62	79	58	70	48	72	51
2012	58	34	73	48	84	53	90	62	82	55	74	46	77	50
2013	51	33	73	48	77	55	81	58	80	54	78	48	73	49
2014	55	33	68	45	78	57	77	54	79	56	72	47	72	49
2015	58	34	71	48	76	54	80	56	77	57	77	54	73	51
2016	53	32	70	45	78	53	82	59	85	60	78	54	74	51
2017	61	39	67	44	78	55	81	58	77	54	77	50	74	50
2018	55	33	81	46	84	58	88	64	84	63	76	52	74	53
2019	**55**	**35**	**65**	**45**	**75**	**54**	**84**	**69**	**80**	**55**	**73**	**54**	**72**	**52**
15-Year Average	57	35	69	46	79	55	82	59	80	57	74	50	73	50

Table 2. Six-year heat stress summary (from May 1st – Sept. 30th)*

	Temperatures > 90°F		Night (10pm-8am) Temperatures > 70°F	
Year	Hours	Days	Hours	Days
2014	0	0	58	15
2015	0	0	114	31
2016	10	3	147	31
2017	14	3	80	18
2018	12	4	123	31
2019	**5**	**2**	**105**	**20**
Average	7	2	105	24

Table 3. The 15-year summary of precipitation (inches per month) recorded during the growing season at the Montcalm Research Center.*

Year	April	May	June	July	August	September	Total
2005	0.69	1.39	3.57	3.65	1.85	3.90	15.05
2006	2.73	4.45	2.18	5.55	2.25	3.15	20.31
2007	2.64	1.60	1.58	2.43	2.34	1.18	11.77
2008	1.59	1.69	2.95	3.07	3.03	5.03	17.36
2009	3.94	2.15	2.43	2.07	4.74	1.49	16.82
2010	1.59	3.68	3.21	2.14	2.63	1.88	15.13
2011	3.42	3.08	2.38	1.63	2.57	1.84	14.92
2012	2.35	0.98	0.99	3.63	3.31	0.76	12.02
2013	7.98	4.52	2.26	1.35	4.06	1.33	21.50
2014	4.24	5.51	3.25	3.71	1.78	2.35	20.84
2015	3.71	2.95	4.79	1.72	2.42	3.9	19.49
2016	2.25	2.77	1.33	3.42	5.35	3.05	18.17
2017	4.45	1.98	6.37	0.92	1.36	0.7	15.78
2018	2.04	5.51	3.64	1.19	7.73	2.65	22.76
2019	**2.64**	**5.46**	**2.90**	**2.04**	**3.31**	**5.72**	**22.07**
15-Year Average	3.08	3.18	2.92	2.57	3.25	2.60	17.60

*Weather data collected at the MSU, Montcalm Research Center, Entrican, MI.

I. 2019-2020 New Chip Processing Variety Box Bin Report

(Chris Long, Trina Zavislan, Damen Kurzer, and Brian Sackett)

Introduction

This project evaluated new chip processing varieties from national and private breeding programs for processing quality after storage conditions. We evaluated a variety's response to pile temperature, as reflected in sucrose and glucose levels, as well as weight loss and pressure bruise susceptibility. Bin 7 contains 36 10 cwt. boxes. We organized the 36 boxes in to six stacks of six. The box design allows air to travel in from a header, or plenum wall, through the forklift holes of each box and up through the potatoes within it. The air continues to flow up through the next box until it reaches the top and is drawn off the top of the chamber. The air is then reconditioned and forced back through the header wall plenums and up through the boxes again. Each box contains a sample door facing the center aisle from which we sampled tubers for bi-weekly or monthly quality evaluations.

Procedure

In 2019, we evaluated and compared 32 new varieties to the check varieties Lamoka, Manistee, and Snowden. Once the varieties were chosen, 1 cwt. of most varieties were planted in a single 34-inch wide row. Some varieties were planted on one half of the row for monthly sampling. Planting occurred on May 8th at the MSU, Montcalm Research Center, Entrican, MI. We planted the varieties at a 10" in-row seed spacing. All varieties received fertilizer in the rates of: 273 lb. N/A, 98 lb P_2O_5/A and 261 lb K_2O/A. The varieties were vine killed after 124 days and allowed to set skins for 21 days before harvest on September 3rd, 2019; which was 145 days after planting. We did not account for variety maturity in harvest timing due to storage and handling restrictions.

We placed approximately 10 cwt. of each variety in a box bin and stacked the boxes in bin 7. For varieties sampled monthly, approximately eight trays of tubers were stacked on top of the box bins. The average storage temperature for all the box bins (box bin 7) was 54.0ºF for the 2019-2020 season. At harvest, we collected nine, 20 lb. samples from each full row variety for weight loss and pressure bruise evaluation. We describe the varieties, their pedigree and scab ratings in Table 4. We also recorded yield, size distribution, chip quality, and specific gravity at

harvest in Table 5. We graded the varieties to remove all "B" size tubers and pick-outs, ensuring the tubers began storage in good physical condition.

The storage season began September 30th, 2019 and ended June 1st, 2020. Bin 7 was gassed with CIPC on November 5th and January 30th. We began variety evaluations on September 30th, followed by a bi-weekly or monthly sampling schedule until early June. We randomly selected forty tubers from each box every two weeks and sent them to Techmark, Inc. for sucrose, glucose, chip color and defect evaluation. We also evaluated pressure bruising by placing nine pressure sample bags for each variety in one of the bulk bins at the storage facility. We placed three bags at each of 3', 8' and 14' from the pile floor. When that bin was unloaded, we weighed the sample bags and calculated percent weight loss. We evaluated a 25-tuber sample from each of the nine bags for the presence or absence of pressure bruise. We recorded the number of tubers and severity of bruise. All pressure bruises were evaluated for discoloration.

This report is not an archive of all the data that we generated for the box bin trial, but rather a summary of the data from the most promising lines. The purpose of this report is to present a summary of information from the best performing lines from this trial that will be moved along the commercialization process. If more detailed information is desired, please contact Chris Long at Michigan State University in the Department of Plant, Soil and Microbial Sciences for assistance at (517) 353-0277 or longch@msu.edu. Additional data is available on the program website, canr.msu.edu/potatooutreach.

Table 4. 2019-20 MPIC Demonstration Chip Box Bin Variety Descriptions

Entry	Pedigree	2019 Scab Rating*	Characteristics
Lamoka (NY139)	NY120 X NY115	2.0	Below average yield, smaller size profile, average specific gravity, good internal quality, common scab susceptible, mid-season maturity.
Manistee (MSL292-A)	Snowden X MSH098-2	3.5	Lower yield, misshapen pickouts, long storage potential, uniform, flat round tuber type, heavy netted skin
Snowden (W855)	B5141-6 X Wischip	3.5	Earlier vine maturity, moderate vascular discoloration, reconditions well in storage, common scab susceptible.
CO10076-4W	CO03243-3W X CO02024-9W	1.8	High yield potential, lower specific gravity, flaky skin, some pitted scab lesions observed in 2019.
Hodag (W5955-1)	Pike X Dakota Pearl	1.5	Above average yield, average specific gravity, earlier vine maturity, marginal off the farm chip color.
Lady Liberty (Niagara, NY152)	B38-14 X Marcy	1.3	High yield potential, medium specific gravity, moderate resistance to common scab, earlier vine maturity.
Mackinaw (MSX540-4)	Saginaw Chipper X Lamoka	2.0	Medium/high yield potential, common scab, late blight and PVY resistant, high specific gravity, slight internal brown spot.
Manistee SEL (MSL292-A)	Snowden X MSH098-2	3.5	A hill selection of Manistee, similar agronomic and processing traits.
MSAA275-3**	Snowden X MSS297-3	2.0	Slightly flattened tuber type, average yield, high proportion A-sized tubers, earlier vine maturity.
MSAA498-18	MSV092-2 X Elkton	0.5	Good chip color and minimal stem end defect, earlier vine maturity and smaller vine type, less common scab susceptibility.
MSBB008-3**	Atlantic x MSR127-2	1.0	Smaller size profile and lower yield, very early vine maturity, average specific gravity.
MSBB058-1**	NY148 X MSR127-2	1.5	Very high specific gravity, earlier vine maturity, below average yield.

MSBB058-4**	NY148 X MSR127-2	2.0	Above average yield, common scab susceptible, marginal appearance, smaller vine type.
MSBB060-1	MSW242-1 X MSS297-3	1.3	Average yield, attractive tuber shape, smaller vine type, slight vascular discoloration.
MSBB131-1**	MSW242-1 X MSS297-3	2.0	Bright skin with an attractive appearance and cream flesh, very early vine maturity, common scab susceptible.
MSBB625-2**	SMSW242-1 X MSS297-3	0.7	Above average yield and specific gravity, moderate internal brown spot, round type, netted skin, slight silver scurf.
MSBB626-11**	Saginaw Chipper x Kalkaska	1.5	High yield potential and high total yield, misshapen pickouts with deep apical ends, earlier vine maturity.
MSW044-1	Kalkaska X Lamoka	0.7	Bright skin, attractive round tuber profile, high specific gravity, common scab tolerant
MSW075-2	MSK061-4 X Nicolet	1.5	Below average yield, smaller size profile, round type with thin skin and a bright appearance.
MSX472-2	MSQ070-1 X MSP292-7	0.7	Smaller size profile, tubers have thin skin and a round shape, good chip quality with minimal stem end defect.
MSZ020-10	Kalkaska X MSM246-B	2.0	Oval tuber type with slightly flattened shape, higher proportion of pickouts, good internal quality.
MSZ052-14**	Pike X MSR127-2	1.0	Moderate alligator hide, marginal chip quality with higher stem end defect score, smaller size profile.
MSZ120-4	Kalkaska X MSQ086-3	1.8	High yield and specific gravity, sticky stolons, variable size profile, good chip color and quality.
MSZ200-3**	MSZ070-1 X Lamoka	2.0	Lower specific gravity, average yield, common scab susceptible, marginal appearance.
MSZ219-13	Saginaw Chipper X MSR127-2	0.0	Larger tuber type, darker netted skin, round shape, no common scab observed, average yield and specific gravity.
MSZ219-14	Saginaw Chipper X MSR127-2	1.5	Bright appearance, uniform round tuber type, marginal chip color with lower stem end defect.

ND7519-1	ND3828-15 X W1353	2.0	Common scab susceptible, earlier vine maturity, smaller size profile and lower yield, average specific gravity.
NY162 (K31-4)	NYE106-2 X NYE48-2	1.5	Very early vine maturity, good internal quality, below average yield, average specific gravity.
NY163 (NYL7-2)	E50-8 X E48-2	1.0	Oval tuber shape with some pointed tubers, lower yield and smaller size profile.
NY165 (M8-5)	NY148 X NYF48-4	0.5	Uniform round tubers with attractive appearance, average yield, higher stem end defect.
NY166 (N16-11)	NY140 X NYE48-2	1.8	Lower US#1 yield but higher total yield, flattened round tuber type, flaking skin.
NYP111-9	NY148 X NYF48-4	0.5	Smaller size profile, buff skin, very high specific gravity, lower stem end defect.
NY169 (NYP14-1)	Snowden X E48-2	2.0	Very low yield, high specific gravity, even split of A and B-sized tubers, very early maturity.
Petoskey (MSV030-4)	Beacon Chipper X MSG227-2	0.0	Very high specific gravity, good internal quality, moderate alligator hide, full season maturity, no common scab observed.
Winterset (CO02321-4W)	NY115 X BC0894-2W	3.5	Below average yield, common scab susceptible, earlier vine maturity, smaller size profile.

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data and qualitative descriptions provided by Potato Outreach Program (P.O.P.), MSU Potato Breeding and Genetics Program and other potato breeding programs.

**Indicated variety sampled monthly, not bi-weekly. These varieties were stored in trays on top of box bins.

Table 5: 2019 Storage Chip Processing Potato Variety Trial
Montcalm Research Center Chip Box Bin

Planting: 5/8/19 Vine Kill: 9/9/19 Harvest: 9/30/19
GDD40: 3133

	CWT/A		PERCENT OF TOTAL[1]							RAW TUBER QUALITY[4] (%)								
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR[2]	OTF CHIP SCORE[3]	HH	VD	IBS	BC	COMMON SCAB RATING[5]	SED SCORE[6]	VINE VIGOR[7]	VINE MATURITY[8]	COMMENTS
MSZ120-4	394	498	79	15	79	0	6	1.090	1.5	0	20	0	0	1.8	0.2	2.5	3.5	sticky stolons, variable size
MSBB626-11	392	530	74	15	74	0	11	1.090	2.0	0	30	0	0	1.5	0.9	3.0	2.0	deep apical ends, misshapen pos
MSBB625-2	368	482	76	22	76	0	2	1.095	2.0	0	50	20	0	0.7	0.7	3.0	3.0	sl silver scurf, round shape, netted skin
CO10076-4W	358	496	72	14	72	0	14	1.074	1.5	0	20	10	0	1.8	0.3	1.5	3.0	pitted scab lesions, flaky skin
MSBB058-4	352	453	78	19	78	0	3	1.085	2.0	0	20	0	0	2.0	0.6	2.0	2.5	poor appearance
Lady Liberty (Niagara)	350	490	72	22	72	0	6	1.085	2.0	0	50	0	0	1.3	0.2	3.0	2.5	deep apical ends, blockier type
Mackinaw	328	542	61	24	61	0	15	1.093	1.5	0	40	10	0	2.0	0.3	2.5	2.5	
Hodag	326	436	75	19	75	0	6	1.084	2.5	0	20	0	0	1.5	0.3	3.0	2.5	
MSZ200-3	323	405	80	19	80	0	1	1.077	2.0	10	40	0	20	2.0	0.6	2.5	3.0	sticky stolons, marginal
MSAA275-3	322	379	85	11	85	0	4	1.080	2.0	0	40	0	0	2.0	1.5	2.5	2.0	slightly flattened tuber type
MSBB060-1	317	387	82	7	78	4	11	1.080	1.5	0	40	0	0	1.3	0.5	2.0	2.5	nice shape
MSZ219-13	283	330	86	3	84	2	11	1.085	1.5	0	20	0	0	0.0	0.5	2.0	3.0	round, larger, darker netted skin
NY165	283	431	66	28	66	0	6	1.080	2.0	0	10	0	0	0.5	0.9	2.5	3.0	round, uniform, nice
MSBB131-1	283	357	79	13	79	0	8	1.080	1.5	0	40	0	0	2.0	0.7	3.0	1.5	bright skin, nice appearance, cream flesh
NYP111-9	282	439	64	27	64	0	9	1.100	1.5	0	30	10	0	0.5	0.2	3.0	3.0	smaller size profile, buff skin
NY166	263	491	54	35	54	0	11	1.081	1.5	0	20	0	0	1.8	0.1	2.5	2.0	flattened round tuber type, flaky skin
NY162	263	405	65	20	65	0	15	1.087	1.5	0	10	0	0	1.5	0.4	2.0	1.5	
MSBB058-1	260	368	71	21	71	0	8	1.098	1.5	0	20	0	0	1.5	0.6	3.0	1.5	
MSAA498-18	250	306	82	14	82	0	4	1.080	1.5	0	20	0	0	0.5	0.1	2.0	2.0	
MSZ052-14	245	362	67	26	67	0	7	1.085	1.5	0	20	0	0	1.0	1.1	3.0	2.5	alligator hide
MSZ020-10	232	347	67	19	67	0	14	1.087	2.0	0	10	0	0	2.0	0.2	1.0	3.5	oval, slightly flattened type
MSW075-2	228	385	59	34	59	0	7	1.081	1.5	0	50	0	0	1.5	0.2	2.5	3.0	round, bright, thin skin
MSBB008-3	218	301	73	24	73	0	3	1.081	2.0	0	40	0	0	1.0	0.3	3.0	1.0	
MSZ219-14	209	313	67	29	67	0	4	1.084	2.5	0	40	0	0	1.5	0.2	3.5	3.0	brighter appearance, uniform round tuber type
MSW044-1	206	380	54	37	54	0	9	1.088	2.0	0	0	0	0	0.7	0.3	3.5	2.5	
ND7519-1	204	329	62	35	62	0	3	1.082	1.5	0	0	0	0	2.0	0.2	3.0	2.0	
Petoskey (MSV030-4)	203	274	74	22	74	0	4	1.096	1.5	0	0	0	0	0.0	0.3	2.5	3.5	lots of alligator hide
MSX472-2	200	381	52	42	52	0	6	1.077	1.5	0	30	0	0	0.7	0.1	3.0	2.5	round, smaller, thin skin
NY163	191	340	56	33	56	0	11	1.086	1.5	0	40	0	0	1.0	0.5	2.5	2.0	oval, some pear shapes, misshapen Pos
Manistee SEL	190	370	51	37	51	0	12	1.078	2.0	0	30	0	0	3.5	0.3	3.0	1.0	lost of pitted scab lesions
Snowden	**187**	**359**	**52**	**44**	**52**	**0**	**4**	**1.076**	**1.5**	**0**	**70**	**0**	**0**	**3.5**	**0.4**	**3.0**	**1.5**	**sl growth crack, variable skin color**
Manistee	180	315	57	31	57	0	12	1.080	2.0	0	10	0	0	3.5	0.4	3.0	1.0	deep apical ends, misshapen pos
Winterset	174	341	51	45	51	0	4	1.086	2.0	0	20	0	0	3.5	0.3	3.0	1.0	
Lamoka	**170**	**285**	**60**	**34**	**60**	**0**	**6**	**1.086**	**2.0**	**0**	**0**	**0**	**0**	**2.0**	**0.3**	**3.5**	**3.0**	
NY169 (NYP14-1)	156	316	49	50	49	0	1	1.090	1.0	0	10	0	0	2.0	0.1	3.0	1.0	
MEAN	**263**	**389**	**67**	**25**	**67**	**0**	**7**	**1.085**	**1.7**	**0**	**26**	**1**	**1**	**1.6**	**0.4**	**2.7**	**2.3**	

[1]SIZE
Bs: < 1 7/8"
As: 1 7/8" - 3 1/4"
OV: > 3 1/4"
PO: Pickouts

[2]SPECIFIC GRAVITY
Data not replicated

[3]OUT OF THE FIELD CHIP COLOR SCORE (SNAC Scale)
Ratings: 1 - 5
1: Excellent
5: Poor

[4]RAW TUBER QUALITY (percent of tubers out of 10)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[5]COMMON SCAB RATING
0.0: Complete absence of surface or pitted lesions
1.0: Presence of surface lesions
2.0: Pitted lesions on tubers, though coverage is low
3.0: Pitted lesions common on tubers
4.0: Pitted lesions severe on tubers
5.0: More than 50% of tuber surface area covered in pitted lesions

[6]SED (STEM END DEFECT) SCORE
0: No stem end defect
1: Trace stem end defect
2: Slight stem end defect
3: Moderate stem end defect
4: Severe stem end defect
5: Extreme stem end defect

[7]VINE VIGOR RATING
Date: 6/17/19
Rating 1-5
1: Slow emergence
5: Early emergence (vigorous vines, some flowering)

[8]VINE MATURITY RATING
Date: 9/3/19
Rating 1-5
1: Early (vines completely dead)
5: Late (vigorous vines, some flowering)

FIELD DATA

Planting date	5/8/19
Vine Kill Date	9/9/19
Harvest Date	9/30/19
Days (planting to vine kill)	124
Days (planting to harvest)	145
GDD_{40} MAWN Station	Entrican
GDD_{40} (planting to vine kill)	3133
Seed Spacing	10"

Results: 2019-2020 Chip Processing Box Bin Highlights

MSZ120-4

This Michigan State University variety has been evaluated in the Box Bin since 2018. At harvest, the specific gravity was 1.090, above the trial average of 1.085. The US#1 yield was 394 cwt/A, the highest yield in the trial (Table 5A). Only one pre-harvest sample was taken on September 3rd, where glucose was 0.002 and sucrose was 2.322. This variety exhibited full season maturity, average common scab incidence, and a higher percentage of US#1 tubers. It had excellent out of the field chip quality, with a 1.5 chip score and less stem end defect than the trial average. Sucrose concentrations were highest on the 10/21/19 sample date and decreased until late January. Concentrations then generally increased until the last sample on 6/1/20, reaching a high of 1.131 (X10). Glucose concentrations were more stable, also high on the 10/21/19 sample, but again rising to 0.007% in late February. The last two samples had increasing glucose concentrations, with the last sample at 0.005%. There was only one incidence of internal color during storage, 1.5% on 2/24/20. Internal color was also very good, with only two samples displaying this defect, both at 6% or lower. There were two samples with total defects above 10%, 2/24/20 and 5/18/20, 14.3% and 16.4%, respectively. Chip defects noted by Techmark, Inc. include bruising observed in six samples, and stem end color in two samples. This variety maintains good chip quality through early June and continues to demonstrate long term storage potential in Michigan. It is being further evaluated in the 2020-2021 Box Bin trial.

Figure 1. MSZ120-4 chip samples at the first processing date (10/1/19) and last processing date (6/1/20).

MSBB058-4

This MSU variety entered the Box Bin trial in 2019. It had an above average yield potential of 352 cwt/A US#1 tubers, the fifth highest in the Box Bin trial. It had an average specific gravity of 1.085, but a higher than average off the farm chip color of 2.0 with slightly higher than average stem end defect. MSBB058-4 was slightly chemically immature at harvest with stable glucose and slightly increasing sucrose between 8/21/19 and 9/3/19. During initial bin cooling and loading the sucrose concentration began to decrease, reaching its lowest concentration on 2/10/20 at 0.288 (X10). Conversely, the highest glucose rating was 0.018% on 1/13/20, reflecting sucrose conversion. Sucrose concentrations rose after the 2/10/20 sample, reaching a high of 1.378 (X10) at the last sample date. Glucose concentration rose slightly during this time but remained more stable. Undesirable color was generally low during storage, excluding the 5/4/20 sample with 9.1%. Internal color was also low but increased from the April samples to the end of storage. Total defects were also highest during this time, with the final two samples having total defects of 28.9% and 29.4%, respectively. Defects observed by Techmark, Inc. include bruising and dark chips. Chip quality was best from October to April but decreased in May and June. This variety will be further evaluated in the 2020-2021 Box Bin trial with bi-weekly, instead of monthly samples, as it demonstrates long-term storage potential with minimal chip defects until April.

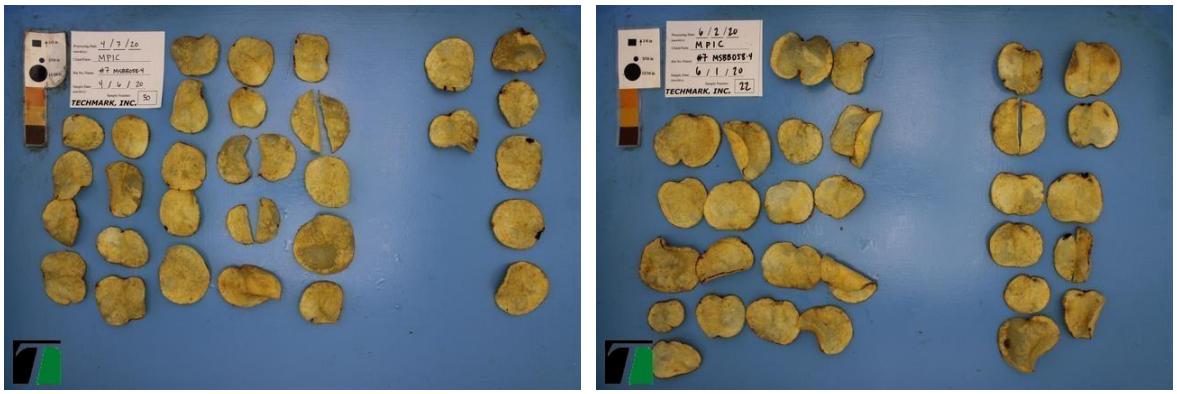


Figure 2. MSBB058-4 chip quality on last acceptable sample date, 4/6/20 (left) and last storage sample, 6/1/20 (right).

NY166

This Cornell University variety was first evaluated by the Potato Outreach Program in 2019. It had an average US#1 and higher than average total yield in the 2019 Box Bin trial. The US#1 yield was 263 cwt/A, at the trial average, and total yield was 491 cwt/A, compared to the trial average of 389 cwt/A. This is reflected in the higher percentage of B-sized tubers, 35% compared to the trial average of 25%. It had a slightly below average specific gravity of 1.081, and an off the farm chip score of 1.5 with minimal stem end defect. Only one pre-harvest sample was conducted on 9/3/19, with 0.001% glucose and a sucrose rating of 0.647 (X10). Sucrose concentrations remained high during initial bin cooling, only beginning to lower in the 1/13/20 sample. Concentrations remained relatively stable, increasing to 0.608 (X10) at the last sample in early June. Glucose concentrations remained between 0.001% and 0.003% during storage. There was no undesirable color during the storage season, and one incidence of internal color, 3.1% on 1/27/20. This was the sample with the highest total defects, 12.8%. The second to last sample on 5/18/20 also had higher than average total defects of 11.1%. Bruised tubers were noted in six sample reports during storage. Chip quality was excellent and continuous from the first sample to bin unloading on 6/1/20. NY166 will be further evaluated as it continues to display excellent chip quality and may have storage potential below 54ºF.

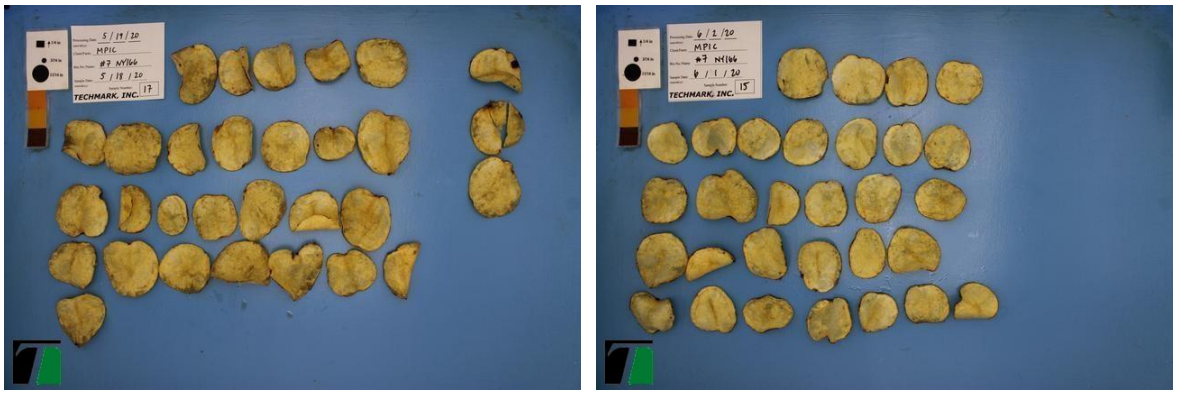


Figure 3. NY166 chip quality on the last two sample dates, 5/18/20 (left) and 6/1/20 (right)

NY165

NY165 is also a Cornell selection that was first evaluated in 2019. This variety had a slightly higher than average US#1 yield, 283 cwt/A. It had a lower than average specific gravity of 1.080, and an off the farm chip score of 2.0. At harvest, it displayed good internal quality, round uniform tubers, and an attractive appearance. NY165 was slightly chemically immature at harvest, based on the pre-harvest samples taken on 8/21/19 and 9/3/19. Between the two sample dates, glucose remained stable at 0.002%, but sucrose increased from 0.409 to 0.477 (X10). Sucrose was even higher, 0.512 (X10) on the first sample date, and decreased to a low of 0.464 on 12/19/19. After this date it rose consistently, reaching a high of 1.591 on the last sample date of 6/1/20. Glucose concentrations followed a similar trend of decreasing through December, and then gradually increasing into June. However, the glucose concentration range was narrower, between 0.001% and 0.004% in all samples. Undesirable color was low during storage, with only three instances, all below 9%. Internal color defects were concentrated at the end of the season, with the last two samples displaying 10.3% and 13.6% of this defect. Total defects were variable during storage, with higher percentages on 10/21/19 and all samples after 4/20/20. Bruises were observed in all but three chip samples. This is especially apparent in the last three chip images, taken between 4/20/20 and 6/1/20. The last acceptable chip sample was taken 4/6/20. NY165 will be further evaluated in the Box Bin trial in 2020 to 2021.

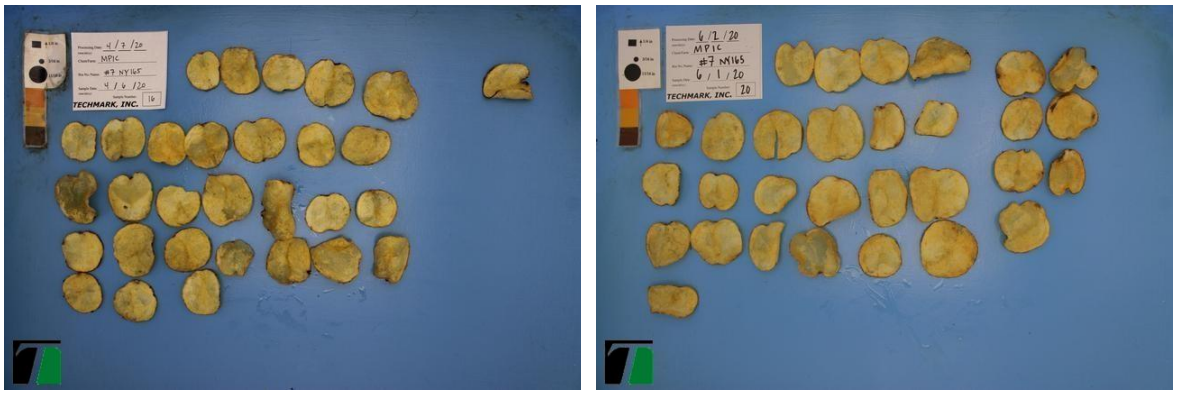


Figure 4. NY165 chip quality on last acceptable sample date, 4/6/20 (left) and last storage sample, 6/1/20 (right).

Snowden

This variety was included as a commercial standard for the 2019-20120 Box Bin trial. It had a lower yield than the trial average, not typical for Snowden, which generally has an average to above average yield potential. It had a very early vine maturity and lower than average specific gravity of 1.076 in 2019. Off the farm chip quality was good with a chip score of 1.5 and an average stem end defect rating. Snowden was chemically mature at harvest, with a slightly decreasing glucose concentration and a decreasing sucrose concentration, from 0.725 (X10) to 0.563 (X10). In storage, sucrose concentrations followed a U-shaped trend, decreasing from bin loading to February, and then increasing until the last storage sample taken on 5/4/20. Correspondingly, glucose concentrations rose sharply towards the end of storage, increasing from 0.004% to 0.010% from 4/20/20 to 5/4/20. Only the last sample displayed undesirable color, and internal color was observed once in March and in the last sample in May. All samples but one had some defects, with the highest incidence of 17.1% on 1/27/20. Bruise was observed in most samples by Techmark, Inc. Snowden continues to be grown and stored in Michigan, and remains the standard for the Box Bin trials.

Figure 6. Snowden chip quality on last acceptable sample date, 4/6/20 (left) and last storage sample 5/4/20 (right).

II. 2019 - 2020 Bulk Bin (500 cwt. Bin) Report

(Chris Long, Trina Zavislan, Damen Kurzer, and Brian Sackett)

Overview and Objectives

The goals of the MPIC Storage and Handling Committee for the 2019-2020 bulk bin storage season were: 1. To further refine optimal storage profiles for Mackinaw, specifically to understand temperature effect on weight loss and pressure bruise development, 2. To further refine optimal storage profiles for Petoskey, specifically to determine the extent of stem end defects and chip defects when cooled, and 3. To study the effects of two different storage temperatures on ND7519-1 and MSZ219-14.

Procedure

Each bin was filled under contract with potato producers in the state of Michigan. The MPIC paid field contract price for the potatoes to be delivered to the demonstration storage. Pressure bruise samples were collected for each bulk bin and designated bulk bins were filled. The varieties and their storage management strategies were established by the MPIC Storage and Handling Committee. For each bulk bin filled, a corresponding box bin containing 10 cwt. was filled and placed into Bin 7. Bin 7 was held at 54ºF, which in most cases is warmer than the corresponding bulk bin of the same variety. This allowed the committee to see if the warmer storage temperature in the box bin would reduce storage life and provided information as to how the bulk bin tubers might physiologically age. Bulk bins 1 and 2 were gassed with CIPC on November 1st, 3 and 4 on October 14th, 5 and 6 on November 19th, and 8 and 9 on November 5th. All bulk bins were gassed with CIPC again on January 30th.

Bulk bin assignments are below:
1 and 2: Mackinaw (Sackett Potatoes)
3 and 4: Petoskey (Walther Farms Cass City)
5 and 6: MSZ219-14 (Thorlund Brothers)
7: Box Bins
8 and 9: ND7519-1 (Sandyland Farms)

We began sugar monitoring the day tubers were loaded into storage and sampled tubers on a two-week schedule thereafter. Forty tubers were removed from the sample door in each bin every two weeks and sent to Techmark, Inc. for sucrose, glucose, chip color and defect evaluation. The sample door is located in the center back side of each storage bin and allows us to take samples from the pile three feet above the bottom of the pile. Pressure bruise evaluation began by collecting nine, 20 to 25 lb. tuber samples as each bin was being filled. Three samples were placed at each of three different levels within the bulk bin pile at 3, 8, and 14 feet from the storage floor.

We evaluated the pressure bruise samples 3 to 5 days after the bin was unloaded. We randomly selected a set of 25 tubers from each bag and visually inspected for pressure bruising. By removing the tuber skin with a knife, we evaluated the discoloration for each flat spot. A visual rating established presence or absence of flesh color (blackening of flesh). We calculated percent weight loss in each tuber sample as it was removed from the storage.

Mackinaw Storage Trial (Bin 1 and 2)

Mackinaw, a promising variety from Michigan State University, has commercialization potential in Michigan due to excellent long-term chip quality with tolerance to stem-end defects, resistance PVY and Late Blight, tolerance to common scab and Fusarium, resistance to Rhizoctonia, and a higher specific gravity. The purpose of this bulk bin experiment was to evaluate glucose and sucrose reaction during pile cooling to 46ºF and 48ºF in Bins 1 and 2, respectively. The initial pulp temperature was 46.4ºF during bin loading, and temperature in both bins was increased to suberization temperature. The bins were then cooled by direct cooling to 50ºF. The bins were further cooled to 48ºF at a rate of either 0.4ºF per day or 0.6ºF per day. After reaching 48ºF, later cooling occurred at a rate of 0.2ºF per day for Bin 1 until the temperature reached 46ºF, while Bin 2 was held at 48ºF. This strategy and cooling rate is used in all bulk bins, which were cooled from field temperature to suberization temperature, to 50ºF, to the target storage temperature.

We filled Bin 1 with Mackinaw on October 8th. The seed was planted in Mecosta, MI on May 7th and vine killed on September 5th (121 DAP, GDD_{40} 3043). This planting was harvested on October 7th, 153 days after planting. At loading, tubers in Bin 1 were 80% bruise free and tubers in Bin 2 were 64% bruise free. The pulp temperature for tubers at the time of bin loading was 46.6ºF. Both bins were gassed with CIPC on November 1st and January 30th. They were unloaded on June 9th and shipped to Utz Quality Foods, Hanover, PA, where they were processed on June 10th.

Results

Bulk Bin 1, Mackinaw (GDD_{40} 3043, 46ºF)

Mackinaw was grown at Sackett Potatoes in a field with Lamoka (Figure 7). The Potato Outreach Program conducted a test dig prior to vine kill, in which ten feet of potatoes were harvested and graded. A US#1 yield of 251 cwt/A, lower than the yield of Lamoka in the same field, at 423 cwt/A, was observed. Specific gravity was 1.092, higher than that of Lamoka at 1.086. There were 9.2 tubers per plant and 2.7 tubers per stem. Internal quality was good with no defects observed, and the chip score was excellent at 1.0.

One pre-harvest sample was taken on 8/13/2019. Both glucose and sucrose concentrations were high, 0.013% glucose and a sucrose rating of 1.991. Slight hollow heart was observed. Chip quality out of the field was evaluated on 10/8/2019 with 3.5% total defects observed. Defects are reported by Techmark, Inc, and are determined using slices cut from stem to bud end. On this date, sucrose and glucose concentrations were 1.279 (X10) and 0.003%, respectively. The SFA chip color was 1.0. The target temperature of 46ºF was reached in early January.

Sucrose concentrations fluctuated during storage but remained above 1.000 (X10) in all but the last three samples. Concentrations generally decreased at the very end of the storage season. Glucose concentrations were also variable but were in a more limited range from 0.001% to 0.006%. Glucose was highest on 1/27/2020 and decreased to 0.002% for the last

two sample dates. There was no undesirable color observed until the 2/24/2020 sample, the four total observations were all below six percent. There were only two instances of internal color, one on 1/27/2020 and the other on 4/20/2020. Total defects were generally lower earlier in the storage season, all below 14% until the 1/13/2020 sample. After this sample, total defects rose to a high of 34.4% on the last same date. While the chips maintained good chip color through the end of the storage season, the last sample with few defects at Techmark, Inc. occurred on 5/18/2020 (Figure 8).

On June 9th, the Bin was unloaded (Figure 9) and the potatoes were sent to Utz Quality Foods, Hanover PA, on June 10th. Sackett Potatoes also evaluated the potatoes on June 9th and observed a specific gravity of 1.092 and Frito Lay Solids of 18.89. A sample was chipped in the Sackett Potatoes lab and photographed by the Potato Outreach program (Figure 10). When evaluated at Utz Quality Foods, the processor identified 2% total chip defects and a very high specific gravity of 1.102 (Figure 11). There were no external defects, only a small amount of pressure bruise and greening. The fry operator had to adjust the slicer thickness due to the very high gravity of these potatoes.

Utz sent a sample of chips to the Potato Outreach Program, and staff sorted potatoes into acceptable chips, chips with internal defects, and chips with external defects using a visual evaluation (Figure 12). 78.5% of chips had no defects, 11.6% had internal defects, and 9.9% had external defects. There was one green chip. These higher percent defects do not indicate unacceptable chips, merely that a defect is present but acceptable to a processor.

At bin unloading, the average weight loss of tubers was 4.36%. 3% of the tubers had bruising with color, while 44% had bruising with no color and 53% were bruise free (Table 6). Mackinaw continues to be a promising variety with commercialization potential in Michigan. It will be further evaluated in the 2020 to 2021 storage season.

Figure 7. The Mackinaw potatoes used in Bulk Bin 1 (left) at Sackett Potatoes on 6/19/2019.

Figure 8. Bulk Bin 1 chips on the first sample date (10/8/19), last acceptable chip date (5/18/20) and last sample date (6/9/2020).

Figure 9. Mackinaw potataoes in Bin 1 during unloading on 6/9/2020.

Figure 10. Mackinaw from Bin 1 chipped by Sackett Potatoes, 6/9/2020.

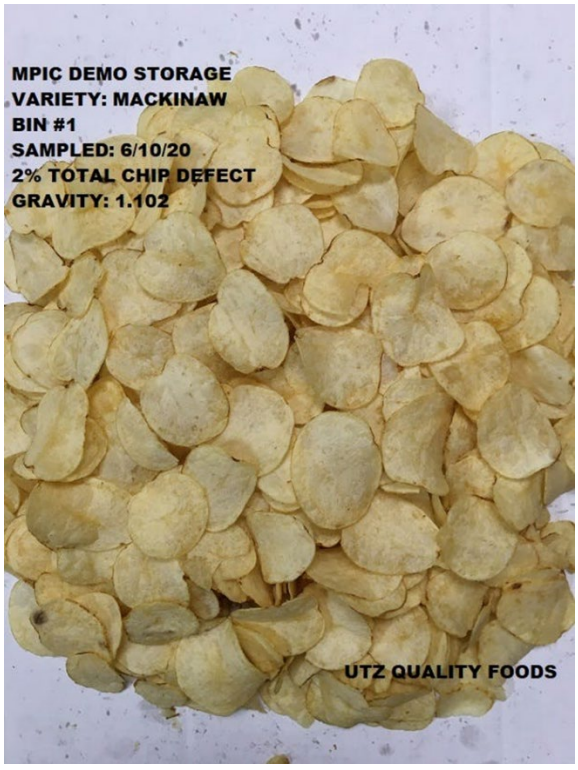


Figure 11. Mackinaw from Bin 1 at Utz Quality Foods, 6/10/2020.

Figure 12. Mackinaw chips from Utz sorted by defect type by the Potato Outreach Program.

Bulk Bin 2, Mackinaw (GDD_{40} 3043, 48ºF)

Chip quality out of the field was very good with no defects reported on the first sample date, October 8th. Defects are reported by Techmark, Inc, and are determined using slices cut from stem to bud end. On this date, sucrose and glucose concentrations were 1.198 percent (X10) and 0.003 percent respectively with a pulp temperature of 51.2ºF.

Sucrose levels were elevated as in Bin 1, but to a lesser extent. Concentrations were lowest between 3/23/2020 and 5/18/2020, after which they rose during the last two sample dates. Glucose concentrations were also variable, reaching a high of 0.005% twice, first on 11/18/2019, then on 3/23/2020. The target temperature of 48ºF was reached in late December, and the bin was maintained until temperature was increased to 50.8ºF beginning in late May. Like Bin 1, Bin 2 had good chip quality for most of storage. There were three instances of undesirable color between March and April, all below seven

percent. Internal color was also good, with only two samples exhibiting browning in May. Total defects were somewhat variable, three samples containing over 20% defects in late January, late March, and early June. In all but five samples Techmark, Inc. observed bruising. While there was a slight increase in the number of chip defects in both May samples, chips from the 6/1/2020 and 6/9/2020 samples had acceptable chip quality, suggesting that holding at a slightly higher temperature may improve chip quality (Figure 13).

Bin 2 was unloaded on June 9th and was processed at Utz on June 10th. During bin unloading, some sprouting was observed in Bin 2 but not in Bin 1 (Figure 14). As in Bin 1, a sample was also chipped at Sackett Potatoes (Figure 15). Sackett Potatoes observed a specific gravity of 1.097 and Frito-Lay solids of 19.65. Utz Quality Foods found a specific gravity of 1.102, identical to Bin 1, and 5% total chip defects, slightly higher than Bin 1 (Figure 16). Utz also noted some sprouting, which resulted in the increased defects observed as internal sprout defects.

At bin unloading, the average tuber weight loss was 4.46%, very slightly higher than in Bin 1. 11% of tubers were bruised with color, while 49% were bruised with no color and 40% had no bruising (Table 6).

Figure 13. Mackinaw chips from the first (10/8/2019) and last (6/9/2020) sample dates.

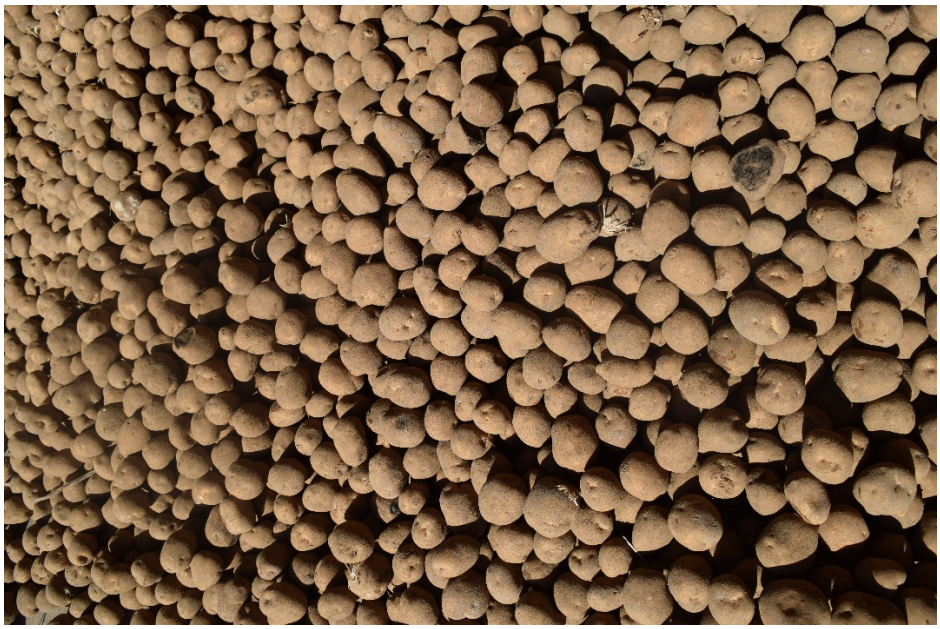


Figure 14. Mackinaw tubers from Bin 2 unloading on 6/9/2020. Some sprouting was observed.

Figure 15. Mackinaw from Bin 2 chipped by Sackett Potatoes, 6/9/2020.

Figure 16. Mackinaw from Bin 2 chipped at Utz Quality Foods on 6/10/2020.

Table 6. 2019-2020 PRESSURE BRUISE DATA
Bulk Bin #1 and #2 Mackinaw (Mecosta, MI)

Location[1]	Average Weight Loss (%)	Average Number of External Pressure Bruises Per Tuber[2]				Average % of Total Tuber Number		
		0	1	2	3+	Without Bruise	Bruised (No Color)	Bruised with Color[3]
14' Bin 1	4.43	21	4	0	0	85	15	0
8' Bin 1	4.44	9	8	7	1	37	59	4
3' Bin 1	4.22	9	12	3	1	37	59	4
OVERALL AVERAGES	**4.36**					**53**	**44**	**3**
14’ Bin 2	4.43	14	9	2	0	55	41	4
8’ Bin 2	4.51	9	11	4	1	36	48	16
3’ Bin 2	4.43	7	11	5	2	28	59	13
OVERALL AVERAGES	**4.46**					**40**	**49**	**11**

[1] Feet above the bin floor.
[2] A Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.
[3] A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored as a tuber "with color".

Loaded	10/8/2019 (both)	Pulp Temp. (at Filling)	46.4ºF (1) 46.4ºF (2)		
Unloaded	6/9/2020 (both)	Target Storage Temp.	46ºF (1) 48ºF (2)	End Temp.	50.6ºF (1) 50.8ºF (2)

Petoskey Storage Trial (Bins 3 and 4)

This Michigan State University variety had commercialization potential in Michigan due storage rot disease tolerance, including *Fusarium,* Pink Rot, and Pythium. It has an above average specific gravity and is generally storable until March or April. Yields are typically average. These two bulk bins were filled with potatoes grown by Walther Farms in Cass City, MI (Figure 17). The potatoes in both bins were planted on April 25th and vines were killed on September 6th (134 DAP, GDD_{40} 3220). Harvest occurred on September 17th, 145 days after planting. At harvest the pulp temperature was 63.1ºF. The tubers were in good condition at bin loading, with 76% bruise free tubers in Bin 3 and 88% bruise free tubers in Bin 4. Petoskey was physiologically and chemically mature at bin loading as indicated by an increasing glucose concentration and decreasing sucrose concentration between two pre-harvest panels taken on 8/19/2020 and 8/27/2020. The bins were loaded on September 17th and treated with CIPC on October 14th and January 30th. These bins were designed to study chip quality and potato storability under two different storage protocols and determine when senescence sweeting occurs.

Figure 17. The Petoskey field at Walther Farms Cass City on 6/17/2019, Petoskey tubers dug on 7/22/2019.

Results

Bulk Bin 3, Mackinaw (GDD_{40} 3220, 48ºF)

The initial target temperature for this bin was 50ºF, which was reached in December by cooling at a rate of 0.2ºF per day, and further cooling to 48ºF at the same rate occurred to increase the longevity of storage as stem end defects and chip defects decreased through January. This target temperature was maintained until the bin was unloaded on 5/18/2020 with a pulp temperature of 47.8ºF. Petoskey displayed a U-shaped trend in sucrose concentration with higher concentrations occurring from bin loading until November, then decreasing to the lowest readings in March, and finally increasing to 0.596 (X10) at bin unloading. Glucose concentrations were also initially higher, then decreased to mostly lower concentrations in January to March, and slowly increased in April and May. Undesirable color was initially observed, but only through November. Internal color was also initially high, reaching 38.5% in the second sample, but was subsequently lower than 10% in all samples, excluding 113.8% on 4/20/20.

Petoskey displayed evidence of reconditioning in storage, with total defects high at the beginning of storage and then decreasing to December and January. Total defects rose again but decreased to zero in March. After the late March sample, defects again rose. See Figure 18 for images of marginal chip quality in September, improved chip quality in January and late March, and decreasing chip quality in May just before bin unloading. Chip defects recorded by Techmark, Inc. include bruise and slight stem end color.

Bin 3 was unloaded on May 18th and processed by Better Made Foods on May 19th (Figure 19). At unloading, the average tuber weight loss was 5.44%. 27% of tubers had no bruising, 37% had bruising with no color, and 36% were bruised with color (Table 7). As in Bin 1 and 2, Sackett Potatoes chipped a sample of tubers (Figure 20). Sackett Potatoes noted a specific gravity of 1.098 and Frito-Lay solids at 19.95. Better Made noted a specific gravity of 1.102. Chip quality was good, with 4.73% internal defects and 3.83%

external defects for a total of 8.56% defects. The AGTRON score was 64.1. Figure 21 shows washed, cut, and chipped potatoes from Bin 3. The Potato Outreach Program also sorted chips processed by Better Made into defect type (Figure 22). POP staff identified two percent by weight of sugar defects, internal defects, and external defects, with the remaining 94% acceptable. No greening was observed.

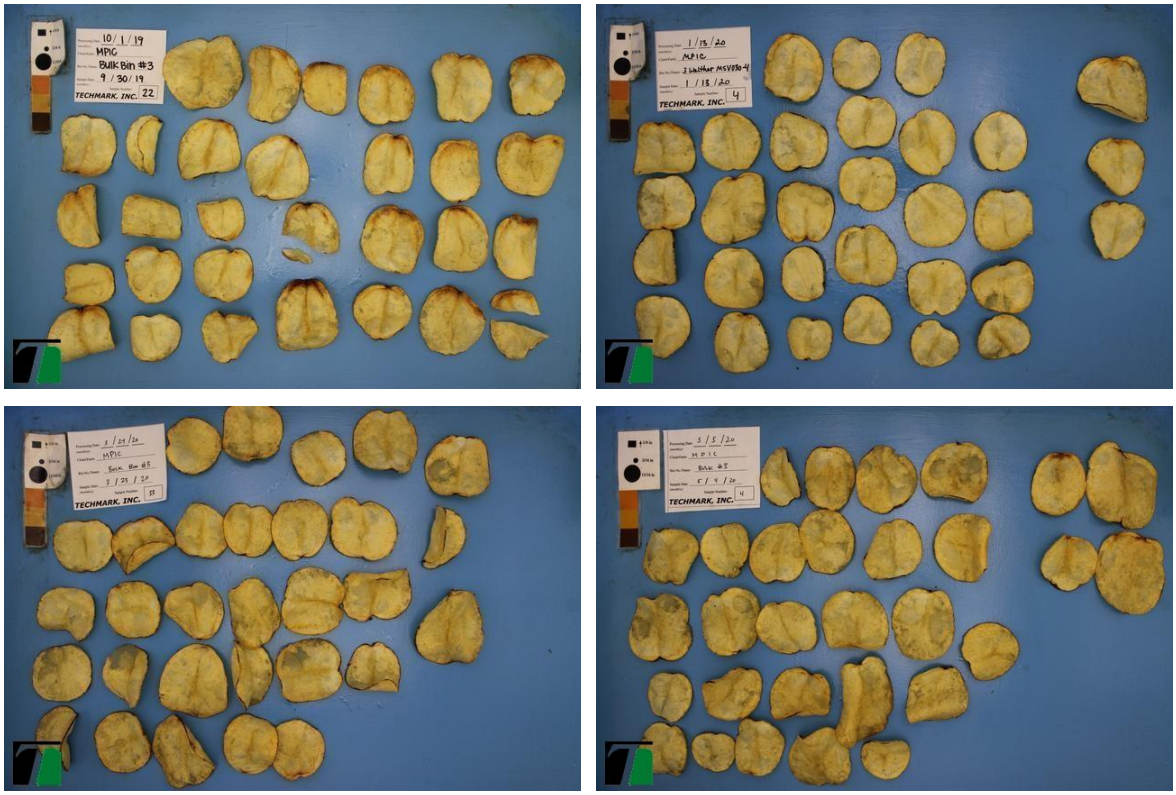


Figure 18. Petoskey chip images on 9/30/19, 1/11/20, 3/23/20, and 5/4/20.

Figure 19. Petoskey from Bin 3 unloaded on 5/18/2020.

Figure 20. Petoskey from Bin 3 chipped by Sackett Potatoes on 5/18/2020.

Figure 21. Raw tubers, washed tubers, and finished chips from Petoskey Bin 3 at Better Made Foods on 5/19/2020.

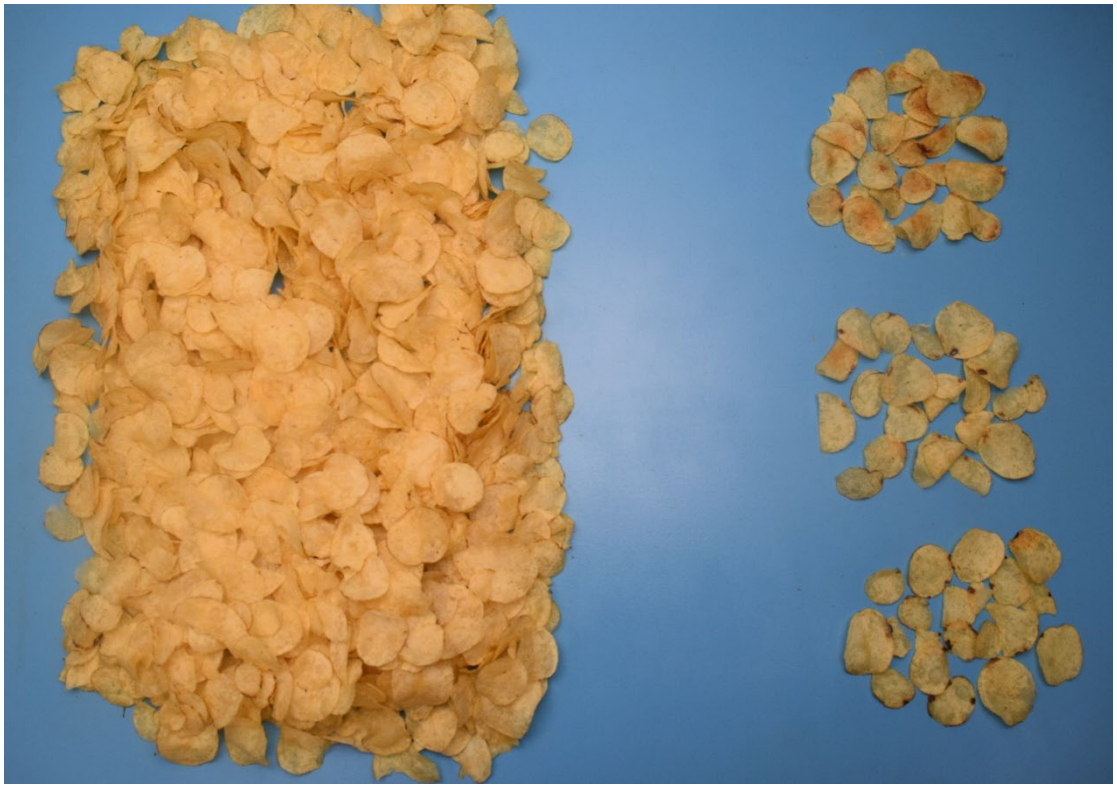


Figure 22. Tubers chipped at Better Made and sorted by the Potato Outreach Program into acceptable (left), sugar defects (top right), internal defects (middle right), and external defects (bottom right).

Bulk Bin 4, Petoskey (GDD_{40} 3220, 50ºF)

This bulk bin was cooled to the target temperature of 50ºF by late January, and this temperature was maintained until bin unloading on 5/18/20. As in Bin 3, sucrose concentrations followed a U-shaped trend with the highest concentrations shortly after bin loading and just before unloading. Concentrations were lowest between February and March. Glucose concentrations remained more stable, between 0.002% and 0.004% for most of the storage season, only increasing to 0.005% at the last sample. There were three samples with undesirable color, one at the beginning of storage and two towards the end of the storage season. Internal color was generally low, excluding the first two samples that had 14.8% and 20.5% internal color, respectively. The other three samples with internal color were at 13% or lower. Total defects were consistently high from bin loading to late February, after which they generally decreased. The sample taken on 1/27/2020 had 44.9% internal defects, the highest observed in Bin 4. The sample taken on 5/4/2020 had the lowest total defects, 3.5%, but the final sample had 30.5% defects. See Figure 23 for images of chips at bin loading, May 4th, and bin unloading. Almost all samples evaluated by Techmark, Inc. had slight to moderate stem end color and bruising.

Bin 4 was unloaded on May 18th with a pulp temperature of 50.2ºF (Figure 24). A sample was chipped at Sackett Potatoes (Figure 25). Sackett Potatoes calculated a specific gravity of 1.098 and Frito lay solids of 19.87. Better Made Snack Foods received and processed the tubers on May 19th. The processor noted a specific gravity of 1.102, 1.01% internal defects, 4.51% external defects, and 5.87% total defects. The Agron score was 66. The tubers were washed, cut, and chipped (Figure 26). Petoskey demonstrating reconditioning, or “cleaning up” in storage, where chip quality improves after initially marginal out of the field and early storage performance. The stem end defect observed in both bins was less severe from March to May, suggesting that the defect was not caused by disease and was managed in storage. This variety continues to display mid-season storability, with processing potential between March and May.

Figure 23. Petoskey from Bin 4 chip samples taken on 9/17/19, 5/4/20, and 5/18/20.

Figure 24. Petoskey from Bin 4 during unloading on 5/18/2020.

Figure 25. Petoskey chipped by Sackett Potatoes on 5/18/2020.

Figure 26. Washed, cut, and chipped tubers of Petoskey at Better Made Snack Foods on 5/19/2020.

Table 7. 2019-2020 PRESSURE BRUISE DATA
Bulk Bin #3 and #4 Petoskey (Cass City, MI)

Location[1]	Average Weight Loss (%)	Average Number of External Pressure Bruises Per Tuber[2]				Average % of Total Tuber Number		
		0	1	2	3+	Without Bruise	Bruised (No Color)	Bruised with Color[3]
14' Bin 3	5.40	13	8	4	0	51	39	11
8' Bin 3	5.28	6	8	8	3	25	33	41
3' Bin 3	5.63	1	8	10	6	4	40	56
OVERALL AVERAGES	**5.44**					**27**	**37**	**36**
14’ Bin 4	6.13	10	10	3	1	41	53	5
8’ Bin 4	6.15	2	6	11	7	7	60	33
3’ Bin 4	6.39	1	4	11	8	4	56	40
OVERALL AVERAGES	**6.22**					**17**	**56**	**26**

[1] Feet above the bin floor.
[2] A Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.
[3] A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored as a tuber "with color".

Loaded	9/17/19(both)	Pulp Temp. (at Filling)	63.1ºF (both)		
Unloaded	5/18/20 (both)	Target Storage Temp.	50.0ºF (3) 48.0ºF (4)	End Temp.	47.8ºF (3) 50.2ºF (4)

MSZ219-14 (Bins 5 and 6)

This Michigan State University selection has been evaluated by the Potato Outreach Program since 2016. It has an average to above average yield potential and is resistant to Common Scab and PVY. Under further evaluation, this variety displayed higher than average chip defects and a below average specific gravity. MSZ219-14 was studied in the bulk bins to determine if it had long term chip quality and storability to make up for these weaknesses. This variety was planted on June 6th at Thorlund Brothers, Greenville, MI. Vine kill occurred on September 24th (110 DAP, 3107 GDD_{40}). The potatoes were harvested on October 25th, 141 days after planting. At bin loading the pulp temperature was 49.0ºF in Bin 5 and 48.6ºF in Bin 6. Tubers were 72% and 64% bruise free. No pre-harvest sample was taken for this variety. Both bins were gassed with CIPC on November 19th and January 30th. The initial plan for the bins was to cool them to 50ºF and 52ºF, respectively. However, the chip quality and agronomic traits caused the research committee to discontinue evaluation. Both bins were held at 54ºF to maintain respiration until the potatoes reached an acceptable processing quality.

Results

Bulk Bin 5, MSZ219-14 (GDD_{40} 3107, 54ºF)

The temperature in Bulk Bin 5 was maintained near 54ºF for the duration of storage. The sucrose concentration followed a U-shaped curve, decreasing until February and then gradually increasing through bin unloading on 3/26/2020. The glucose concentration was consistently high through December, decreased through February, and then increased until bin unloading. Most samples had a high percentage of total defects, with the lowest incidence of 33.4% occurring on 2/24/2020. Internal color was also high, with the lowest incidence of 21.2% occurring on 12/2/2019. Techmark, Inc. noted moderate stem end color, bruise, dark chips, or hollow heart in each sample. See Figure 27 for chip quality at bin loading and unloading. The bin was unloaded on March 26th and the potatoes were sent

to Campbells, Inc. for canning. At unloading, the average weight loss was 5.89% with 15% bruise free tubers, 77% of tubers with bruise and no color, and 8% of tubers with bruise and color (Table 8). MSZ219-14 is no longer under evaluation by the Potato Outreach Program.

Figure 27. Bulk bin 5 first chip sample on 10/25/19, and last chip sample on 3/23/20.

Bulk Bin 6, MSZ219-14 (GDD_{40} 3107, 54ºF)

This bin displayed performed similarly compared to Bin 5 in terms of total chip defects, internal color, and undesirable color. Sucrose concentrations were initially high and generally decreased from December to the end of the storage season. Glucose concentrations in Bin 6 were initially higher than those of Bin 5 but decreased to 0.002% at the last sample date in March. Undesirable color was comparable to Bin 5, as was internal color and total defects. The highest internal color incidence occurred on 11/4/2019 at 73.6%. The following sample on 11/18/20 had the highest total defects, 80.8%. Figure 28 shows the first and last chip image of MSZ219-14 in Bin 6. At Bin unloading, the pulp temperature was 49.6ºF. Average weight loss was 5.76%, and 28% of tubers were bruise free. Of the bruised tubers, 69% were bruised with no color and 3% were bruised with color (Table 8).

Figure 28. Bulk bin 6 first chip sample on 10/25/19, and last chip sample on 3/23/20.

Table 8. 2019-2020 PRESSURE BRUISE DATA
Bulk Bin #5 and #6 MSZ219-14 (Greenville, MI)

Location[1]	Average Weight Loss (%)	Average Number of External Pressure Bruises Per Tuber[2]				Average % of Total Tuber Number		
		0	1	2	3+	Without Bruise	Bruised (No Color)	Bruised with Color[3]
14' Bin 5	5.18	5	10	6	3	20	80	0
8' Bin 5	5.16	3	11	8	3	13	76	11
3' Bin 5	7.34	3	7	10	5	12	76	12
OVERALL AVERAGES	**5.89**					**15**	**77**	**8**
14’ Bin 6	5.34	8	8	8	1	32	68	0
8’ Bin 6	4.46	10	8	6	1	40	60	0
3’ Bin 6	7.49	3	9	6	7	12	79	9
OVERALL AVERAGES	**5.76**					**28**	**69**	**3**

[1] Feet above the bin floor.
[2] A Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.
[3] A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored as a tuber "with color".

Loaded	10/25/19(both)	Pulp Temp. (at Filling)	49.0ºF (5) 48.6ºF (6)		
Unloaded	3/26/20 (both)	Target Storage Temp.	54.0ºF (both)	End Temp.	49.8ºF (5) 49.6ºF (6)

ND7519-1 Storage Trial (Bins 8 and 9)

This North Dakota selection has been evaluated by the Potato Outreach Program since 2016 and has been evaluated in the Michigan SNAC trial for two years. It has an average to above average specific gravity, a uniform medium sized tuber profile, average yields, and is tolerant to common scab. In storage, it has a better than average chip color, and has an earlier maturity than Snowden. Internal heat necrosis has been observed in the variety in the past, which has the potential to translate in chip defects or physiological storage issues. In 2019, these potatoes were planted on May 16th and Sandyland Farms, Howard City, MI (Figure 29). The field was vine killed on September 4th, (111 DAP, 2937 GDD_{40}) and harvested October 14th, 151 days after planting. At loading, the pulp temperature for Bin 8 was 44ºF with 72% bruise free tubers. Bin 9 tubers were 46ºF with 60% bruise free tubers. Two pre-harvest samples were taken from this field on August 20th and September 3rd. ND7519-1 was mature at harvest, the sucrose rating decreased from 0.768 (X10) to 0.671 (X10) between the two samples. The Potato Outreach Program conducted a ten-foot test dig of this variety, and calculated a US#1 yield of 626 cwt/A with 84% US#1 tubers. There were 16.6 tubers per plant and 3.0 tubers per stem. The specific gravity was 1.087 and chip color was excellent. Both bins were gassed with CIPC on November 5th and January 30th.

Figure 29. The field of ND7519-1 at Sandyland Farms on 6/19/2019.

Results

Bulk Bin 8, ND7519-1, (GDD_{40} 2937, 44ºF)

Bulk Bin 8 was cooled to 48ºF by December and was further cooled to 46ºF at 0.2ºF per day by January. While there was some concern about the internal heat necrosis observed in the past, this defect had not been observed in chip samples in December. Therefore, the bin was further cooled to 44ºF 0.2ºF per day. This temperature was achieved in February and was maintained until bin unloading. Sucrose concentrations were initially high in Bin 8 tubers, with the sucrose concentration at the first sample date 1.015 (X10). Concentrations decreased through late January, and subsequently rose until the bin was unloaded on 3/23/2020. Glucose concentrations followed a similar trend, with concentrations starting and ending high, at 0.011% in early and late samples. Total defects were typically above 5% in each sample, and the highest percentage of defects was observed on the 12/2/2019 sample with 23.8% total defects. Chip defects were primarily dark chips or bruising, as internal color and undesirable color did not account for most defects observed. Undesirable color defects were low, only reaching 4.1% on the last sample date. Internal color was also lower, present in only four samples and reaching a high of 6% in the 3/9/2020 sample.

The bin was unloaded on 3/23/2020, and the tubers were shipped to Herr Foods, Nottingham, PA (Figure 30). A sample of potatoes was chipped at Sackett Potatoes on 3/23/2020. Sackett Potatoes reported a specific gravity of 1.084 and Frito-Lay score of 17.44. The tubers were processed on 3/24/2020 at Herr Foods. Herr's recorded as specific gravity of 1.087, an AGTRON score of 52.2, and 1.9% minor defects. Color, crispness, and flavor were all rated "above average." The processor sent a bag of tubers to the Potato Outreach Program for visual defect evaluation. The tubers were collected prior to the Opti-sort and are a good indicator of total defects present in the bin. Potato Outreach Program staff sorted the chips into acceptable, sugar defects, internal defects, external defects, and greening defects. 92% of chips were acceptable, 3% had sugar defects, 2% had internal defects, 2% had external defects, and 1% had greening defects (Figure 32). At bin

unloading, tuber weight loss was 4%, with 20% bruise free tubers, 75% bruised with no color, and 5% bruised with color (Table 9).

Based on sugar data calculated by Techmark, Inc., this bin had been senescence sweetening since early March (Figure 33). The lower storage temperature of 44ºF slowed the senescence sweetening process, demonstrated in the lower proportion of sugar defects in Bin 8 compared to the chips in Bin 9, produced from tubers held at a warmer temperature. There was no evidence of cold induced sweetening in either bin, suggesting this variety has the potential to be stored even color. Unfortunately, some internal heat necrosis was visible in the finished chips toward the end of storage that was not observed in the raw tuber flesh in the field. This fact, combined with mid-season storage potential, has reduced industry interest in the variety.

Figure 30. ND7519-1 tubers from Bulk Bin 8 on 3/23/20.

Figure 31. Chips produced at Sackett Potatoes on 3/23/20.

Figure 32. Chips from Bulk Bin 8 sorted by defect type. Acceptable (left), sugar defects (top right), internal defects (middle right), external defects (middle right), greening (bottom right).

Figure 33. The first (left) and last (right) chip sample images, taken 10/15/19 and 3/23/20.

Bulk Bin #9, ND7519-1, (GDD_{40} 2937, 46ºF)

Bulk Bin 9 had a higher target temperature than Bin 8 and reached 48ºF by December 2019. The target temperature was initially proposed to be 48ºF, but the bin was further cooled to 46ºF at 0.2ºF per day, reaching the new target temperature in January. It was held at this temperature until bin unloading in March. Sucrose concentrations were comparable to those of Bin 8, and followed a U-shaped trend of initial higher concentrations, decreasing sucrose through January, and increasing concentrations towards the end of storage. Glucose concentrations were lower, evidenced by senescence sweetening that is more apparent in Bin 9. There were two samples with undesirable color and two with internal color, the first and last storage sample taken. Total defects observed in Bin 9 were higher at the start and end of storage, and lower during the middle of storage, between November and February. The tubers sampled on 1/13/2020 had no defects observed. Figure 34 shows the first sample, sample taken on 1/13, and last sample from Bin 9. Bruising was the most observed chip defect. Bin 9 was unloaded on 3/23/2020 (Figure 35). At unloading, the average tuber weight loss was 4.14%. 30% of tubers were bruise free, 67% had bruise without color, and 3% had bruise with color (Table 9). Sackett Potatoes calculated a specific gravity of 1.087 and Frito-Lay Score of 17.95 (Figure 36).

Herr Foods received the tubers from Bin 9 on 3/24/2020. At Herr's, the AGTRON score was 58.8, the specific gravity was 1.087, and the finished chips were rated above average for color, crispness, and flavor. The potatoes had 0.2% minor defects and no major defects.

Potato Outreach Program staff sorted chips from Herr's, and found 91% acceptable chips, 5% sugar defects, 0.5% internal defects, 3% external defects, and 0.5% greening (Figure 37). The higher percentage of sugar defects in Bin 9 (5% vs 3% in Bin 8), show that the warmer storage temperature of Bin 9 may lead to more senescence sweetening.

Figure 34. Chip samples from Bin 9 taken 10/15/19, 1/13/20, and 3/23/20.

Figure 35. ND7519-1 from Bin 9 unloaded on 3/23/20.

Figure 36. ND7519-1 chips produced at Sackett Potatoes 3/23/20.

Figure 37. Chips from Bin 9 sorted as acceptable (left), sugar defects (top right), internal defects (middle right), external defects (middle right), and greening (lower right).

Table 9. 2019-2020 PRESSURE BRUISE DATA
Bulk Bin #8 and #9 ND7519-1 (Howard City, MI)

Location[1]	Average Weight Loss (%)	Average Number of External Pressure Bruises Per Tuber[2]				Average % of Total Tuber Number		
		0	1	2	3+	Without Bruise	Bruised (No Color)	Bruised with Color[3]
14' Bin 8	2.22	5	10	6	4	20	73	7
8' Bin 8	4.13	6	8	8	4	23	71	7
3' Bin 8	5.67	5	12	5	3	19	80	1
OVERALL AVERAGES	**4.00**					**20**	**75**	**5**
14’ Bin 9	3.63	8	10	6	1	32	67	1
8’ Bin 9	4.05	8	11	5	1	32	63	5
3’ Bin 9	4.75	6	6	5	8	25	71	4
OVERALL AVERAGES	**4.14**					**30**	**67**	**3**

[1] Feet above the bin floor.
[2] A Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.
[3] A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored as a tuber "with color".

Loaded	10/15/19 (both)	Pulp Temp. (at Filling)	44.0ºF (8) 46.0 ºF (9)		
Unloaded	3/23/20 (both)	Target Storage Temp.	48.0ºF (8) 50.0ºF (9)	End Temp.	44.0ºF (8) 46.0ºF (9)

2019-2020 MICHIGAN RUSSET POTATO STORAGE REPORT MICHIGAN POTATO INDUSTRY COMMISSION

Chris Long, Coordinator, Trina Zavislan, and Damen Kurzer

Introduction and Acknowledgements

Russet potatoes are primarily grown for fresh market use in Michigan and are not stored during the winter months. There has been industry and commercial interest in exploring storage potential of several standard russet varieties in Michigan to evaluate fry color and sugar defects of commercial varieties after time in storage. There are many variety trials underway in Michigan that are evaluating russet varieties for yield, solids, disease resistance, and desired tuber size profile with the hope of exhibiting the positive attributes of these lines to growers and processors. The information in this report allows the industry to make informed decisions about the value of adopting russet storage practices in Michigan.

Please see the Michigan Potato Demonstration Storage Annual Report for detailed information on the facilities at the Montcalm Research Center and weather data in during the 2019 growing season.

The Ben Kudwa Building, built in 2008, has three independently ventilated, 600 cwt. bulk bins. The first of these bulk bins, bin 7, was converted to box bin storage that holds 36, 10 cwt. box bins to provide storage profiles on early generation potato varieties. The box bin is an entry point into storage profiling that allows the industry to learn about a varieties' physical and chemical storability. All russet storage took place in the box bin from 2019 to 2020. A storage profile consists of monthly sampling of potatoes to obtain: sucrose and glucose levels, Munsell color score, and sugar end defects. With this information, we can create the storage profile of a variety, providing the industry with a clearer picture of where a line can or cannot be utilized. The Michigan potato industry hopes to use these storage profiles to improve in areas such as long-term storage quality, deliverability of product and, ultimately, sustained market share.

The storage facility, and the work done within it, is directed by the MPIC Storage and Handling Committee and Michigan State University (MSU) faculty. The funding and financial support

for this facility, and the research conducted within it, is largely derived from the MPIC. The committee occasionally receives support for a given project from private and/or public interests.

We wish to acknowledge all the support and investment we receive to operate and conduct storage research. First, we express our gratitude for the partnership we enjoy between the MPIC and Michigan State University. Thank you to the MPIC Storage & Handling Committee for their investment of time, guiding the decisions and direction of the facility. Special thanks to Butch Riley (Gun Valley Ag. & Industrial Services, Inc.) for his annual investment in the sprout treatment of the storage facility. We would also like to acknowledge a long list of additional contributors who invested much time to help foster a quality storage program: Todd Forbush (Techmark, Inc) and Mathew Klein (Farm Manager, MSU Montcalm Research Center).

I. 2019-2020 Russet Processing Variety Box Bin Report

(Chris Long, Trina Zavislan, Damen Kurzer, and Brian Sackett)

Introduction

All russet varieties were stored in trays on top of the boxes in Bin 7. The box design allows air to travel in from a header, or plenum wall, through the forklift holes of each box and up through the potatoes within it. The air continues to flow up through the next box until it reaches the top and is drawn off the top of the chamber. The air is then reconditioned and forced back through the header wall plenums and up through the boxes again. Each tray contains tubers from which we sampled for monthly quality evaluations.

Procedure

In 2019, we evaluated and compared nine russet varieties to the check varieties Russet Norkotah and Russet Burbank. Once the varieties were chosen, .5 cwt. of the varieties were planted in a single 34-inch wide row. Planting occurred on May 8th at the MSU, Montcalm Research Center, Entrican, MI. We planted the varieties at a 10" in-row seed spacing. All varieties received fertilizer in the rates of: 273 lb. N/A, 98 lb P_2O_5/A and 261 lb K_2O/A. The varieties were vine killed after 124 days and allowed to set skins for 21 days before harvest on September 3rd, 2019; which was 145 days after planting. We did not account for variety maturity in harvest timing due to storage and handling restrictions.

We placed approximately 5 cwt. of each variety in 6 trays on top of the boxes in bin 7. The average storage temperature for all the box bins (box bin 7) was 54.0ºF for the 2019-2020 season. We describe the varieties, their pedigree and scab ratings in Table 1. We also recorded yield, size distribution, chip quality, and specific gravity at harvest in Table 2. We graded the varieties to remove all "B" size tubers and pick-outs, ensuring the tubers began storage in good physical condition.

The storage season began in September, with the first samples collected on October 8th, and ended June 1st, 2020. Bin 7 was gassed with CIPC on November 5th and January 30th. We randomly selected forty tubers from each variety every month and sent them to Techmark, Inc.

for sucrose, glucose, and color rating using the Munsell Color Standard “Color Standards for Frozen French Fried Potatoes (Figure 1).”

Please contact Chris Long at Michigan State University in the Department of Plant, Soil and Microbial Sciences for additional information at (517) 353-0277 or longch@msu.edu. Additional data is available on the program website, canr.msu.edu/potatooutreach.

Figure 1. The Munsell Color Scale used to evaluate russet potatoes.

Table 1. 2019-20 MPIC Demonstration Russet Box Bin Variety Descriptions

Entry	Pedigree	2019 Scab Rating*	Characteristics
AO02183-2	A97236-6 X Premier Russet	1.0	Full season maturity, variable skin, heavy russetting, deeper eyes, higher yield, very high specific gravity.
A08344-4sto	A01667-3 X Dakota Trailblazer	0.5	Higher yield, average specific gravity, mid-season maturity, higher percentage A-sized tubers.
Castle Russet (PORO6V12-3RUS)	PA00V6-4 X PA01N22-1	0.5	Heavy russet skin, higher specific gravity, slight hollow heart, earlier vine maturity.
Clearwater Russet (AOA95154-1)	Bannock Russet X A8915204	0.5	Higher yield, high specific gravity, smaller vine type.
Dakota Russet (ND8229-3)	Marcy X AH66-4	1.0	Attractive appearance, good internal quality, average specific gravity, higher yield potential.
Payette Russet (A02507-2LB)	EGAO9702-2 X GemStar Russet	0.5	Some skinning, blocky tuber shape, high specific gravity, good internal quality.
Ranger Russet (A7411-2)	Butte X A6595-3	2.5	Darker skin, moderate alligator hide, very high specific gravity, moderate vascular discoloration.
Russet Burbank	Unknown	2.0	Lowest yield in trial, low specific gravity, misshapen tubers, pitted scab lesions, mainly B-sized tuber profile.
Russet Norkotah	ND9526-4RUS X ND9687-5RUS	0.5	Average trial yield, below average specific gravity, moderate vascular discoloration, earlier vine maturity.
Umatilla Russet (AO82611-7)	Butte X A77268-4	1.5	Higher specific gravity, smaller tubers, inconsistent shape.
Vanguard Russet (TX08352-5RUS)	TXA549-1RUS X AOTX98137-1RU	0.5	Moderate alligator hide, split of B and A-sized tubers, earlier vine maturity.

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data and qualitative descriptions provided by Potato Outreach Program (P.O.P.), MSU Potato Breeding and Genetics Program and other potato breeding programs.

Table 2: 2019 Russet Processing Potato Variety Trial
Montcalm Reseach Center

Planting: 5/8/19 Vine Kill: 9/9/19 Harvest: 9/30/19
GDD[40]: 3133

	CWT/A		PERCENT OF TOTAL[1]						RAW TUBER QUALITY[4] (%)							
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR[2]	HH	VD	IBS	BC	COMMON SCAB RATING[5]	VINE VIGOR[7]	VINE MATURITY[8]	COMMENTS
AO02183-2	275	415	66	29	66	0	5	1.092	0	80	0	0	1.0	2.5	4.0	variable skin, heavy russetting, severe ah, deep eyes
A08433-4sto	249	359	69	20	68	1	11	1.081	0	20	0	0	0.5	2.5	3.0	
Dakota Russet	225	366	61	34	61	0	5	1.084	0	10	0	0	1.0	2.0	3.0	nice appearance
Payette Russet	221	326	67	21	65	2	12	1.092	0	30	0	0	0.5	1.5	2.0	skinning, blocky
Clearwater Ruset	216	346	62	34	59	3	4	1.087	0	70	0	0	0.5	2.0	2.5	
Ranger Russet	145	385	37	54	37	0	9	1.097	0	70	0	0	2.5	3.0	3.0	darker skin, alligator hide
Castle Russet	117	258	45	49	45	0	6	1.088	10	50	0	0	0.5	2.0	1.5	heavy netted russetted skin
Umatilla Russet	111	378	29	62	29	0	9	1.087	0	30	0	0	1.5	2.5	2.0	small tubers, inconsistent shape
Russet Norkotah	**110**	**256**	**43**	**51**	**43**	**0**	**6**	**1.072**	**0**	**80**	**0**	**0**	**0.5**	**2.5**	**1.0**	
Vanguard	103	225	45	49	45	0	6	1.068	0	20	0	0	0.5	2.0	1.0	alligator hide
Russet Burbank	40	224	18	66	18	0	16	1.075					2.0	2.5	2.5	misshapen pickouts, pitted scab
MEAN	**165**	**322**	**49**	**43**	**49**	**1**	**8**	**1.084**	**1**	**46**	**0**	**0**	**1.0**	**2.3**	**2.3**	

[1]SIZE
Russets
Bs: < 4 oz
As: 4 - 10 oz
OV: > 10 oz
PO: Pickouts

[2]SPECIFIC GRAVITY
Data not replicated

[3]RAW TUBER QUALITY
(percent of tubers out of 10)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[4]COMMON SCAB RATING
0.0: Complete absence of surface or pitted lesions
1.0: Presence of surface lesions
2.0: Pitted lesions on tubers, though coverage is low
3.0: Pitted lesions common on tubers
4.0: Pitted lesions severe on tubers
5.0: More than 50% of tuber surface area covered in pitted lesions

[5]VINE VIGOR RATING
Date: 6/17/19
Rating 1-5
1: Slow emergence
5: Early emergence (vigorous vine, some flowering)

[6]VINE MATURITY RATING
Date: 9/3/19
Rating 1-5
1: Early (vines completely dead)
5: Late (vigorous vines, some flowering)

FIELD DATA

Planting Date	5/8/19
Vine Kill Date	9/9/19
Harvest Date	9/30/19
Days (planting to vine kill)	124
Days (planting to harvest)	145
GDD_{40} MAWN Station	Entrican
GDD_{40} (planting to vine kill)	3133
Seed Spacing	10"

Results: 2019-2020 Chip Processing Box Bin Highlights

For each of the nine varieties and two standard varieties, we summarize storage performance, display images of fried potatoes, and display graphs of glucose and sucrose concentrations compared to Russet Norkotah and Russet Burbank. We also summarize the percentage of excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4) fries at each sample. Finally, we compare the percent of sugar end defects.

A08433-4sto: This variety was evaluated monthly until April, when fry color became marginal. It had a storage glucose profile comparable to Russet Norkotah and sucrose profile comparable to Russet Burbank (Figures 2 and 3). Sugar ends were only observed in February (Figure 4). Fry quality was excellent through February, acceptable in March, and marginal in April (Figure 5).

Table 3. A08433-4sto monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January			

Figure 2. A08433-4sto glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

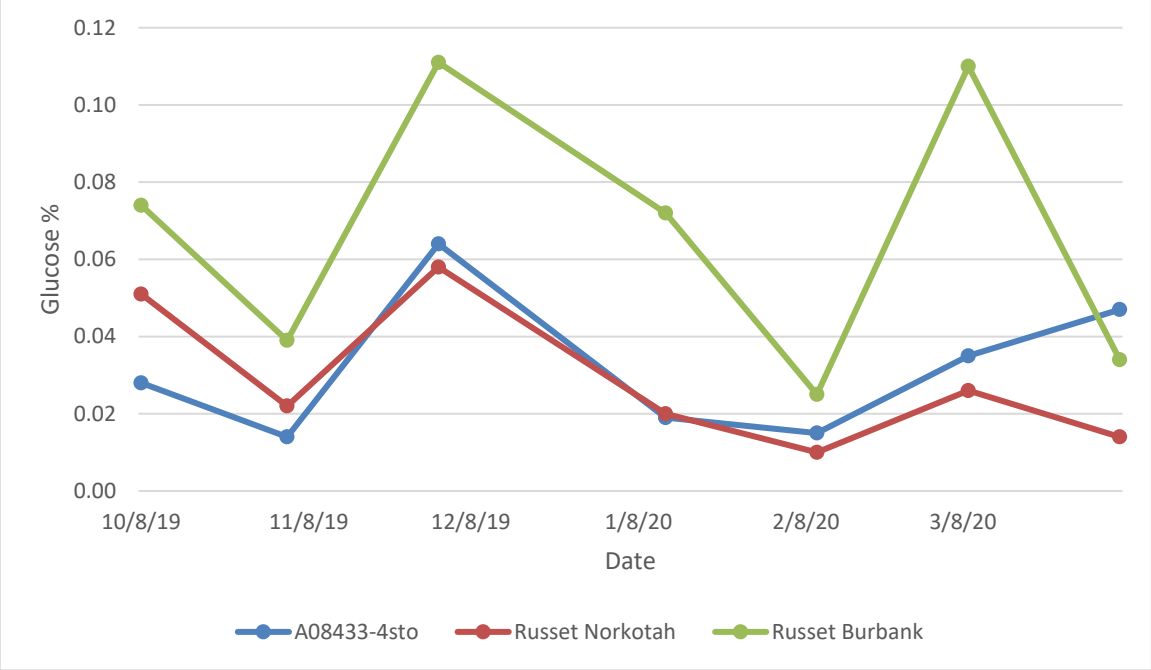


Figure 3. A08433-4sto sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

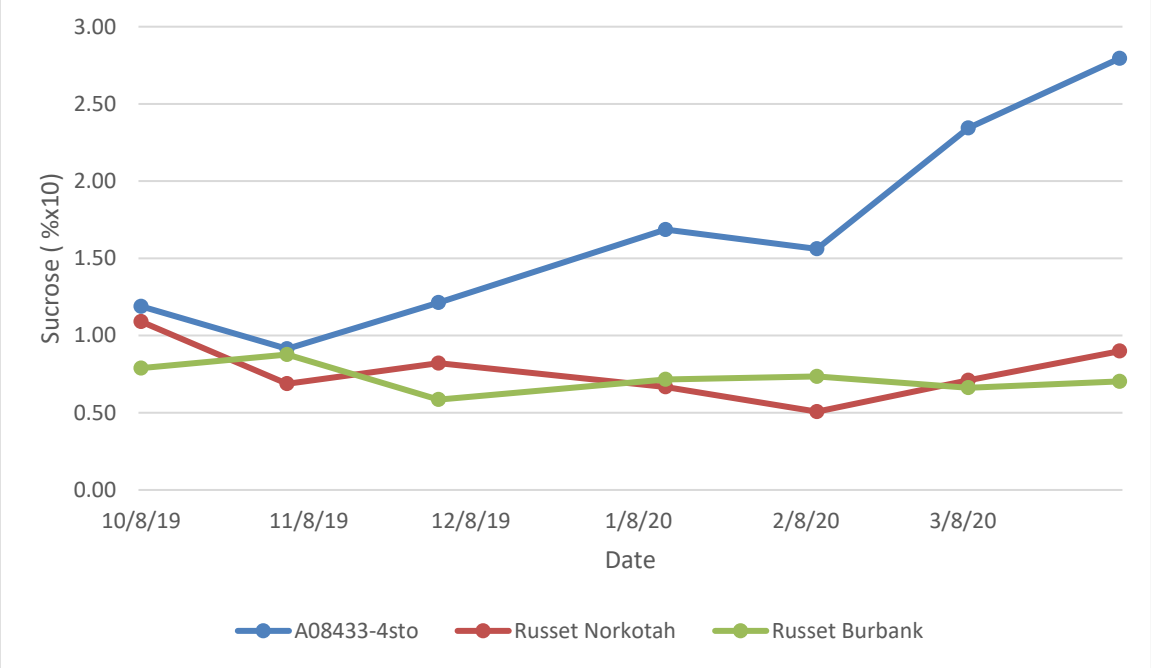


Figure 4. A08433-4sto percent sugar ends for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

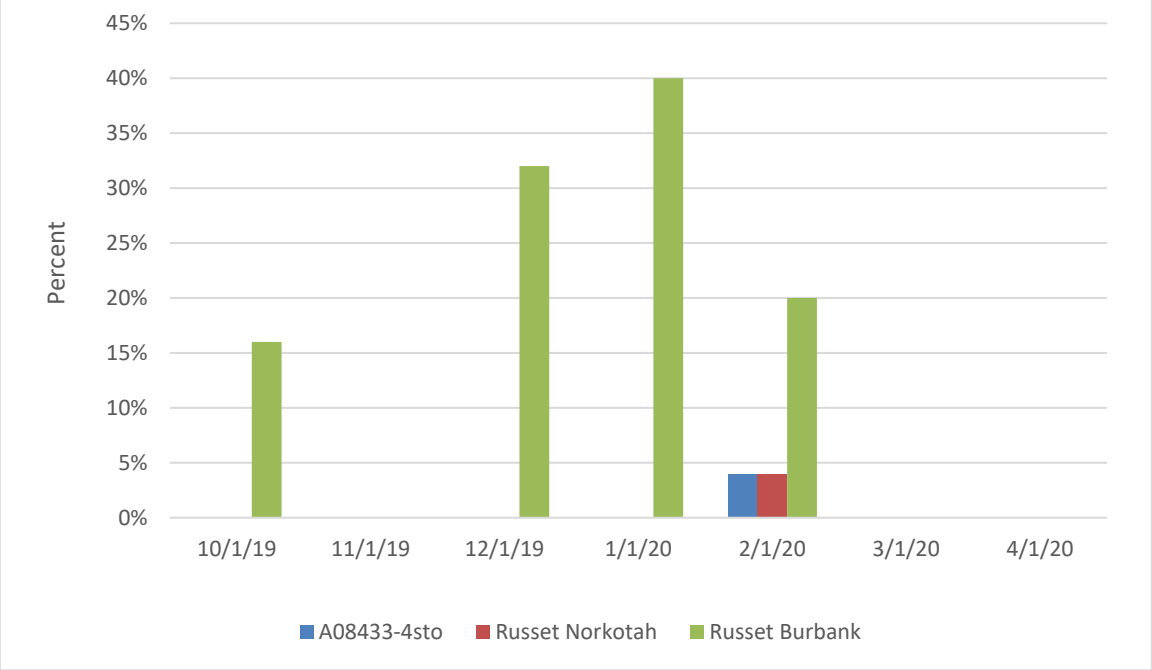
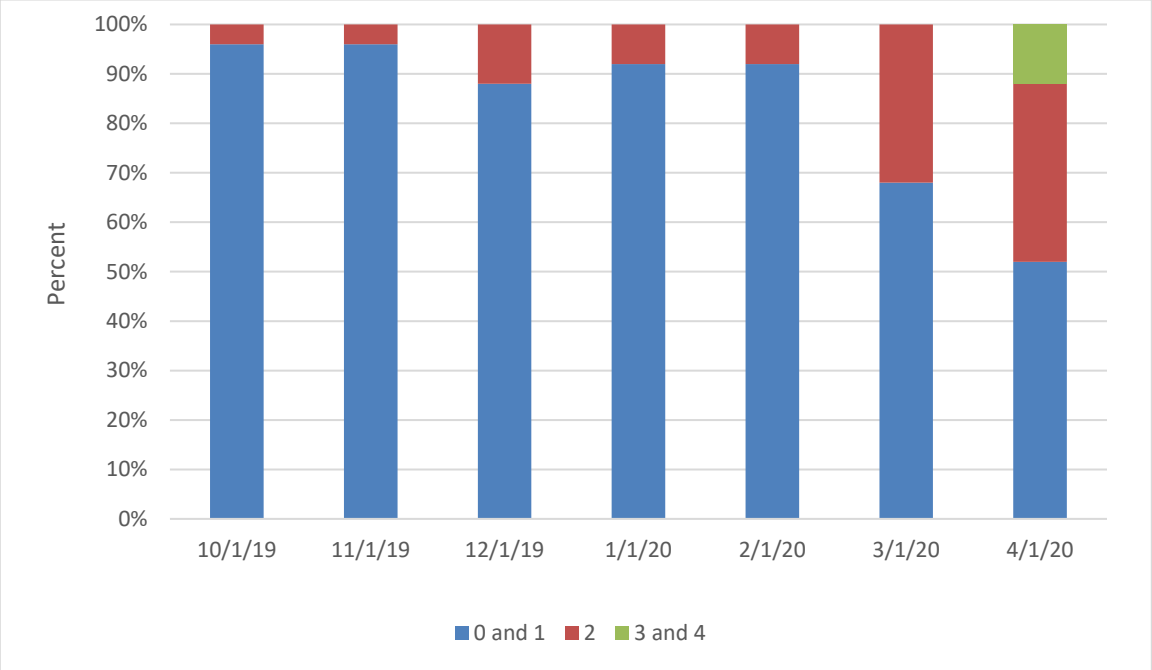


Figure 5. A08433-4sto percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



AO02183-2: This variety was evaluated monthly until June. It had a storage glucose profile lower than both Russet Norkotah and Russet Burbank, and sucrose profile higher than either check variety, especially after March (Figures 6 and 7). Sugar ends were only observed in May (Figure 8). Fry quality was excellent through May and acceptable in June (Figure 9).

Table 4. AO02183-2 monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January		May	

June	

Figure 6. AO02183-2 glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

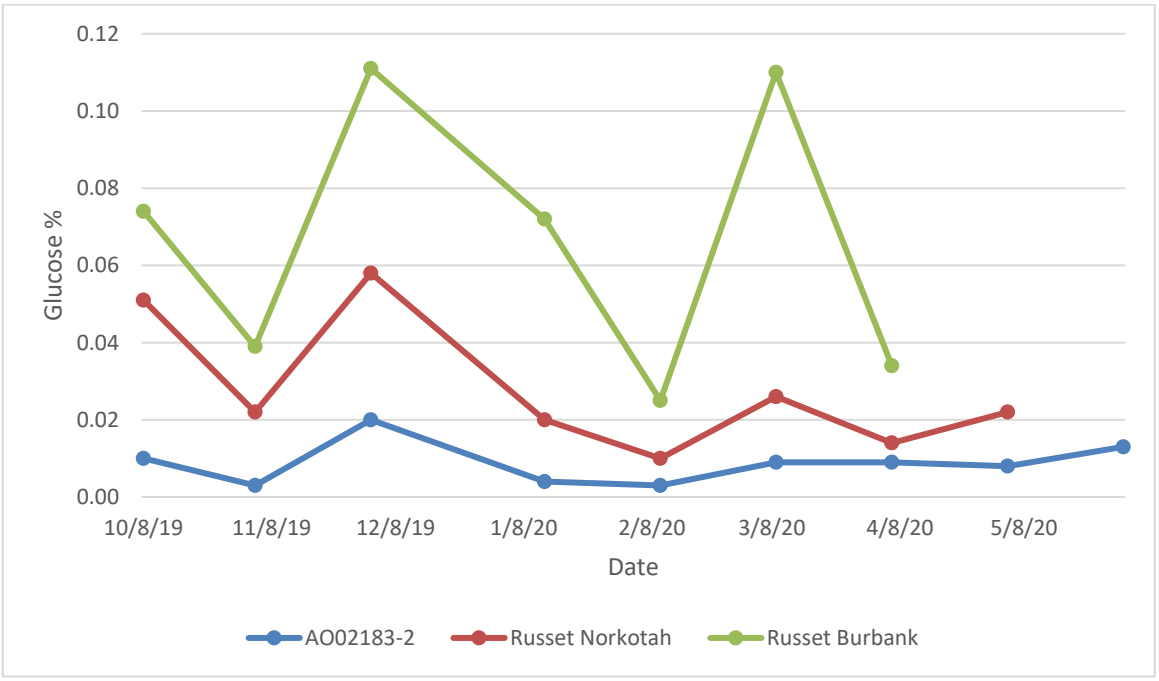


Figure 7. AO02183-2 sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

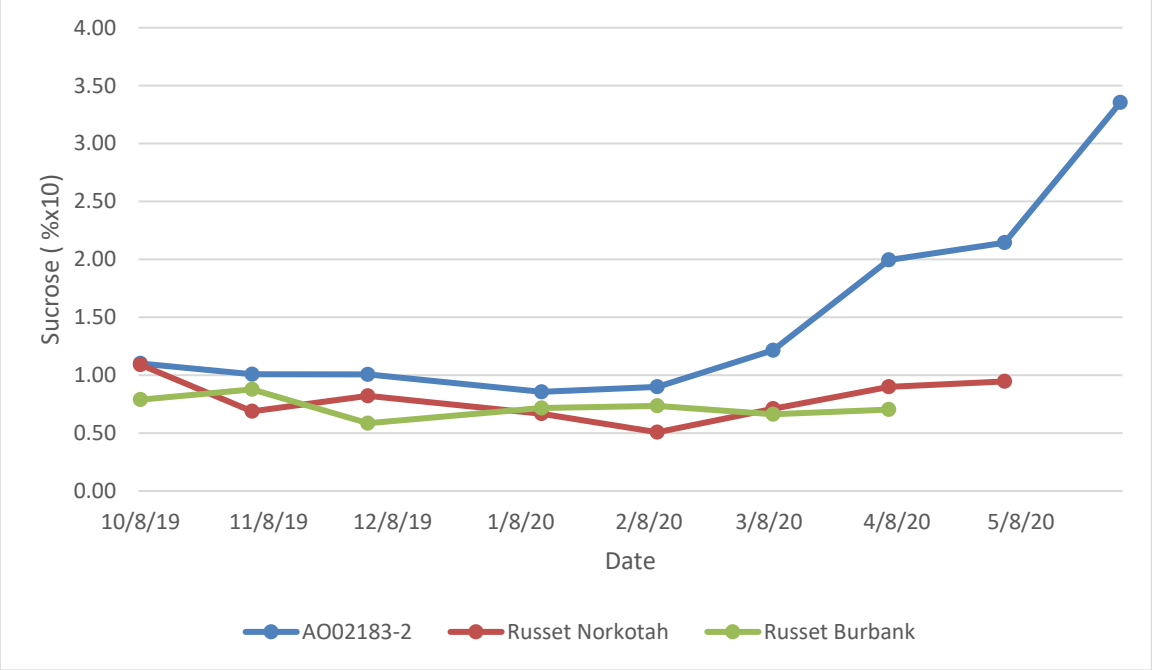


Figure 8. AO02183-2 percent sugar ends for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

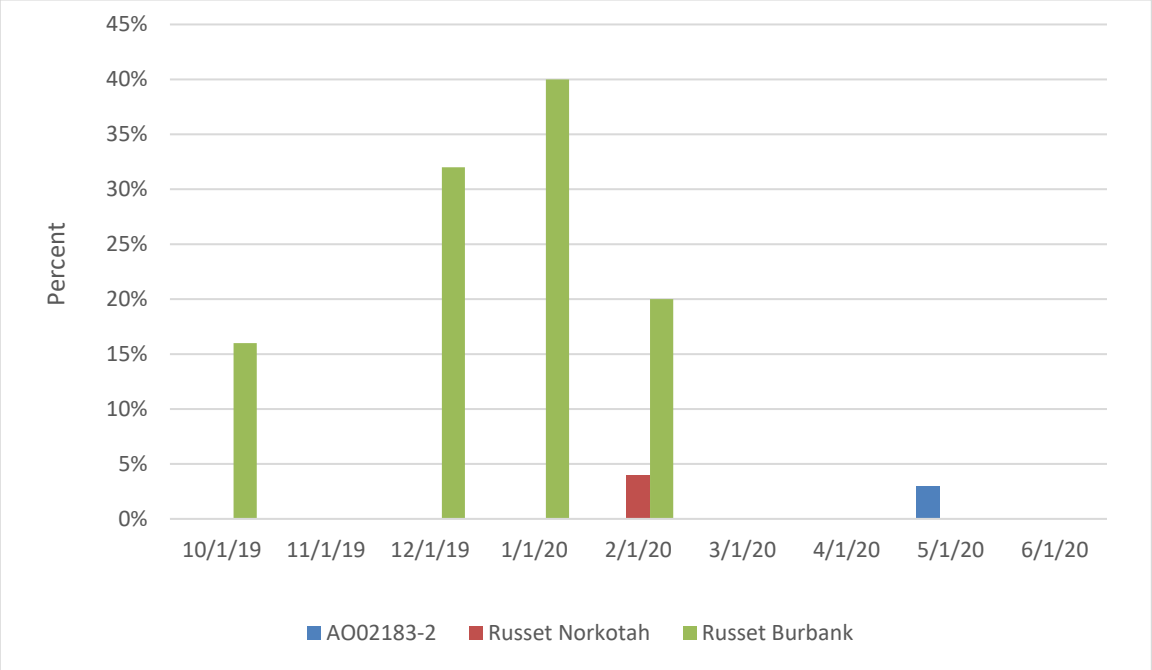
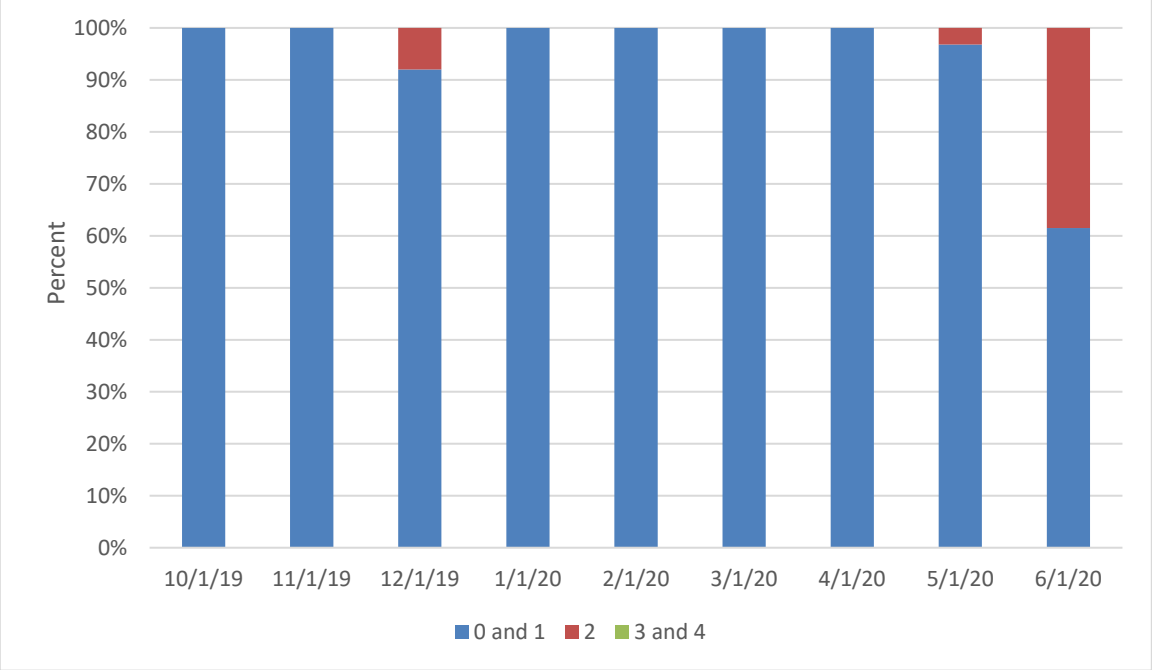


Figure 9. AO02183-2 percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Castle Russet: This variety was evaluated monthly until May. It had a storage glucose profile comparable to Russet Norkotah and sucrose profile higher than either check variety, especially after March (Figures 10 and 11). Sugar ends were only observed in January (Figure 12). Fry quality was excellent in all but three samples occurring in December, January, and April, which had some acceptable fries as well (Figure 13).

Table 5. Castle Russet monthly fry quality pictures from Techmark Inc.

Month

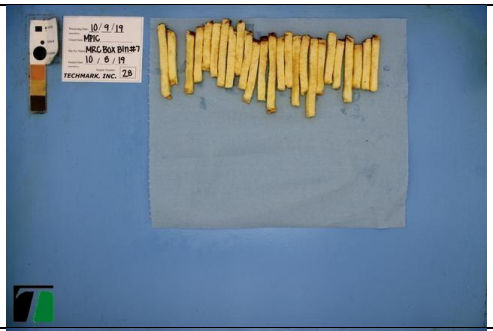
October		February	
November		March	
December		April	
January		May	

Figure 10: Castle Russet glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

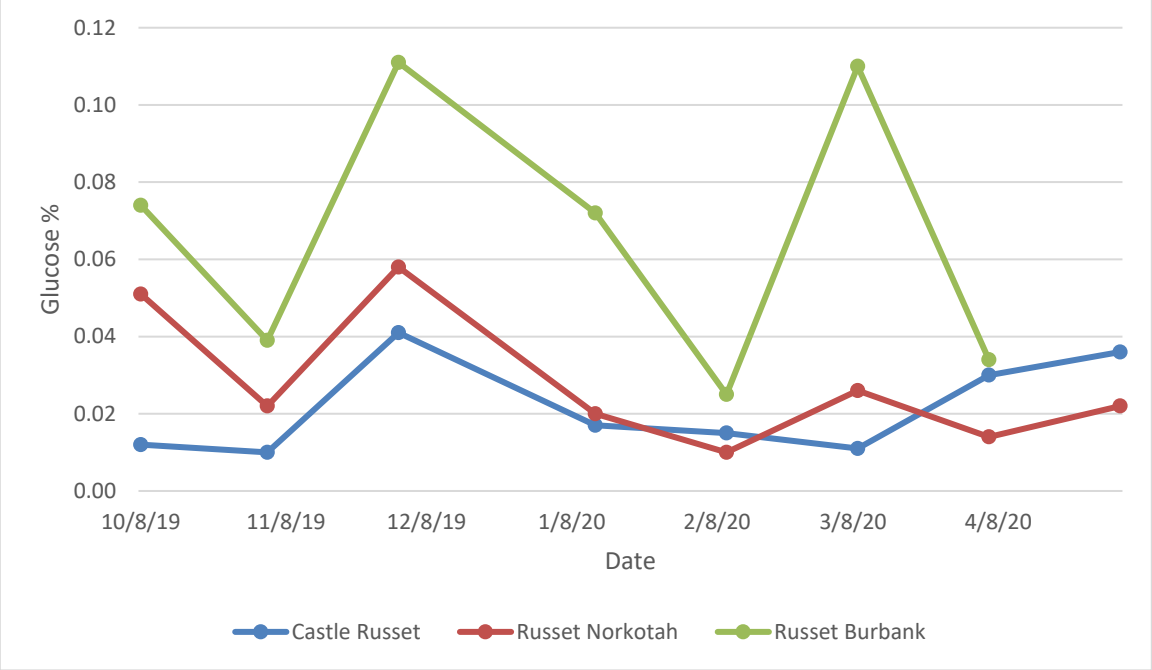


Figure 11: Castle Russet sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

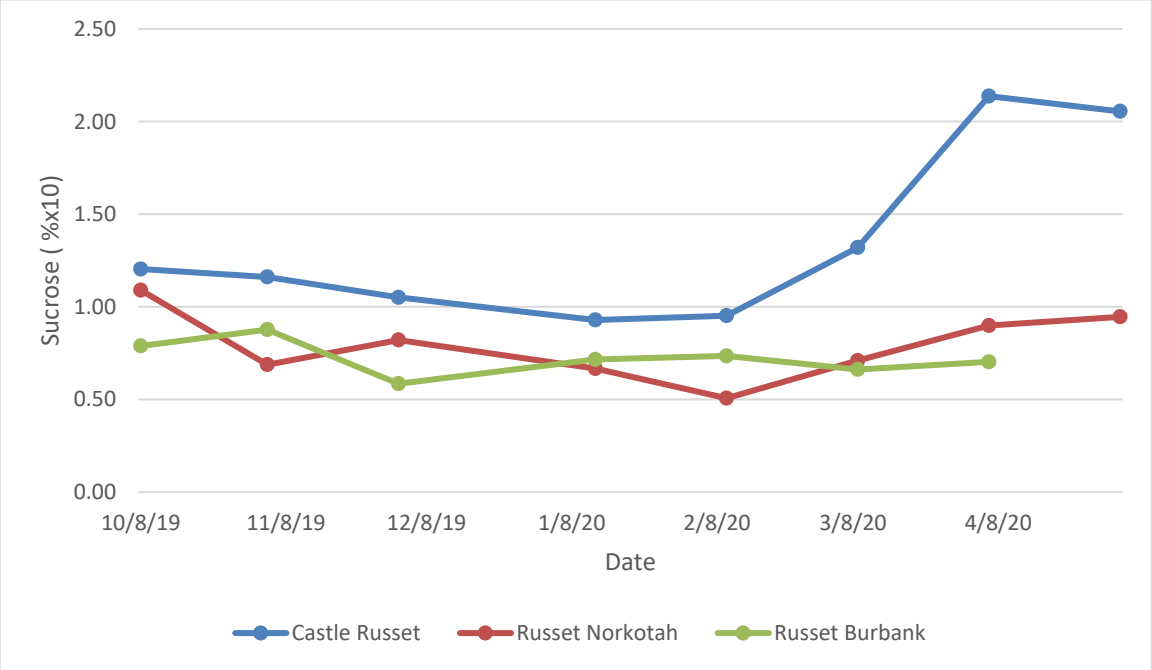


Figure 12: Castle Russet sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

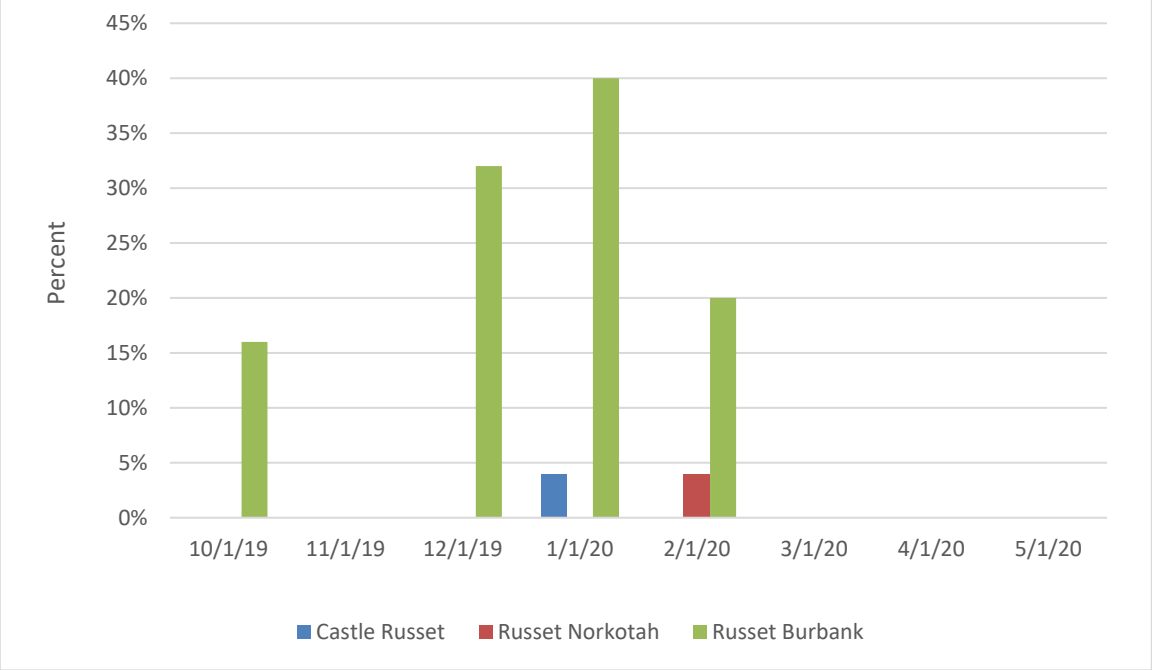
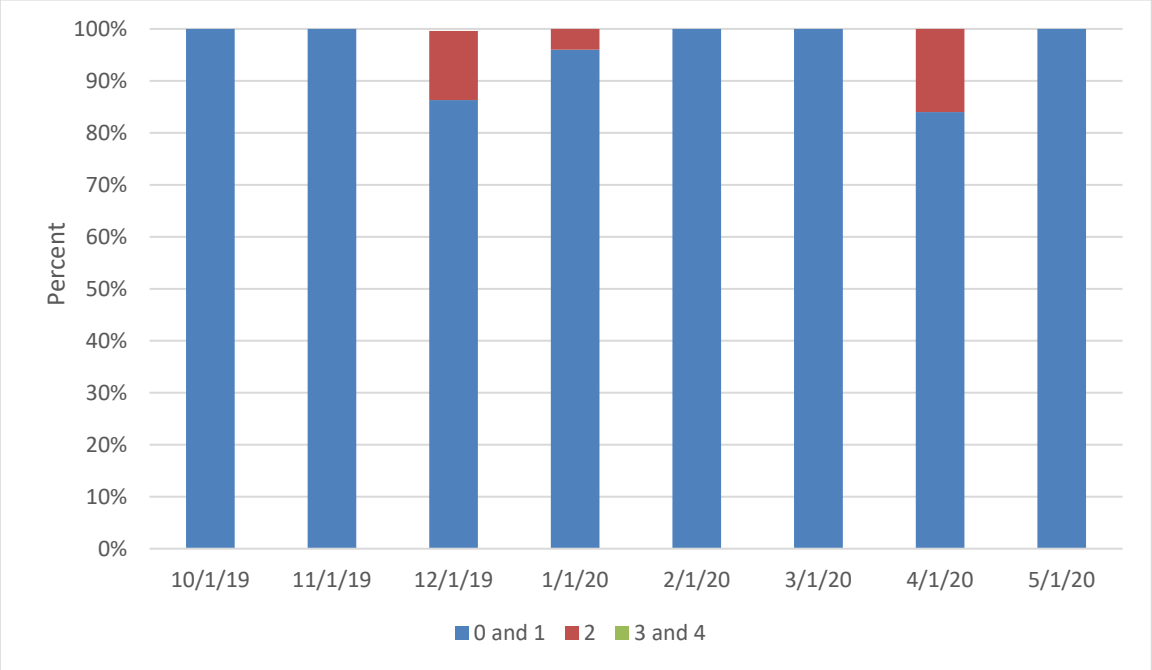
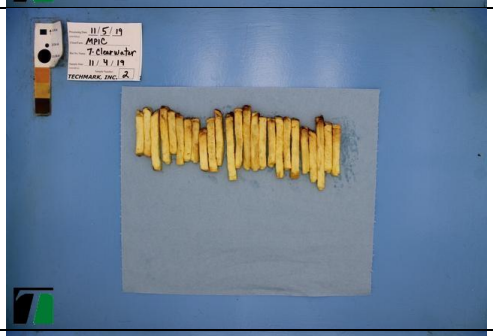
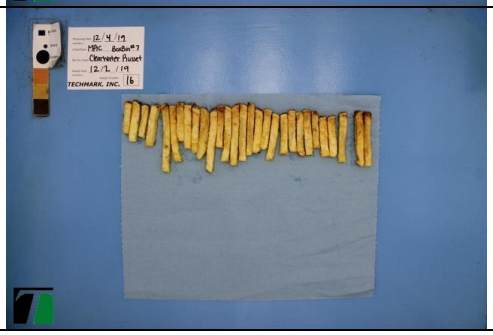


Figure 13: Castle Russet percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Clearwater Russet: This variety was evaluated monthly until June. It had a storage glucose profile like Russet Norkotah through February, until it became lower through June, and sucrose profile comparable to Russet Burbank until it rose in March (Figures 14 and 15). Sugar ends were observed in October and February (Figure 16). Fry quality was excellent each month, with some acceptable fries in December (Figure 17).

Table 6. Clearwater Russet monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	

January		May	
June			

Figure 14: Clearwater Russet glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

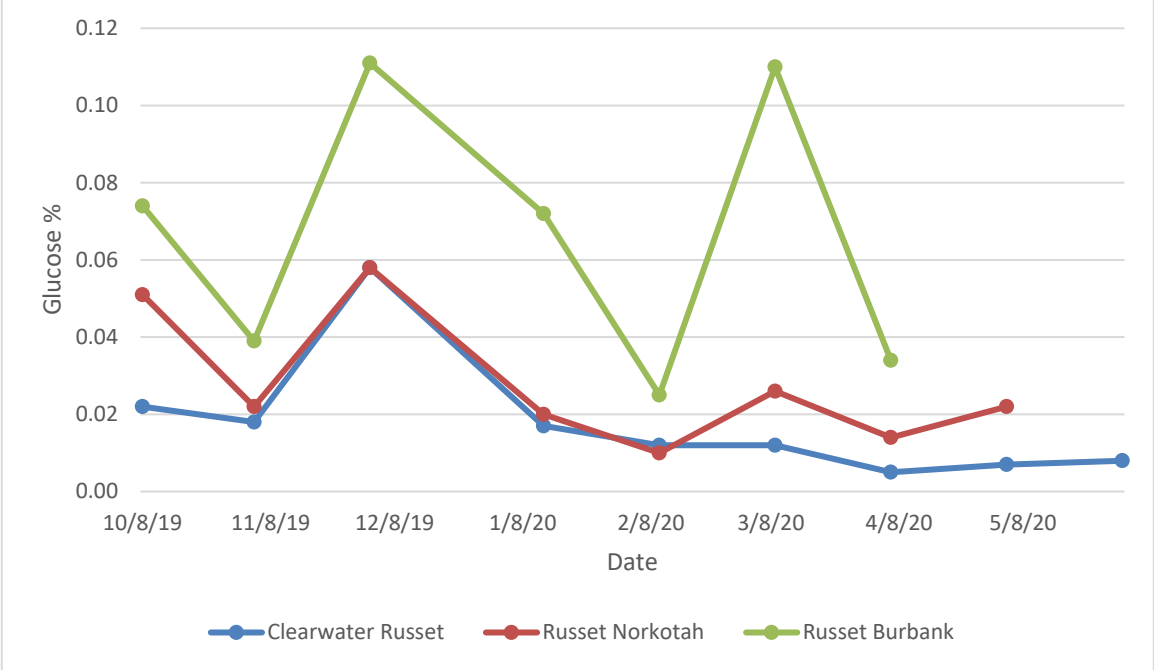


Figure 15: Clearwater Russet sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

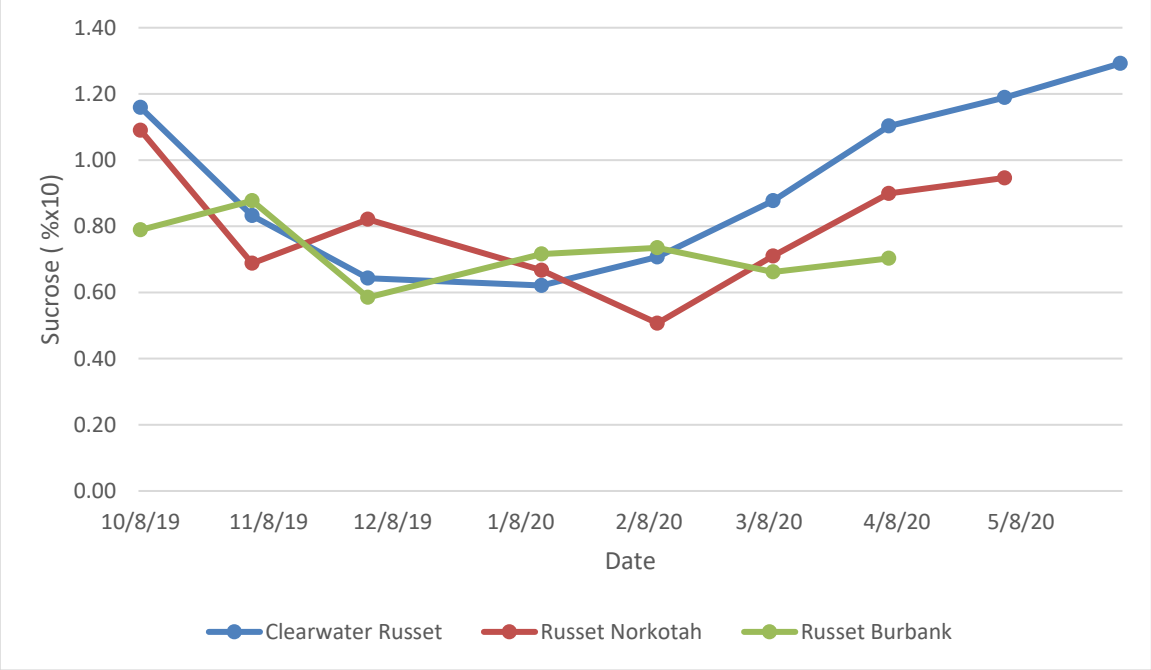


Figure 16: Clearwater Russet sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

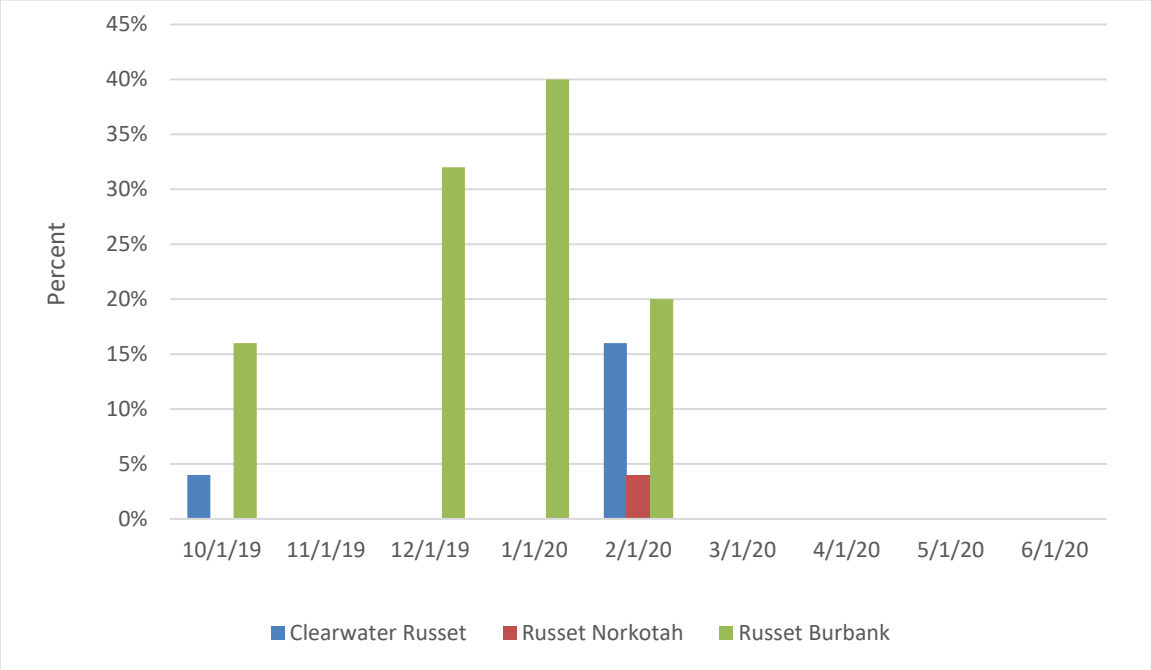
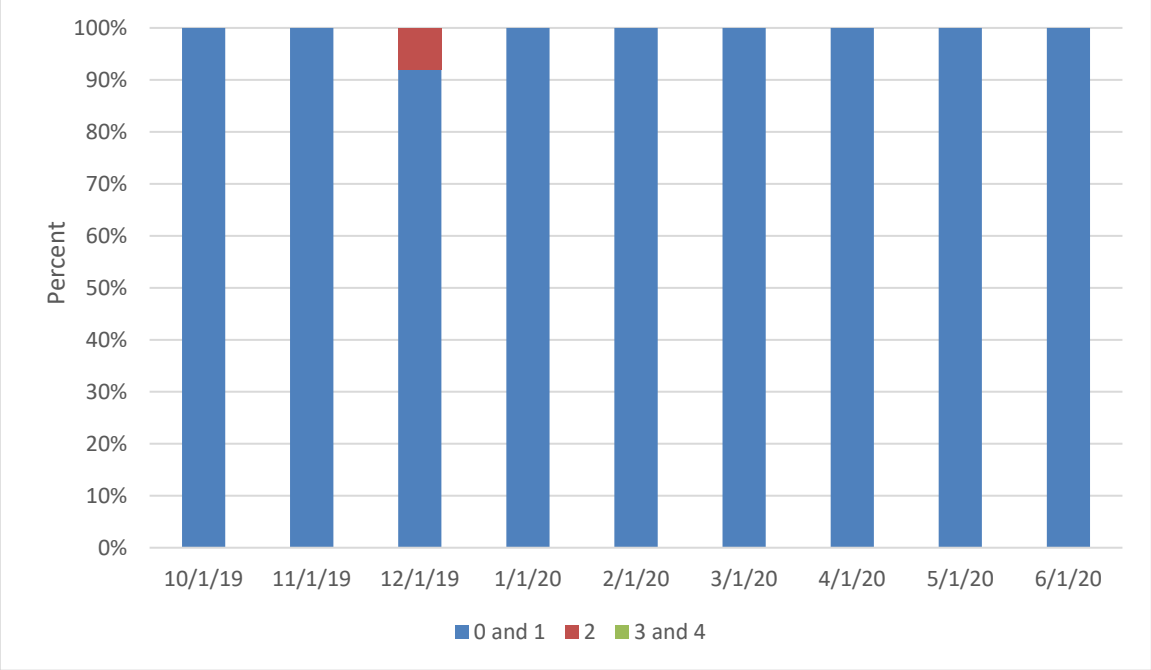
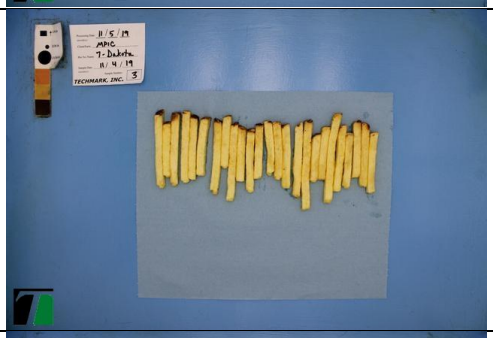
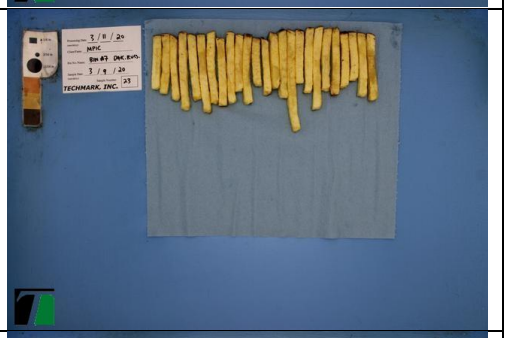


Figure 17: Clearwater Russet percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Dakota Russet: This variety was evaluated monthly until June. It had a storage glucose profile lower than both check varieties and sucrose profile comparable both checks until it rose in March (Figures 18 and 19). No sugar ends were observed (Figure 20). Fry quality was excellent each month, with some acceptable fries in May (Figure 21).

Table 7. Dakota Russet monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January		May	

June	

Figure 18: Dakota Russet glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

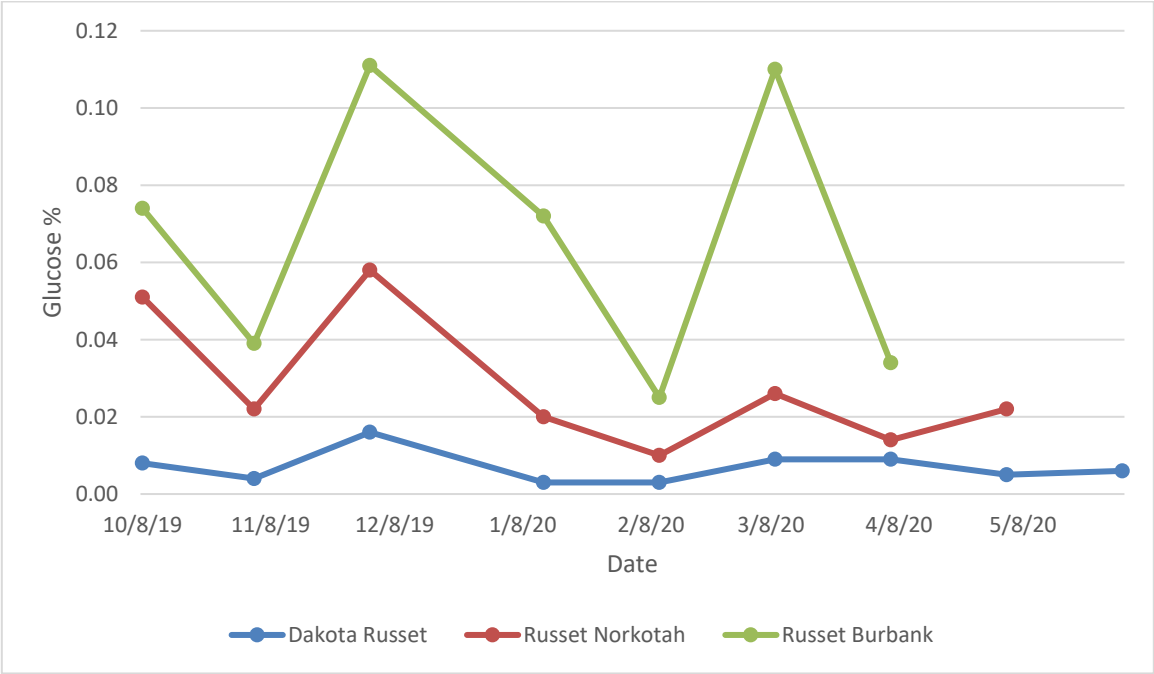


Figure 19: Dakota Russet sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

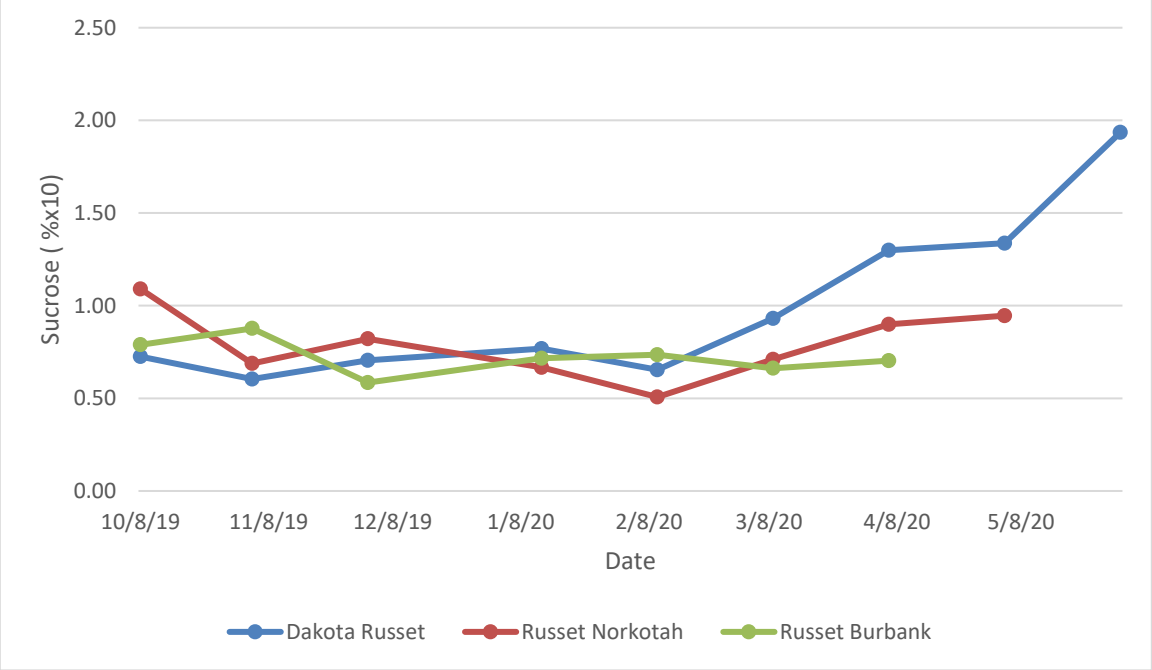


Figure 20: Dakota Russet sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

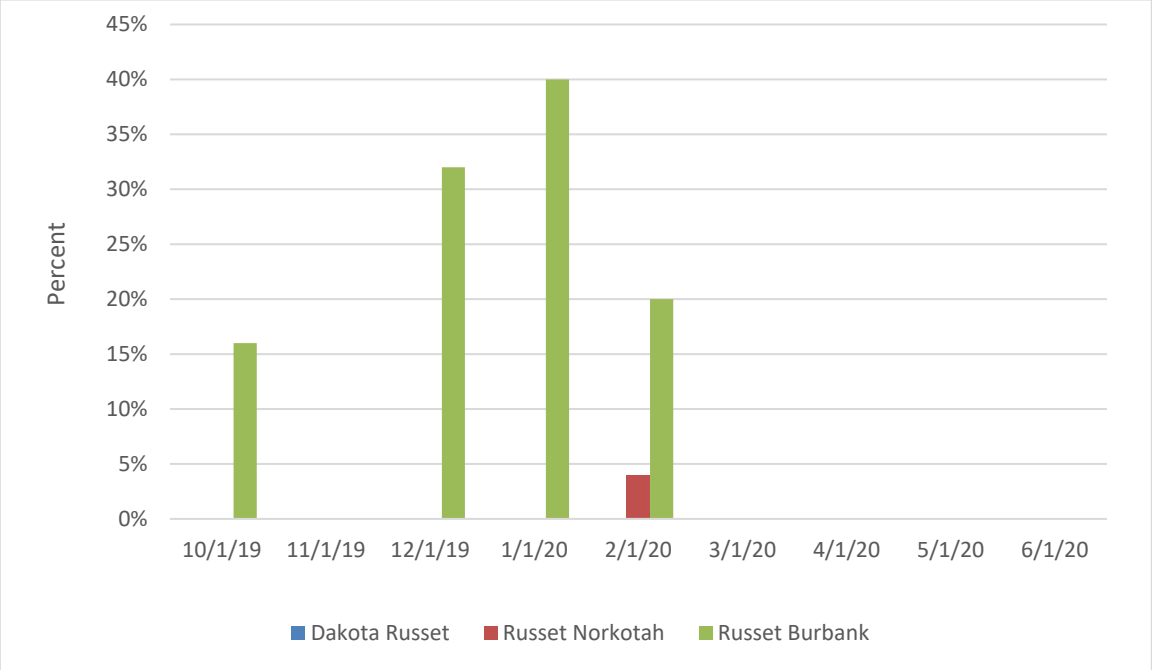
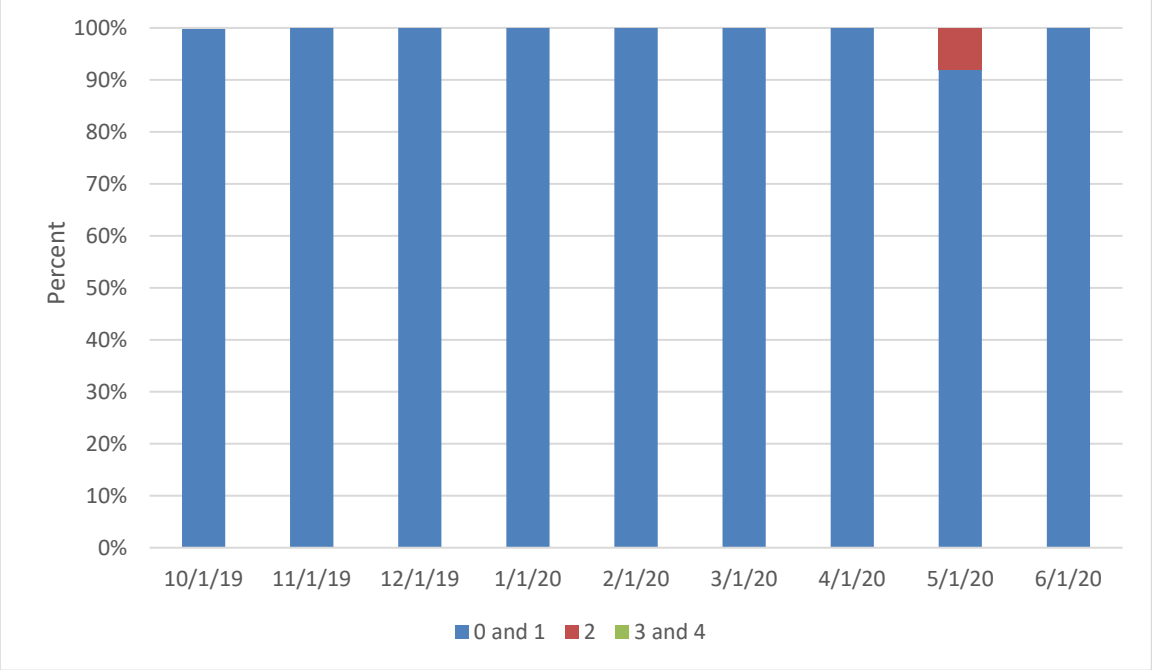


Figure 21: Dakota Russet percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Russet Norkotah: This variety was evaluated monthly until May. See individual varieties for comparisons on sucrose, glucose, and percent sugar defects. Fry quality was excellent until February with some acceptable fries in the March, April, and June samples (Figure 21). This variety was accidently processed as a chip sample in January, so fry quality is unavailable for this month (Table 8, Figure 21).

Table 8. Russet Norkotah monthly fry quality pictures from Techmark Inc.

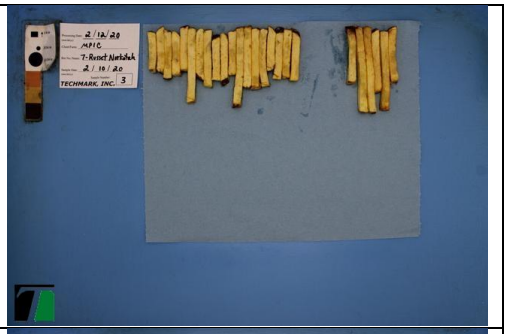
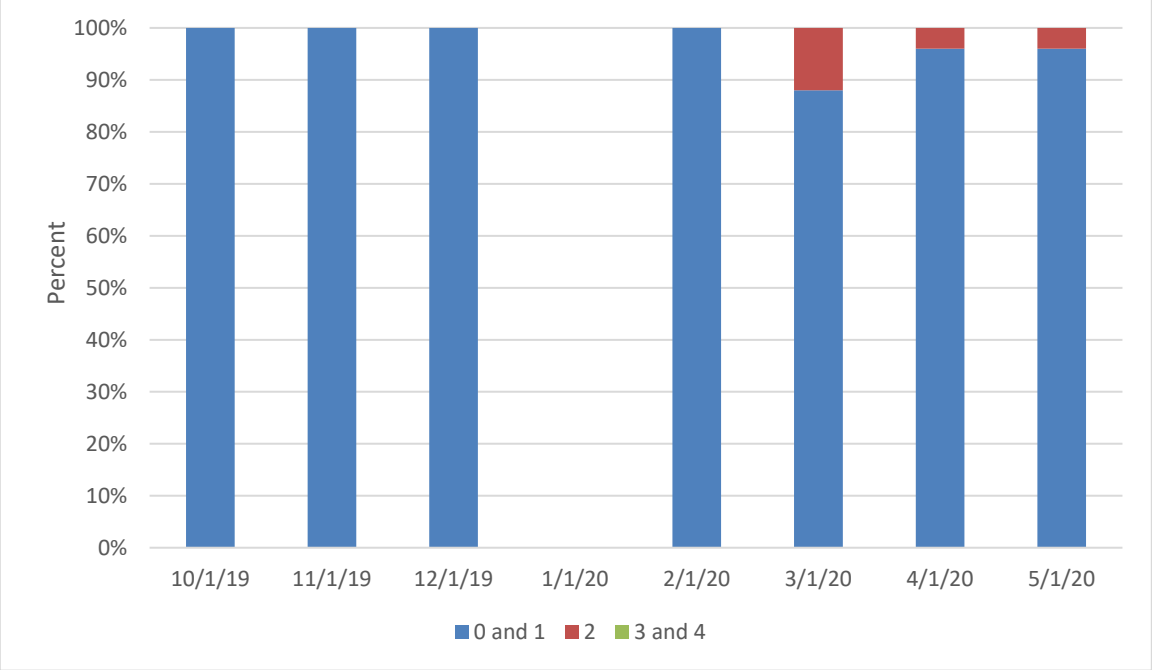
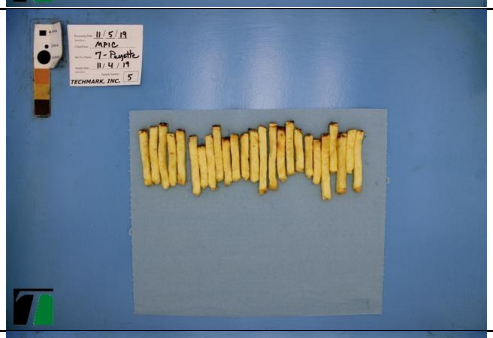
Month		Month	
October		February	
November		March	
December		April	
January		May	

Figure 21: Russet Norkotah percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Payette Russet: This variety was evaluated monthly until June. It had a storage glucose profile lower than both check varieties and sucrose profile initially comparable to both checks until it rose in January (Figures 22 and 23). Sugar ends were observed in February and were below 5% (Figure 24). Fry quality was excellent each month, with some acceptable fries in June (Figure 25).

Table 9. Payette Russet monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January		May	

June	

Figure 22: Payette Russet glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

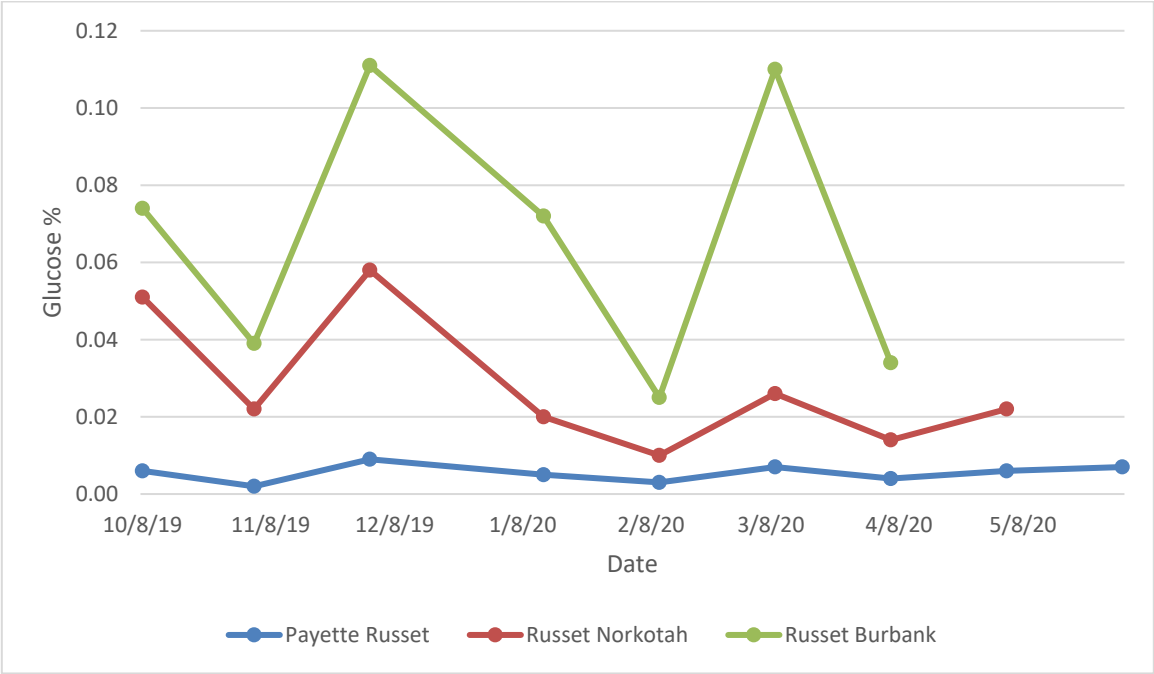


Figure 23: Payette Russet sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

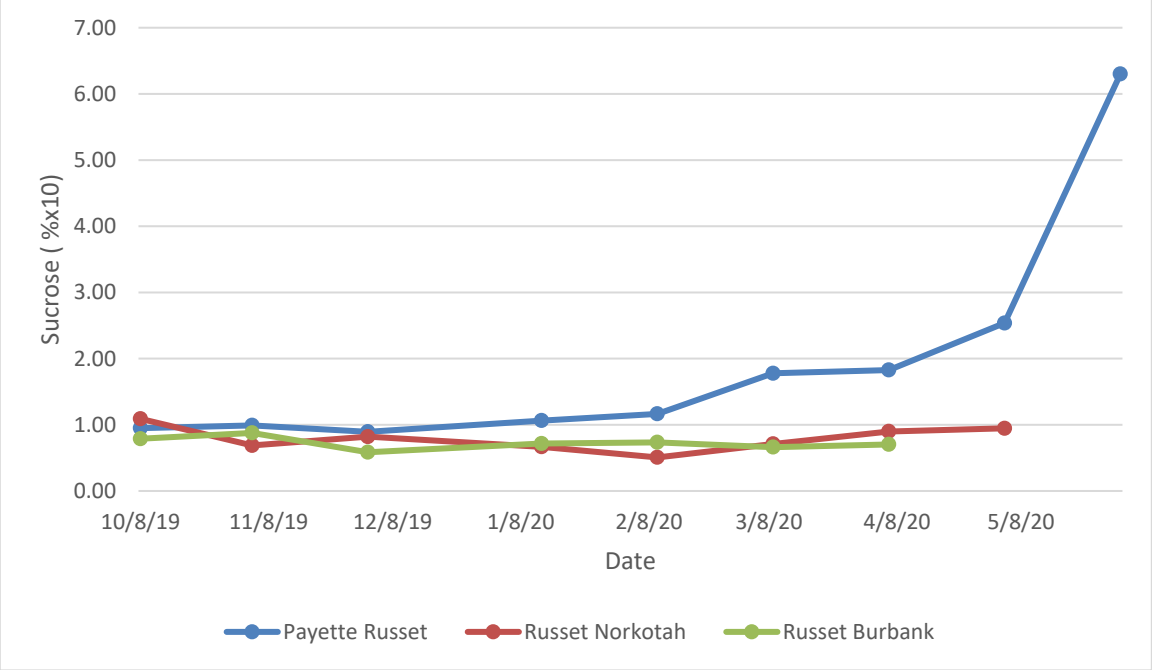


Figure 24: Payette Russet sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

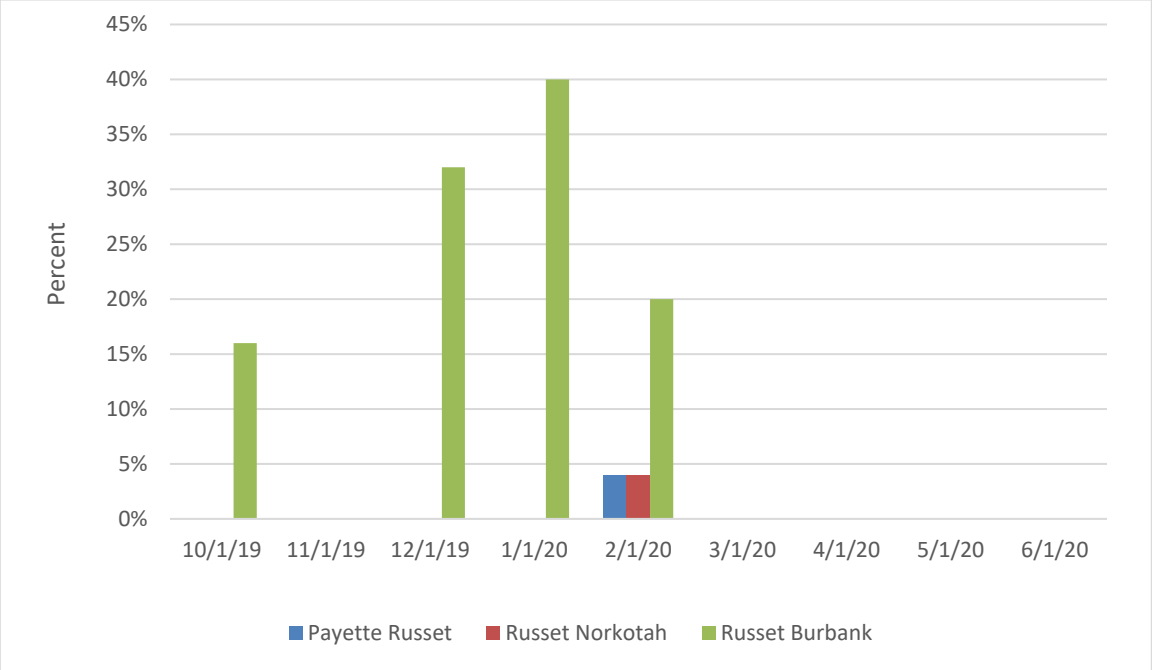
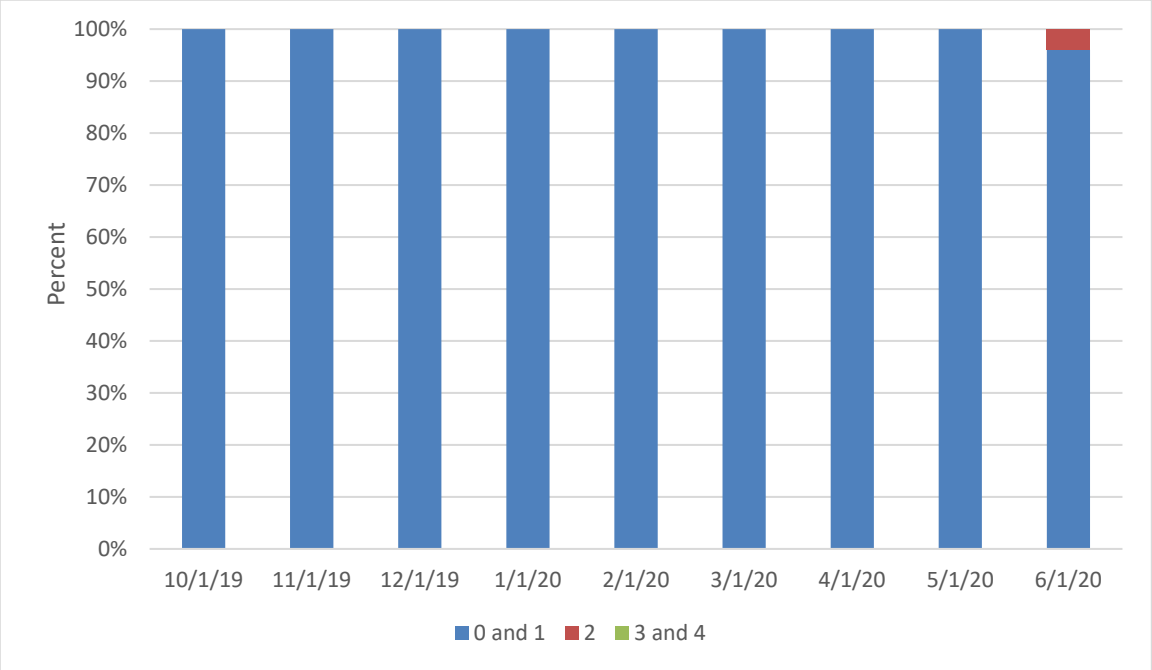


Figure 25: Payette Russet percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Ranger Russet: This variety was evaluated monthly until April. It had a storage glucose profile very similar to Russet Norkotah and sucrose profile consistently higher than both checks (Figures 26 and 27). Sugar ends were observed in the March and April samples, 12% at each date (Figure 28). Fry quality was excellent each month, with some acceptable fries in April (Figure 29).

Table 10. Ranger Russet monthly fry quality pictures from Techmark Inc.

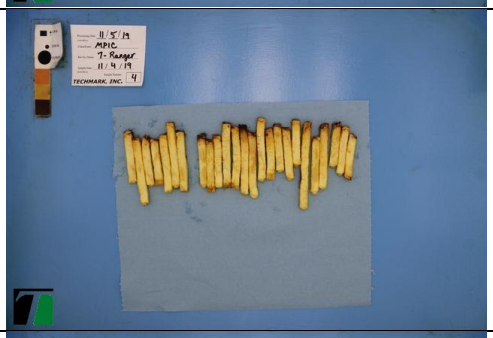
Month		Month	
October		February	
November		March	
December		April	
January			

Figure 26: Ranger Russet glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

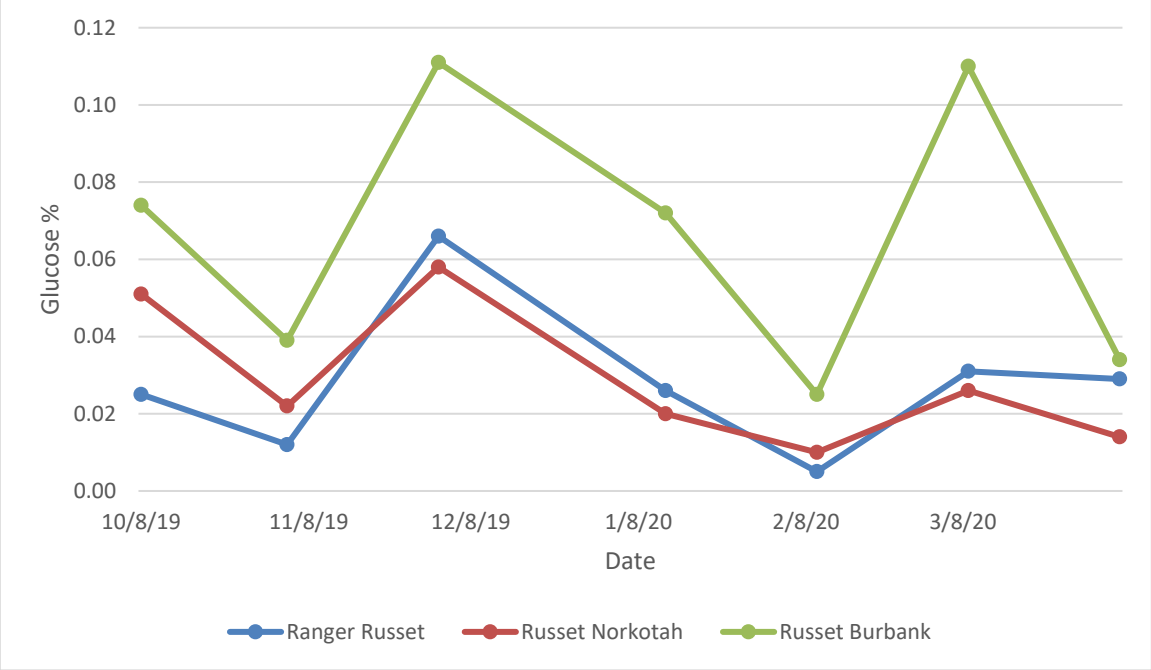


Figure 27: Ranger Russet sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

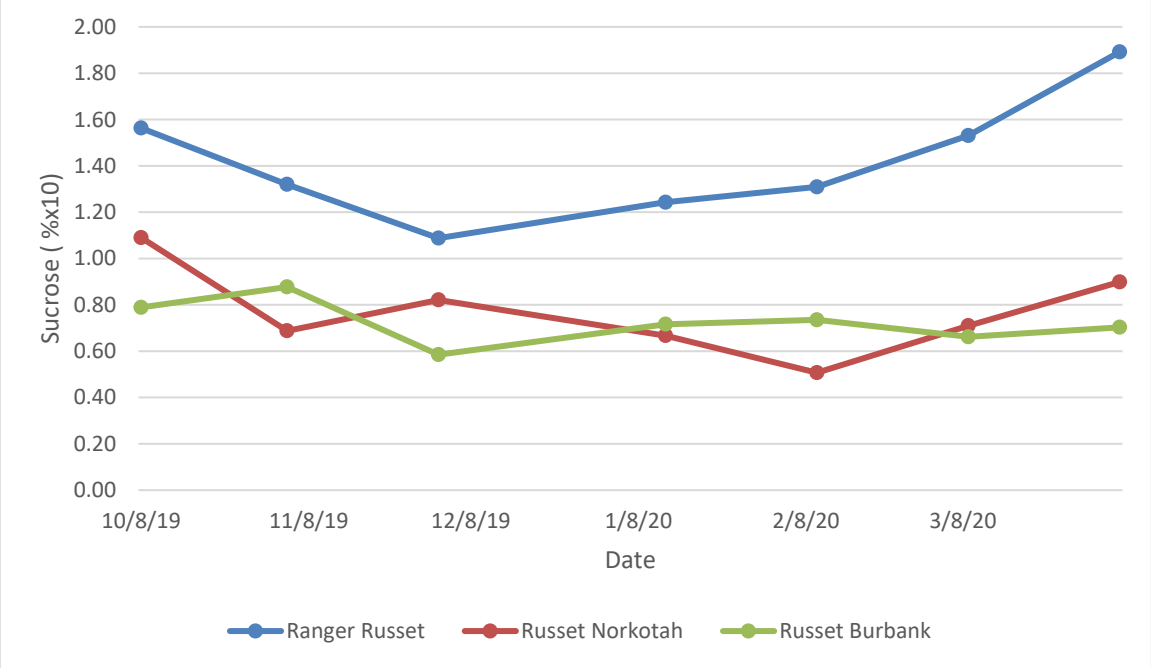


Figure 28: Ranger Russet sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

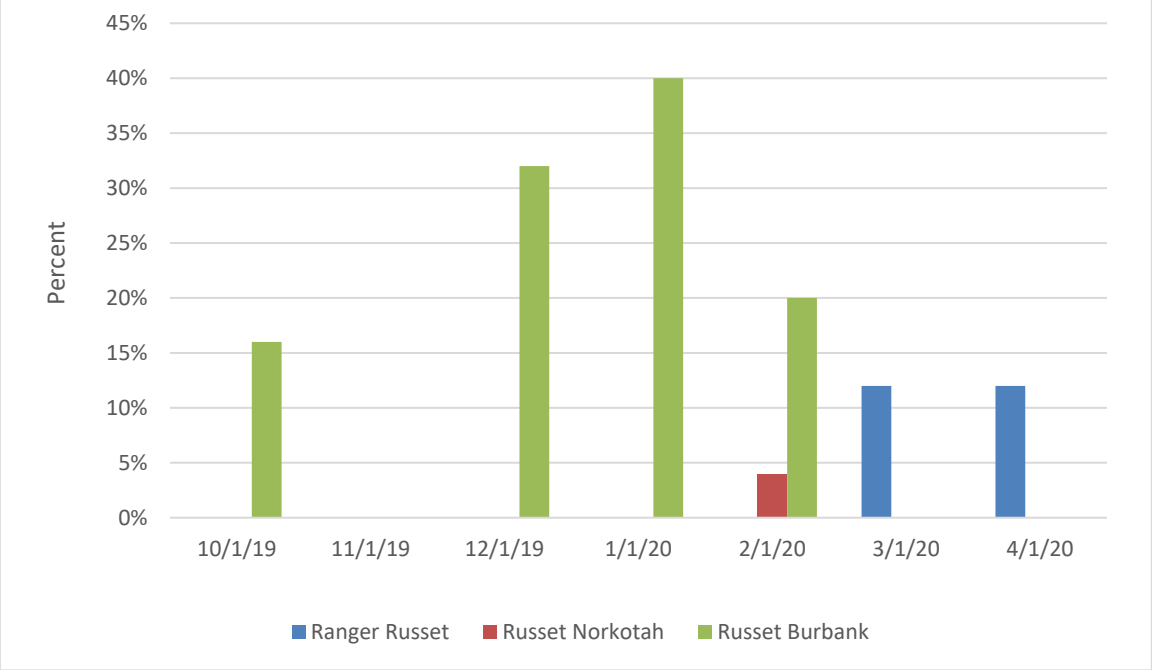
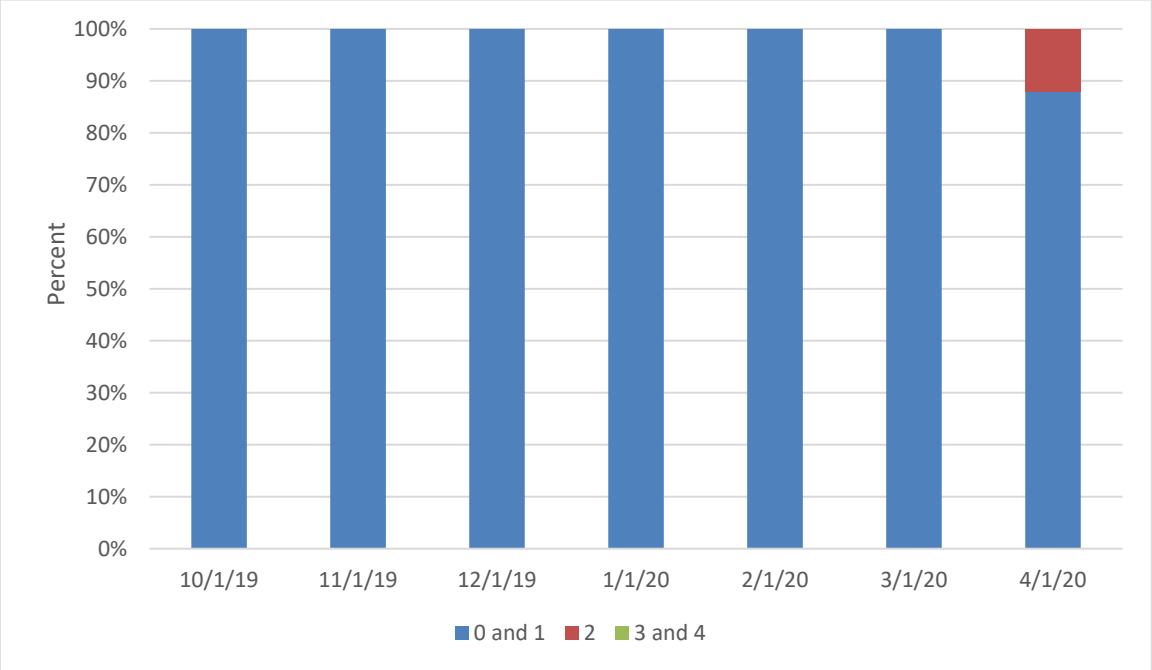


Figure 29: Ranger Russet percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).

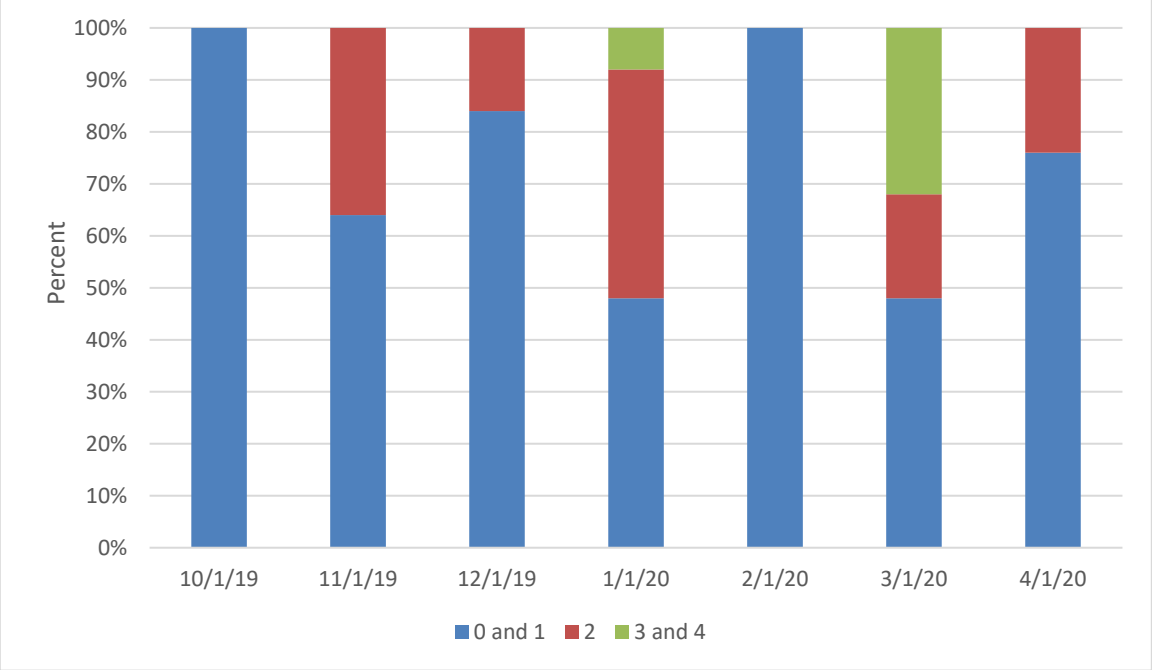


Russet Burbank: This variety was evaluated monthly until April. See individual varieties for comparisons on sucrose, glucose, and percent sugar defects. Fry quality was poorer compared to other varieties, with two samples containing unacceptable fries and only two samples of all excellent fries (Figure 30).

Table 11. Russet Burbank monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January			

Figure 30: Russet Burbank percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Umatilla Russet: This variety was evaluated monthly until June. It had a storage glucose profile between both check varieties and consistently elevated sucrose profile (Figures 31 and 32). Sugar ends were observed in January, February, and April (Figure 33). Fry quality was excellent each month, with some acceptable fries in January and April (Figure 34).

Table 12. Umatilla Russet monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January		May	

June	

Figure 31: Umatilla Russet glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

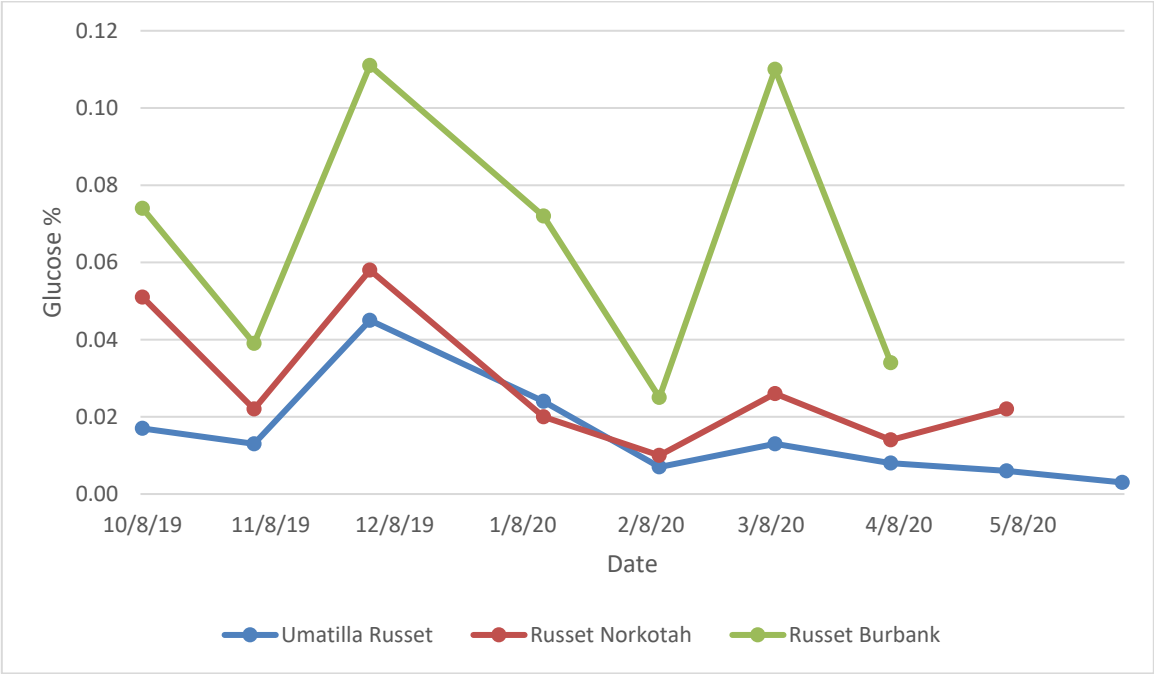


Figure 32: Umatilla Russet sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

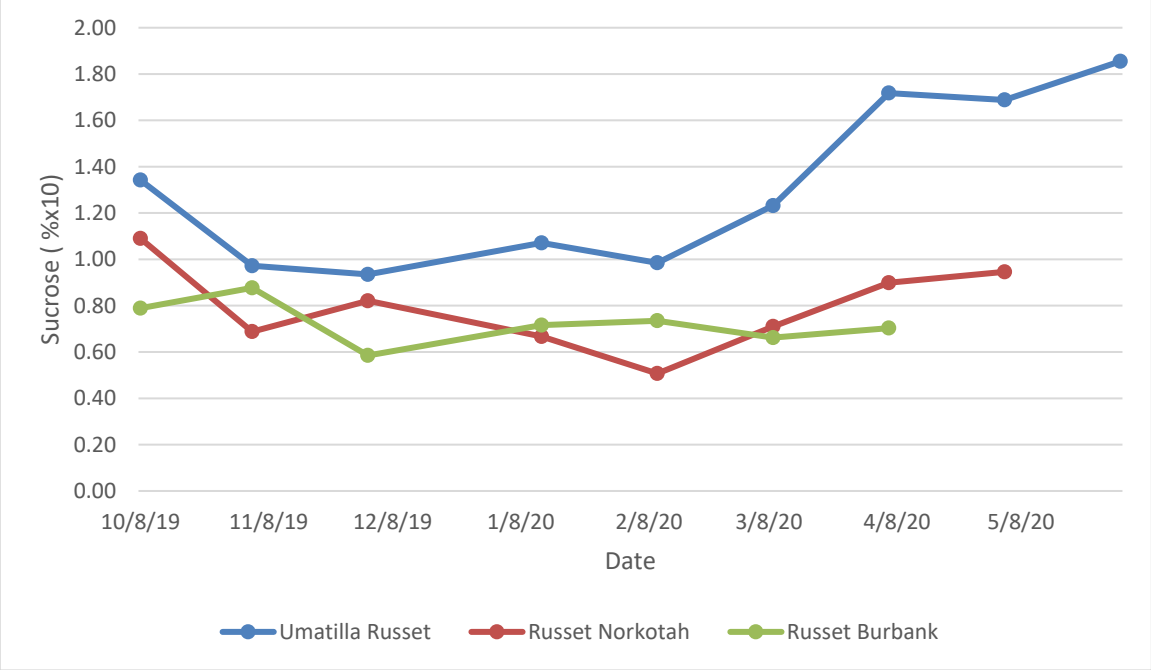


Figure 33: Umatilla Russet sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

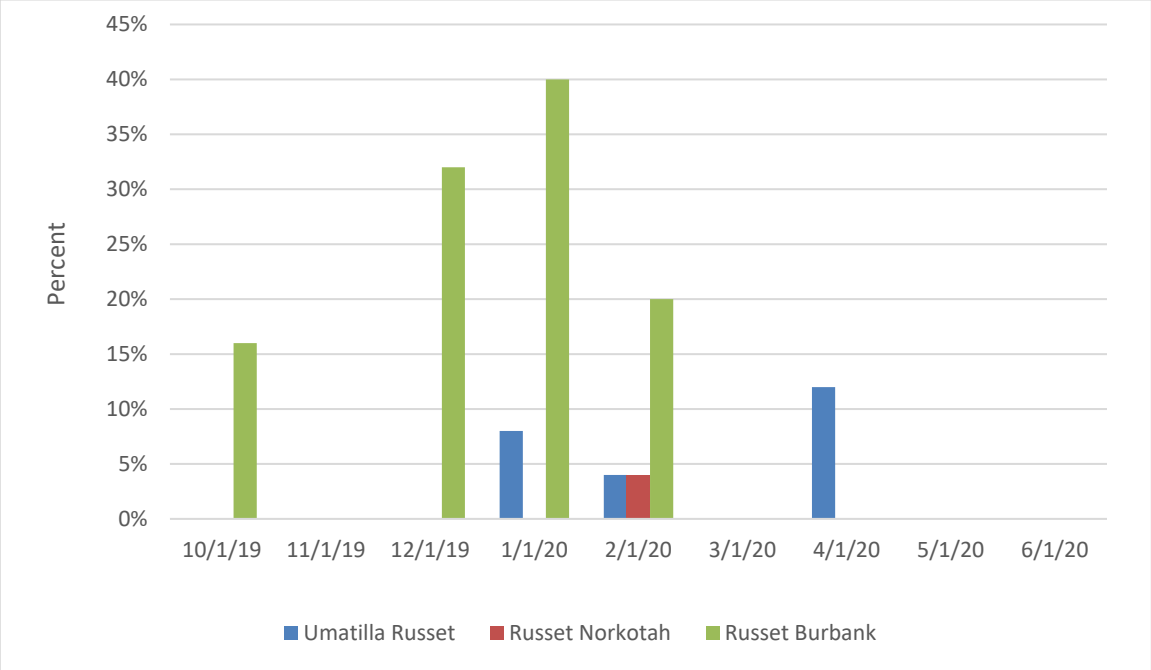
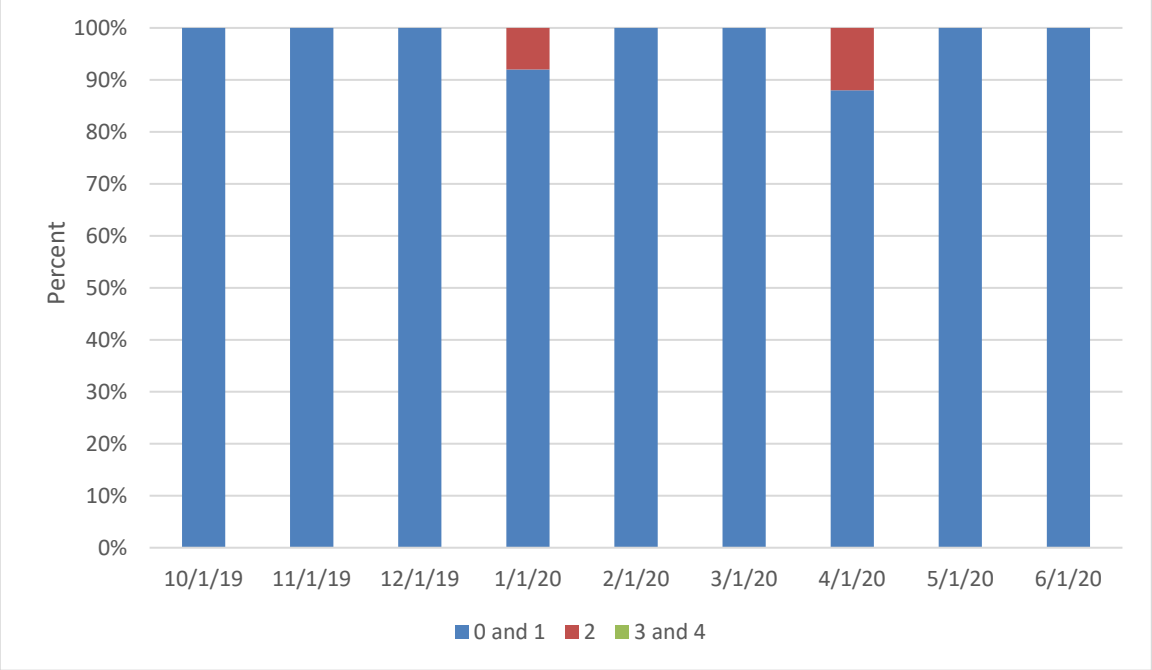


Figure 34: Umatilla Russet percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



Vanguard: This variety was evaluated monthly until April. It had a storage glucose profile between both check varieties and sucrose profile like both check varieties (Figures 35 and 36). Sugar ends were observed once in December (Figure 37). Fry quality was at least 60% excellent in all samples, with the lowest fry quality in February and April (Figure 38).

Table 13. Vanguard monthly fry quality pictures from Techmark Inc.

Month		Month	
October		February	
November		March	
December		April	
January			

Figure 35: Vanguard glucose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

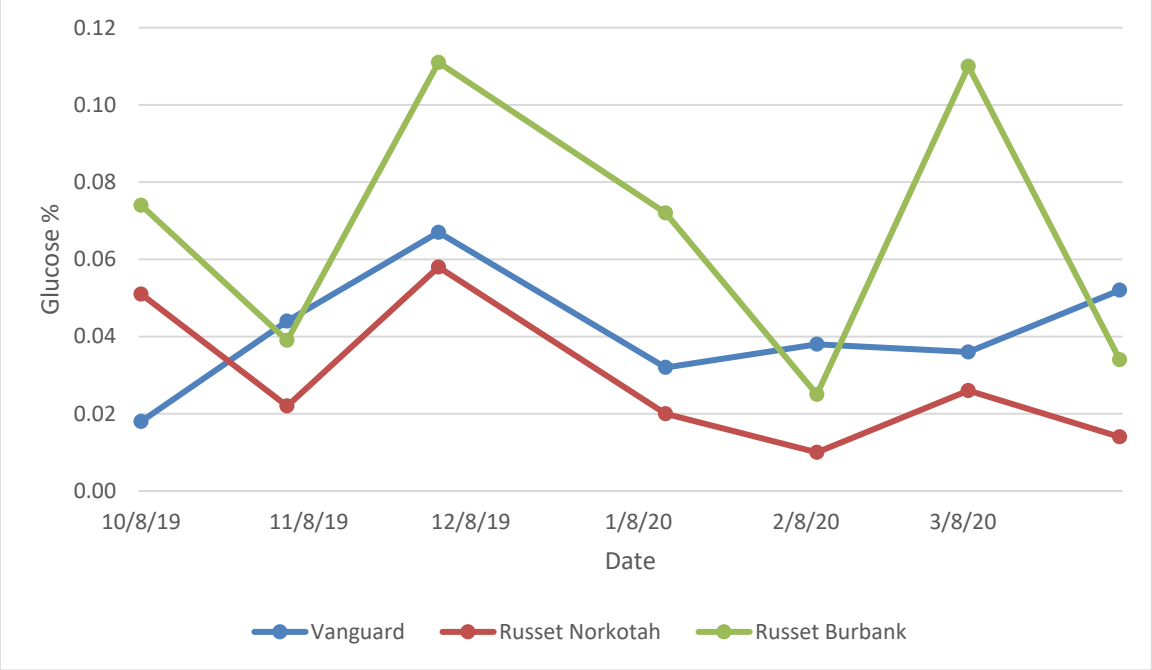


Figure 36: Vanguard sucrose concentrations for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

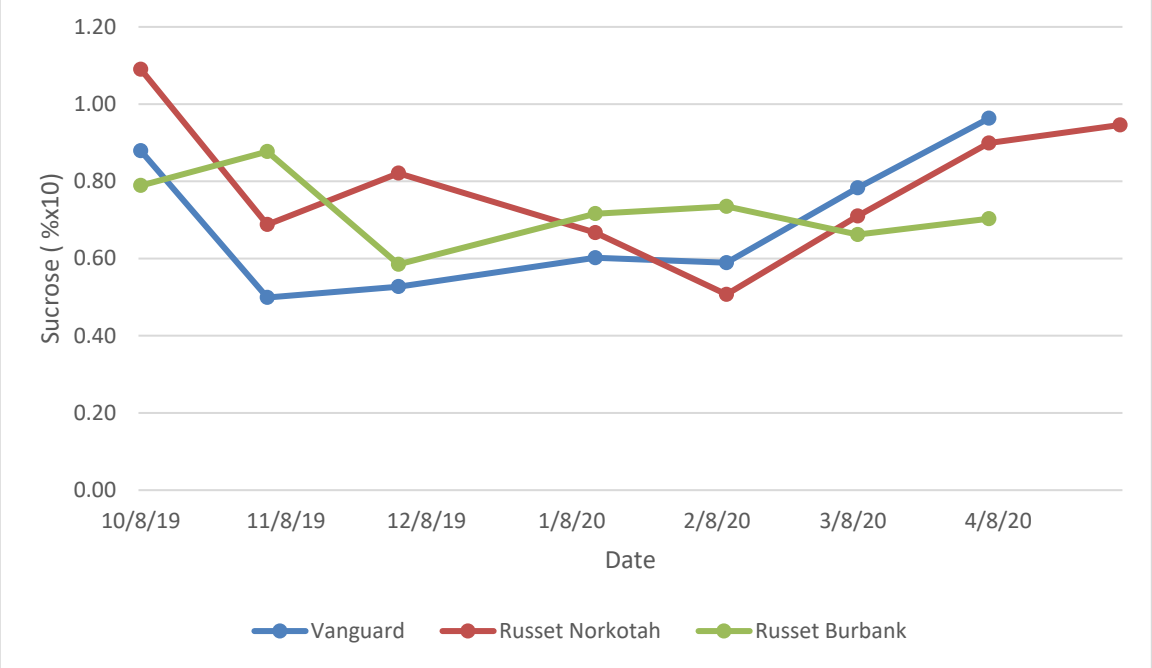


Figure 37: Vanguard sugar end percentages for the 2019-2020 storage season compared to Russet Norkotah and Russet Burbank.

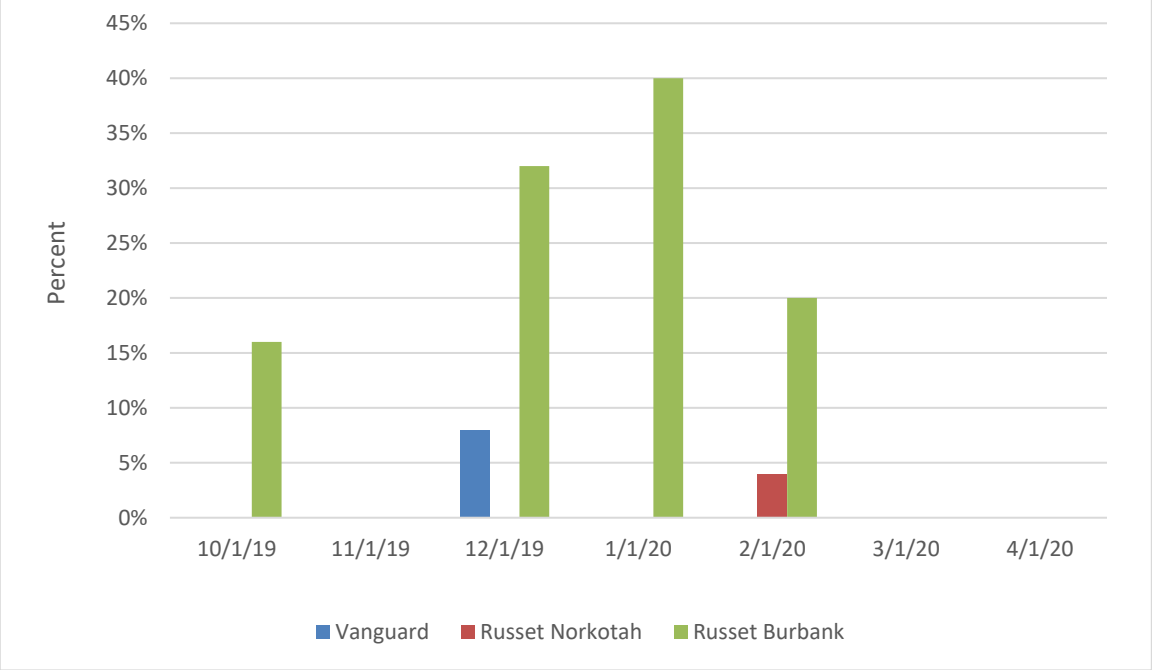
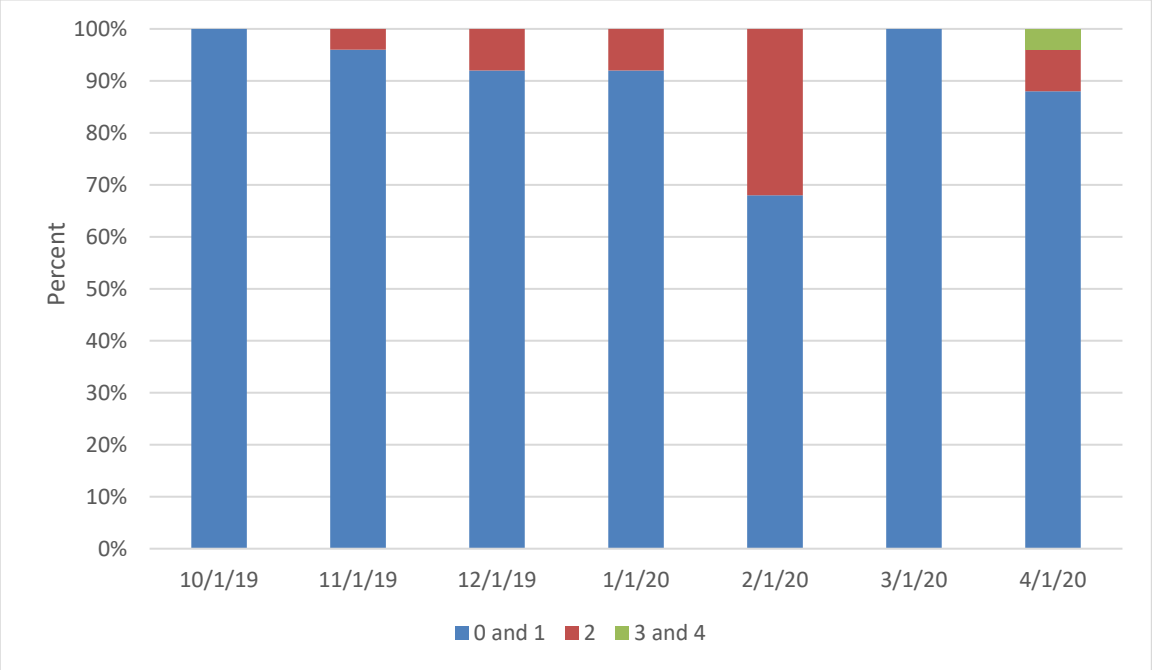


Figure 38: Vanguard percent fry color for the 2019-2020 storage season. Fry quality is: excellent (Munsell scores 0 and 1), acceptable (Munsell score 2), and unacceptable (Munsell scores 3 and 4).



MICHIGAN STATE UNIVERSITY EXTENSION

AgBioResearch MICHIGAN STATE UNIVERSITY

Phosphorus Use Guidelines for Potato Soil Fertility and Plant Nutrition 2020

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Jeff Rutan, Post-doctoral Research Associate
See soil.msu.edu for more information

The long-term goal of this study is to ensure soil fertility, optimal nutrient use, and profitability for potato growers while simultaneously reducing the risks for nutrient loss and improving water quality for all Michigan residents. Unnecessary P fertilizer applications are an economic loss for the grower and can become an environmental risk or contaminant within individual watersheds.

Potato production has changed substantially even in the last 20+ years since the inception of the Tri-State Fertilizer Recommendations. Major changes include: 1) newer varieties appear to have a smaller rooting system resulting in greater influence of sub-optimal growing conditions as compared to older varieties which tend to have a larger, more stable rooting system and thus more forgiving in sub-optimal growing conditions, and 2) a larger percentage of production occurs on leased as compared to owned lands. As current and future production acres expand to more marginally productive soils, data on potato P response will be required to justify P applications.

Project Purpose/Impact:

1) Current potato producer P practices do not align with MSU guidelines causing many grower operations to be non-compliant with nutrient GAAMPs and the inability to gain MAEAP verification. The proposed field studies will specifically address potato P applications with regard to confirming or revising nutrient GAAMPs as management practices, varieties and soil conditions have changed since inception of the GAAMPs document.
2) A significant knowledge gap exists between P fertilizer additions and potato response. Soils within Michigan often contain 2.5-3 times the recommended agronomic levels of soil test phosphorus and this legacy P may impact all watersheds for several decades. The logistics of potato production (i.e., short-rooted, coarse textured soils, low nutrient holding capacity soil, irrigated, and high input high value cropping system) create inherent obstacles with regard to P management. Strategies that maximize P use efficiency yet simultaneously remain productive long-term through incremental improvements in soil quality and disease suppression will be essential.

A review of the original objectives include:

1. Conduct potato phosphorus (P) fertilizer response trials (0-200 lb. P_2O_5 per acre in 40 lb. increments) at multiple residual soil P levels and across a range of soil pH.
2. Identify and update P concentration and crop removal values (tubers, petioles, leaves).
3. Build knowledge and support for programming focused on optimal P application guidelines and revise MSU recommendations and nutrient GAAMPs if required.

4. Focus on integrating grower field operations with current and previously collected research farm data and combine across data sets.

A summary of the project activities and milestones to date as related to each of the objectives listed above:

1. To examine potato response to P application a total of 11 research trials were conducted from 2019 – 2020 across a range of soil pH (6.0 – 7.4), and residual soil test P (STP) levels [64 (deficient) to 210 (sufficient) mg kg^{-1} Bray-P1] at both MSU research farm (MRF) and on-farm sites. Despite limited in-person activities due to Covid-19 in 2020, 4 of 4 on-farm field studies (6 P rates and 4 replications) were successfully completed in Michigan's Lower Peninsula. Across years, the Soil Fertility and Plant Nutrition Program effectively collaborated with growers and the MSU Potato Outreach Program (POP) to implement on-farm trials at 4 sites in Three Rivers, and 2 sites each in Newberry, Cass City, and Dundee, Michigan. Tuber grading included sorting, counting, and weighing by market class. Post-harvest soil samples were collected at either a single or two depths to assess residual P_2O_5 levels.
2. Similar to the 2019 season, 2020 potato plant petiole samples were collected at 30 and 45 days after emergence (DAE) in addition to whole plants at the Dundee site 64 DAE, which were partitioned into tubers, stems, and leaflets for P content analysis. At 30 DAE (45 DAE), laboratory analyses indicated mean petiole P content was 0.464 (0.345), 0.363 (0.227), 0.392 (0.516), and 0.315 (0.336) % across Dundee, Three Rivers I and II (STP=83 and 210 ppm, respectively), and Cass City, respectively. When ordered greatest to least, dry matter, P_2O_5 concentration and uptake occurred in tubers, leaflets, and stems (Table 1). Despite a lack of response to P fertilization in tubers and leaflets, potato stem response was variable.
3. To assess potato P response, data were subjected to analysis of variance (ANOVA) and regression analysis. Petiole P conc. at 30 DAE was combined with 2019 data (11 site years total), and preliminary Cate-Nelson analyses indicated a critical P sufficiency conc. of 0.22 % P, in harmony with MSU Ext. Bul. E486 recommendations. After tuber P conc. was analyzed in 2020, values were combined across MRF (2019) and Dundee (2019-2020) sites and indicated mean P_2O_5 content was 0.559 – 0.588 % which removed 0.109 – 0.115 pounds P_2O_5 per CWT (Table 2). Tuber P removal values were compared to the reported value (0.13 lb P_2O_5 cwt^{-1}, MSU Ext. Bul. E2904; 2019 Michigan nutrient utilization GAAMPS). Analysis of residual STP levels taken at two depths (0 to 4 in and 4 to 8 in) indicated increased STP at the MSU research farm in 2019 only when P application rates exceeded 80 lbs P_2O_5 ac^{-1} (Table 3). Total tuber yield response to P fertilizer was variable 2019 to 2020 with increased tuber yield at 50% of P-deficient sites (<75 ppm Bray-P1), and 43% of P-sufficient sites. Multiple regression analysis indicated that preplant soil temperature and soil test zinc levels affected relative yield response to P fertilizer application. In 2020, ANOVA and regression analysis indicated total tuber yield responded to P fertilizer when preplant STP levels were deficient (i.e. <75 ppm Bray-P1), and optimized with a P_2O_5 rate of 87 lbs ac^{-1} (Tables 4 to 6).
4. Effective communication between MSU personnel and growers enabled on-farm visits for data collection and tuber harvests. To generate data in a production environment, research trials were established within grower fields and managed by the grower in harmony with the production area. Starter P placements used with growers' on-farm equipment were mirrored at Dundee and MRF research sites, and enabled application of research methods. Total tuber yields collected at

Table of Contents

MRF in 2019 were combined with previous years (2014-16, 2018), and optimized with 44 lbs P_2O_5 ac^{-1} across STP levels 128-312 ppm.

A summary of upcoming project activities as related to each of the objectives listed above:

1. No further research will be conducted. Field activities were concluded in autumn 2020 with 11 research trials conducted from 2019 – 2020. Assistance received from growers and the MSU POP enabled successful execution of on-farm studies, and generated a framework of communication and coordination which can enable future collaboration.
2. All samples have been analyzed, and data compiled. Phosphorus concentration and crop removal values (tubers, petioles, and leaves) have been identified. No further analyses need be completed as final results are being drafted into publication format.
3. Current data will be shared with the Michigan Potato Industry Commission. Additionally, final results will be shared with growers and industry as results are being compared to MSU recommendations and to nutrient GAAMPs with final revisions planned for 2021.
4. Data generated in 2019 and 2020 were compiled and analyzed across data sets (see above) for various measurements. Additional yield data generated prior to 2019 at the MRF research site were integrated to enable calculation of an optimal P rate with regression analysis.

Table 1. Effect of phosphorus (P) application rate at potato senescence on 'Tablestock' potato dry matter production, P concentration, and P uptake analyzed partitioned into tubers (T), stems (S), and leaflets (L) at Dundee, MI, 2020.

	—Dry Matter—			—P_2O_5 Conc. —			—P_2O_5 Uptake—		
P rate	T	S	L	T	S	L	T	S	L
—lbs P_2O_5 ac^{-1}—	ton ac^{-1}			percent (%)			lbs ac^{-1}		
0	3.0	0.3 b†	0.6	0.53	0.23 a	0.28	31.7	1.3 c	3.5
40	3.3	0.4 ab	0.7	0.54	0.25 a	0.32	34.5	1.9 ab	4.2
80	7.8	0.4 a	0.8	0.55	0.23 a	0.28	37.9	1.9 abc	4.1
120	3.5	0.4 a	0.8	0.54	0.24 a	0.31	36.7	2.1 a	4.9
160	3.2	0.4 a	0.7	0.52	0.20 b	0.28	33.3	1.5 bc	4.0
200	3.6	0.4 a	0.7	0.54	0.23 a	0.32	38.6	2.1 a	4.2
Pr > F	0.28	0.10	0.40	0.93	0.05	0.63	0.15	0.05	0.52

†Values followed by the same letter are not sig. different at alpha=0.1.

Table 2. Effect of phosphorus (P) application rate at potato senescence on tuber P_2O_5 concentration and removal analyzed across 'chipping' and 'tablestock' potato types at Lakeview (2019) and Dundee (2019 to 2020), MI.

	Tuber	Tuber
P rate	P_2O_5 Conc.	P_2O_5 Removal
—lbs P_2O_5 ac^{-1}—	Percent (%)	P_2O_5 CWT^{-1}
0	0.586 a†	0.115 a
40	0.559 a	0.109 a
80	0.588 a	0.115 a
120	0.561 a	0.111 a
160	0.571 a	0.114 a
200	0.586 a	0.113 a
	ANOVA	
Site Year (SY)	0.0001	<0.0001
P Rate (PR)	0.4117	0.6225
SY x PR	0.3332	0.6420

†Values followed by the same letter are not sig. different at alpha=0.1.

Table 3. Residual soil test phosphorus (P) (Bray-P1) as affected by P application rate collected prior to potato tuber harvest at the Michigan State University Montcalm Research Farm (2019) and Dundee (2019-2020), MI.

P rate	MRF, 2019				Dundee, 2019				Dundee, 2020			
(P_2O_5)	0-4"		4-8"		0-4"		4-8"		0-4"		4-8"	
lbs ac^{-1}	————————mg kg $soil^{-1}$————————											
0	174	bc†	176	a	134	a	120	a	194	a	150	a
40	176	bc	147	a	135	a	102	a	194	a	137	a
80	160	c	138	a	142	a	115	a	195	a	148	a
120	226	ab	171	a	145	a	119	a	179	a	178	a
160	210	abc	179	a	155	a	136	a	206	a	148	a
200	255	a	170	a	158	a	113	a	211	a	179	a
Pr > F	0.0860		0.7116		0.4857		0.4485		0.8673		0.8191	

†Values followed by the same letter are not sig. different at alpha=0.1.

Table 4. 'Chipping' potato tuber yield as affected by phosphorus (P) application rate, and separated by tuber size (i.e., B, A, total) at two soil test P levels in Three Rivers, MI, 2020.

P rate	STP=83 ppm†			STP=210 ppm		
	B's	A's	Total	B's	A's	Total
—lbs P_2O_5 ac^{-1} —	————————CWT ac^{-1}————————					
0	34.7 b‡	404.2 a	473.4 a	23.5 a	510.2 a	554.3 a
40	35.0 b	387.0 a	451.8 a	18.7 a	512.4 a	554.4 a
80	41.9 ab	413.4 a	475.6 a	26.1 a	591.5 a	637.8 a
120	43.5 ab	447.9 a	510.9 a	27.0 a	630.8 a	688.0 a
160	51.2 a	429.8 a	503.7 a	26.9 a	601.2 a	656.1 a
200	48.5 a	441.5 a	502.0 a	31.5 a	549.8 a	596.7 a
Pr > F	0.0818	0.1842	0.2872	0.4051	0.3227	0.2694

†Bray-P1 soil P extractant.

‡Values followed by the same letter are not sig. different at alpha=0.1.

Table 5. 'Tablestock' potato tuber yield as affected by phosphorus (P) application rate, separated by tuber size (i.e., B, A, total), and soil test P=171 ppm in Dundee, MI, 2020.

P rate	Yield		
	B's	A's	Total
—lbs P_2O_5 ac^{-1}—	————CWT ac^{-1}————		
0	45.7 a†	374.4 a	430.7 a
40	39.6 a	411.7 a	462.2 a
80	45.3 a	422.7 a	483.7 a
120	58.5 a	366.6 a	437.5 a
160	46.2 a	395.3 a	454.5 a
200	43.7 a	424.6 a	481.1 a
Pr > F	0.1134	0.5881	0.6961

†Values followed by the same letter are not sig. different at alpha=0.1.

Table 6. 'Chipping' potato tuber yield as affected by phosphorus (P) application rate, separated by tuber size (i.e., B, A, total), and soil test P=64 ppm in Cass City, MI, 2020.

P rate	Yield		
	B's	A's	Total
—lbs P_2O_5 ac^{-1}—	————CWT ac^{-1}————		
0	53.0 a†	329.3 b	384.7 b
40	57.6 a	318.6 b	378.6 b
80	59.6 a	390.7 a	451.5 a
120	49.7 a	389.3 a	441.0 a
160	53.4 a	387.1 a	441.7 a
200	57.3 a	329.8 a	452.2 a
Pr > F	0.8874	0.0057	0.0128

†Values followed by the same letter are not sig. different at alpha=0.1.