Michigan State University
AgBioResearch

In Cooperation With
Michigan Potato Industry Commission

Michigan Potato Research Report
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Michigan Potato Industry Commission
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To all Michigan Potato Growers and Shippers,

Research is at the core of the work that continues on the part of the industry. Through research we are able to test, to study, and to advance Michigan potato production by bringing experiments to life. As crop research expands, we learn more about diseases and storage management. We are able to look at potatoes and their resistance to insects. We can look at the levels of individual elements in a potato and learn more about their relationship with one another, creating a better vegetable in the process.

This year our focus included the genetic makeup of the potato along with continued soil health analysis. The research is aimed to raise the efficiency and sustainability of modern potato production in Michigan, as well as a variety of storage and handling issues. Weather data, insect resistance, and tuber set were also a priority in the research conducted this past year in working towards our overall goal to create an economical, healthy and abundant food source.

The following research report was compiled with the help of the Michigan Potato Industry Commission, Michigan State University's AgBioReseach Stations, and Michigan State University Extension. On behalf of all parties, we are proud to present you with the results of the 2015 potato research projects.

We would like to thank our many suppliers, researchers, and all others involved in making this year's research season a success. As the industry faces new challenges and strives for the perfect potato, we are inspired by the level of cooperation in the industry and look toward future success.

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2015 MICHIGAN POTATO RESEARCH REPORT

C. M. Long, Coordinator

INTRODUCTION AND ACKNOWLEDGMENTS

The 2015 Potato Research Report contains reports of the many potato research projects conducted by Michigan State University (MSU) potato researchers at several locations. The 2015 report is the 47th 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 principle 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 go to Bruce Sackett for the management of the MSU Montcalm Research Center (MRC) and the many details which are a part of its operation. We also want to recognize Michelle Wieferich at MPIC and Aaron Yoder, MSU for helping with the details of this final draft.

WEATHER

The overall 6-month average maximum and minimum temperatures during the 2015 growing season were nearly identical to the 15 year averages at 73°F and 50°F respectively (Table 1). The average maximum temperatures during the month of September was noticeably higher than 15-year average by 4 °F. Extreme heat events were minimal in 2015 as in the previous growing season (Table 3) where essentially there were only 3 hours (within one day) in which temperatures exceeded 90 °F during the entire summer. The previous 6-year average is of 17 hours over 4 days. Additionally, high nighttime temperatures (over 70 °F) were much lower than normal; in 2015, 6 fewer days and 77 fewer nighttime hours were recorded when compared with the 6-year averages. In May, there was one day where temperatures dropped below 32 °F (30.8°F on May 20th); from September-October 15th, there were no records of temperatures dropping below 32°F.

Rainfall for April through September was 17.59 inches, which was 1.91 inches above the 15-year average (Table 2). A total of 6.75 inches of irrigation water was applied at the MRC during the months of June, July and August. In general, precipitation during the warmest months (July and August) was below average, while early and late season precipitation (April and Septermber) was above average. Precipitation in June was 2.07 inches higher than the previous 15 year average.

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

Year	April		May		June		July		August		September		6-Month Average	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2001	61	37	70	49	78	57	83	58	72	70	69	48	72	53
2002	56	36	63	42	79	58	85	62	81	58	77	52	73	51
2003	56	33	64	44	77	52	81	58	82	58	72	48	72	49
2004	62	37	67	46	74	54	79	57	76	53	78	49	73	49
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	73	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**
15-Year Average	58	35	68	46	78	55	82	58	79	58	73	49	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
2001	3.28	6.74	2.90	2.49	5.71	4.43	25.55
2002	2.88	4.16	3.28	3.62	7.12	1.59	22.65
2003	0.70	3.44	1.85	2.60	2.60	2.06	13.25
2004	1.79	8.18	3.13	1.72	1.99	0.32	17.13
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**	**2.96**	**4.79**	**1.72**	**2.42**	**3.90**	**19.50**
15-Year Average	2.90	3.64	2.72	2.76	3.23	2.35	17.59

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

Year	Temperatures > 90°F		Night (10pm-8am) Temperatures > 70°F	
	Hours	Days	Hours	Days
2010	0	0	218	43
2011	14	4	174	32
2012	70	15	143	30
2013	14	3	140	28
2014	0	0	58	15
2015	**3**	**1**	**66**	**22**
Average	17	4	133	28

GROWING DEGREE DAYS

Table 4 summarizes the cumulative growing degree days (GDD) for 2015 while providing historical data from 2004-2015 as well. GDD are presented from May 1st – September 30th using the Baskerville-Emin method with a base temperature of 40 °F. The total GDD base 40 by the end of September in 2015 was 3789 (Table 4), which is slightly higher than the 12-year average of 3741 at the same time. This appears to be due to higher than average daily maximum temperatures during the months of May and September.

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

Year	May	June	July	August	September
2004	516	1235	2101	2851	3567
2005	419	1358	2289	3187	3906
2006	532	1310	2298	3180	3707
2007	639	1503	2379	3277	3966
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**
Average	555	1331	2250	3108	3741

*2004-2015 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 2015 was rented from Steve Comden, directly to the West of the Montcalm Research Center in the field referred to as 'Comden 2'. This acreage was planted to a field corn crop in the spring of 2014 and harvested fall 2014 with crop residue disked into the soil. In the spring of 2015, the recommended rate of potash was broadcast applied following deep-chisel plowing. The ground was field cultivated and direct planted to potatoes. The area was not fumigated with Vapam prior to potato planting, but Vydate® and Verimark® were applied in-furrow at planting.

The soil test analysis for the general crop area (taken in January 2015) was as follows:

	lbs/A			
pH	P	K	Ca	Mg
6.2	262 (131 ppm)	116 (58 ppm)	1488 (744 ppm)	184 (92 ppm)

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

Application	Analysis	Rate	Nutrients ($N-P_2O_5-K_2O-Ca-Mg$)
Broadcast at plow down	0-0-0-21-12	300 lbs/A	0-0-0-63-48
	10%B	6 lbs/A	0.6 lb. B/A
	0-0-62	150 lbs/A	0-0-93
	0-0-22-11-22	200 lbs/A	0-0-44-22-44
At planting	28-0-0	20 gpa	60-0-0
	10-34-0	16 gpa	19-65-0
At cultivation	28-0-0	24 gpa	72-0-0
	10-34-0	16 gpa	19-65-0
At hilling	46-0-0	100 lbs/A	46-0-0
Late side dress (late varieties)	46-0-0	175 lbs/A	81-0-0

HERBICIDES AND PEST CONTROL

A pre-emergence application of Linex at 1.25 quarts/A and Brawl II at 1.0 pints/A was made in late May.

Verimark and Vydate were applied in-furrow at planting at a rate of 13.5 fl oz/A and 2 quarts/A, respectively. Vydate was also applied as a foliar spray at a rate of 1.0 quarts/A. Foliar applications of the insecticides Rimon, Radiant, Blackhawk and Agri-mek were made at 8, 8, 3, and 12 oz./A respectively.

Fungicides used were: Elixir, Manzate and Bravo for a total rate of 11.2 lbs, 4 lbs., and 6 pts/A respectively.

Potato vines were desiccated with Reglone on September 10th at a rate of 2 pints/A.

2015 MSU POTATO BREEDING AND GENETICS RESEARCH REPORT
January 26, 2016

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INTRODUCTION

At Michigan State University, we have been dedicated to developing improved potato varieties for the chip-processing and tablestock markets for over 25 years. 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 integrates traditional and biotechnological approaches to breed for disease and insect resistance that is positioned to respond to scientific and technology opportunities that emerge.

In Michigan, variety development requires that we primarily develop high yielding round white potatoes with excellent chip-processing from the field and/or storage. In addition, there is 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 Experiment Station, 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. 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, beetle resistance and higher specific gravity). I am happy to see the increase in scab, late blight and PVY resistance in the breeding material and selections. The USDA/AFRI SolCAP project developed a new set of genetic markers (8,303) called SNPs that are located in the 39,000 genes of potato. We now have expanded the number of SNPs to 12,000 and are looking at 30,000 SNPs on the next version of the 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. 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.

Furthermore, the USPB is supporting national early generation trials called the National Chip Processing Trial (NCPT) which will feed lines into the SFA trial and also fast track lines into commercial testing. We are taking advantage of the NCPT fast track to have seed increased for promising chip-processing lines. We have also been funded through the USDA/SCRI Acrylamide project to link genetic markers with lower acrylamide traits. This project is nearing completion and we have lines with lower tuber asparagine and lower acrylamide forming potential in the processed chips. We also have funding to develop genome editing technologies that may not be classified as genetic engineering through a USDA/BRAG grant. This technology can be used to introduce lower sugars, bruising and asparagine. We also hope to use the technology to edit late blight resistance genes. 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 the breeding of improved chip-processing and tablestock potatoes.

The breeding goals at MSU are based upon 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 as well as the reliance on chemical inputs such as insecticides, fungicides and sprout inhibitors, and improve overall agronomic performance with 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. This past year we constructed a greenhouse to expand our breeding and certified minituber seed production. This greenhouse is at the MSU Crops facility on south campus. We also are creating a companion tissue culture lab at the facility. We hope to upgrade the grading line and expand storage capacity in the near future.

I. Varietal Development

Breeding

The MSU potato breeding and genetics program is actively producing new germplasm and advanced seedlings that are improved for cold chipping, and resistance to scab, late blight, and Colorado potato beetle. For the 2015 field season, progeny from about 600 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 novelty market classes. During the 2015 harvest, over 1,300 selections were made from the 65,000 seedlings produced. In addition, about 40 third year selections from elite chip-processing crosses were made in a commercial field with high scab pressure. All potential chip-processing selections will be tested in January and April 2016 directly out of 45°F (7.2°C) and 50°F (10°C) storages. Atlantic, Pike (50°F chipper) and Snowden (45°F chipper) 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 400 and 115 selections were made, respectively; based upon 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. 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 that was developed in our lab to remove viruses. We feel that this technique predictably as well as quickly remove virus from tissue culture stocks. Our results show that we are able to remove both PVY and PVS from lines. We tested the removal of PLRV and succeeded.

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 MSR127-2 (scab resistant), McBride (scab resistant), MSQ086-3, (verticillium wilt resistant), Manistee, MSM246-B and MSR061-1 (Saginaw Chipper) (scab, late blight and PVY resistant), MSV313-2, MSW474-1 (scab resistant), MSV507-40 (scab resistant), MSV301-2 (scab resistant), MSX540-4 (scab, late blight and PVY resistant) and MSZ219-14 (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. These are MSV301-2, MSV358-3, MSW485-2, MSW509-5, MSV030-4 and MSX540-4.

Tablestock

Efforts have been made to identify lines with good appearance, 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 resistant lines, incorporate resistance to late blight along with marketable maturity and excellent tuber quality, and select more russet and yellow-fleshed lines. We have also been spinning off some pigmented skin and tuber flesh lines that may fit some specialty markets. We are proposing the release of MSX001-4WP as Purple Soul. There is also interest in some additional specialty 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 a table russet, round white, red-skin, and improved Yukon Gold-type yellow-fleshed potatoes. Some of the tablestock lines were tested in on-farm trials in 2015, while others were tested under replicated conditions at the Montcalm Research Center. Promising tablestock lines include MSL211-3, MSS576-05SPL, MSV093-1, MST252-1Y, MSV179-1 and MSQ131-A. We have a number of tablestock selections with late blight resistance (MSS576-5SPL, MSQ131-A, MSS487-2 and MSS176-1). MSL211-3 has earliness and a bright skin. MSQ558-2RR and MSR226-ARR are red-fleshed chippers. We are increasing seed of Missuakee for international markets due to its late blight resistance and Golden nematode resistance. Jacqueline Lee is being licensed to Australia.

Disease and Insect Resistance Breeding

Scab: In 2015 we had two locations to evaluate scab resistance: a commercial field with a history of severe scab infection (Sackett Potatoes) and a highly infected site at the Montcalm Research Center in the commercial production area. The commercial site and the new site at the Montcalm Research Center both gave us the high infection levels. The susceptible checks of Snowden and Atlantic were highly infected with pitted scab. Promising resistant selections were McBride, MSR061-1, MSR127-2, MSU383-A, MSQ440-2, MST252-1Y, MSV179-1, MST424-6, MST386-1P, MSW474-01, MSV383-B, MSZ219-1, MSZ219-14, MSU379-1, MSW509-5, MSZ222-19 as well as the Z-series selections from the commercial scab site. 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. All susceptible checks were scored as susceptible.

Fig. 1. Scab Disease Nursery Ratings in Early Generation Lines

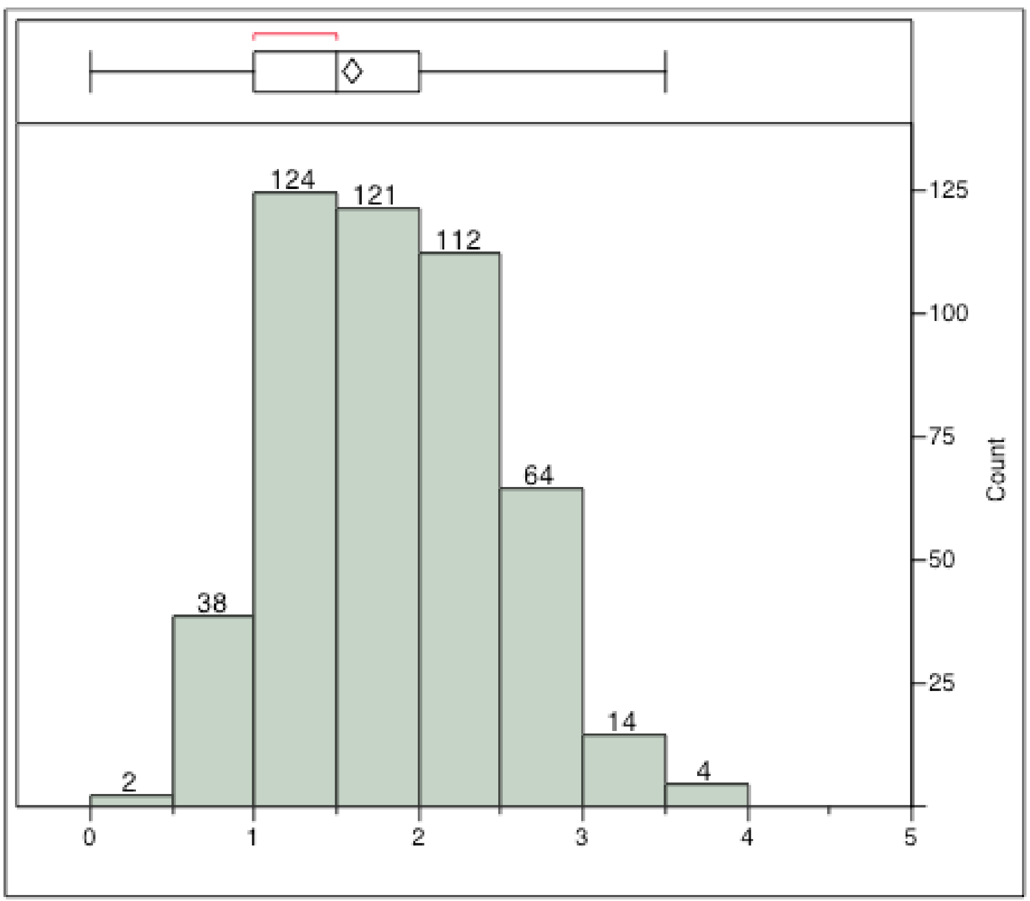
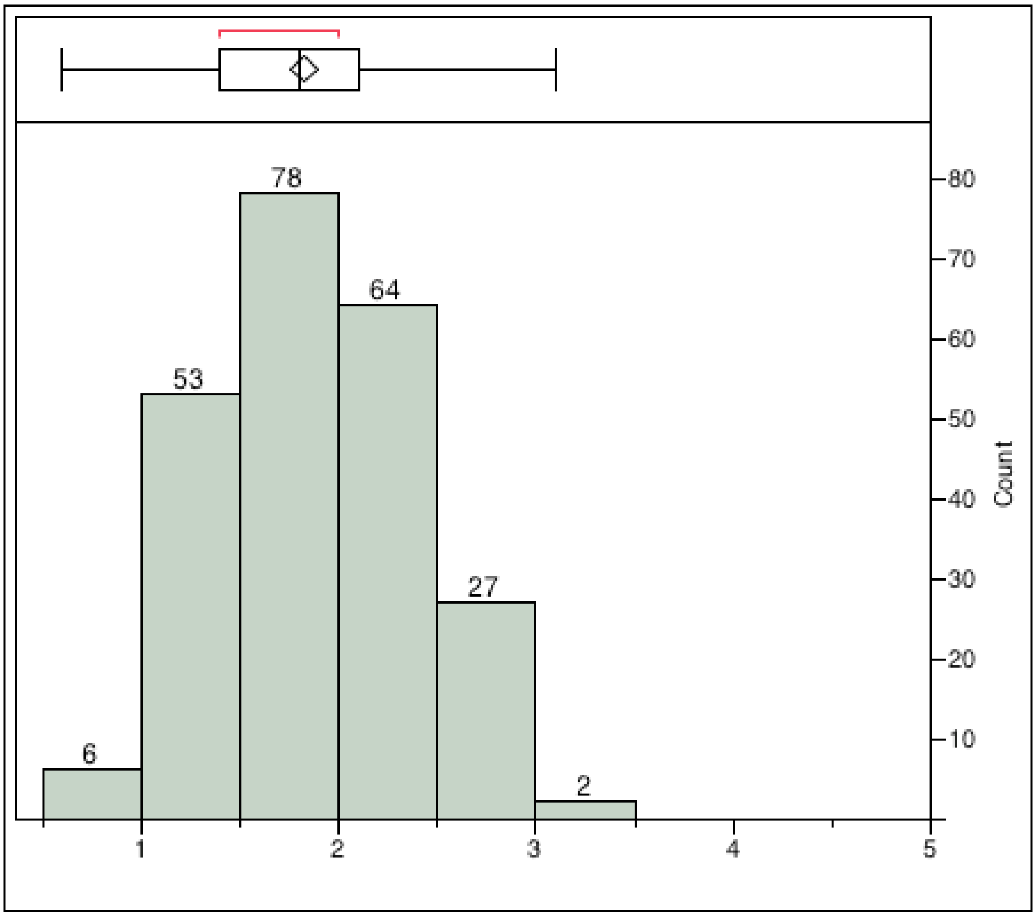


Fig. 2. Scab Disease Nursery Ratings in Advanced Breeding Lines



Based upon this data, scab resistance is increasing in the breeding program. 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.

We conducted a three-year selection study at Sackett Potatoes to select scab-resistant chip-processors. Starting with about 5,000 progeny from elite crosses we narrowed the population to about 40 selections that had commercial potential based upon shape, yield, scab resistance, chip-processing quality and high solids. In 2015 we made 18 selections from 40 scab-resistant chip-processing selections. The most most-promising selections are listed in Table 1. These lines are now placed in tissue culture for further testing. Some lines need virus cleanup.

Table 1. ***Streptomyces*** **Scab Trial Results from On-Farm trial location.**

PRELIMINARY TRIAL: Scab resistant "MSZ" LINES
MONTCALM RESEARCH FARM
May 18 to September 16, 2015 (121 days)
DD Base 40°F 3048[6]

	CWT/A		PERCENT OF TOTAL[1]		SFA	PERCENT (%) TUBER QUALITY[2]						
LINE	US#1	TOTAL	US#1	SP GR	OTF	HH	VD	IBS	BC	SCAB[3]	BRUISE[5]	MAT[4]
MSZ096-02	394	416	95	1.088	1.0	0	0	0	0	1.8	1.6	3.5
MSZ020-04	393	456	86	1.090	1.5	10	10	0	0	nd	0.7	
MSZ045-09	362	399	91	1.074	1.0	10	10	0	0	1.5	0.2	4.0
MSZ118-02	354	416	85	1.089	1.0	0	0	10	0	nd	0.4	
MSZ120-04	347	403	86	1.089	1.5	0	10	0	0	2.0	0.6	4.0
Atlantic	**333**	**370**	**89**	**1.095**	**1.5**	**10**	**5**	**10**	**0**	**2.8**	**1.8**	**2.0**
MSZ219-14	326	358	91	1.089	1.0	20	20	0	0	0.5	1.3	3.5
MSZ096-03	321	359	89	1.081	1.5	0	30	5	0	1.0	1.6	3.5
MSZ022-19	308	337	91	1.086	1.5	0	10	0	0	1.8	0.5	3.0
MSZ062-18	307	371	82	1.077	1.5	0	5	0	5	0.5	0.6	2.5
MSZ022-16	303	335	91	1.089	1.0	10	25	10	0	0.8	1.3	3.0
MSZ026-08	302	334	91	1.083	1.0	0	10	0	0	2.3	0.8	3.0
Snowden	**298**	**368**	**81**	**1.090**	**1.0**	**0**	**30**	**0**	**0**	**3.2**	**1.7**	**2.0**
MSZ062-31Y	291	353	83	1.073	1.0	0	0	0	0	1.0	0.6	3.0
MSZ219-29	280	298	94	1.079	1.0	10	25	5	0	0.5	1.2	2.0
MSZ219-46	273	279	98	1.087	1.5	10	15	0	0	0.3	0.7	3.0
MSZ052-13	271	306	88	1.089	1.0	0	15	0	0	0.3	1.8	2.5
MSZ118-19	269	302	89	1.093	1.0	0	15	0	0	0.5	2.2	3.0
MSZ062-50	266	294	91	1.089	1.0	0	5	0	0	0.5	1.8	4.0
MSZ022-07	263	301	87	1.083	1.0	10	10	0	0	0.8	0.8	2.0

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. This is a GREEEN-funded project. In 2015 we conducted late blight trials at the Clarksville Research Center. We inoculated with the US23 genotype and the results are summarized in Figures 3 and 4. Fourteen sources of resistance can be traced in the pedigrees of these resistant lines. This data infers that we have a broad genetic base to combine resistance genes and also should be able to respond to changes in the pathogen.

Fig. 3. Foliar Late Blight Reaction in Early Generation Lines

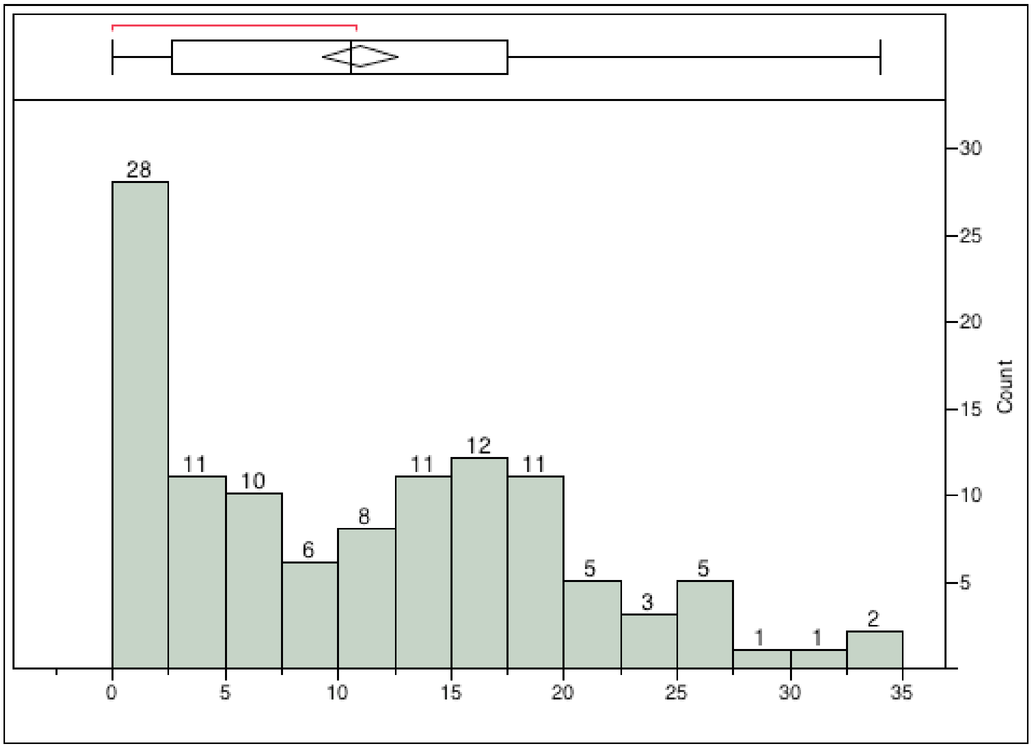
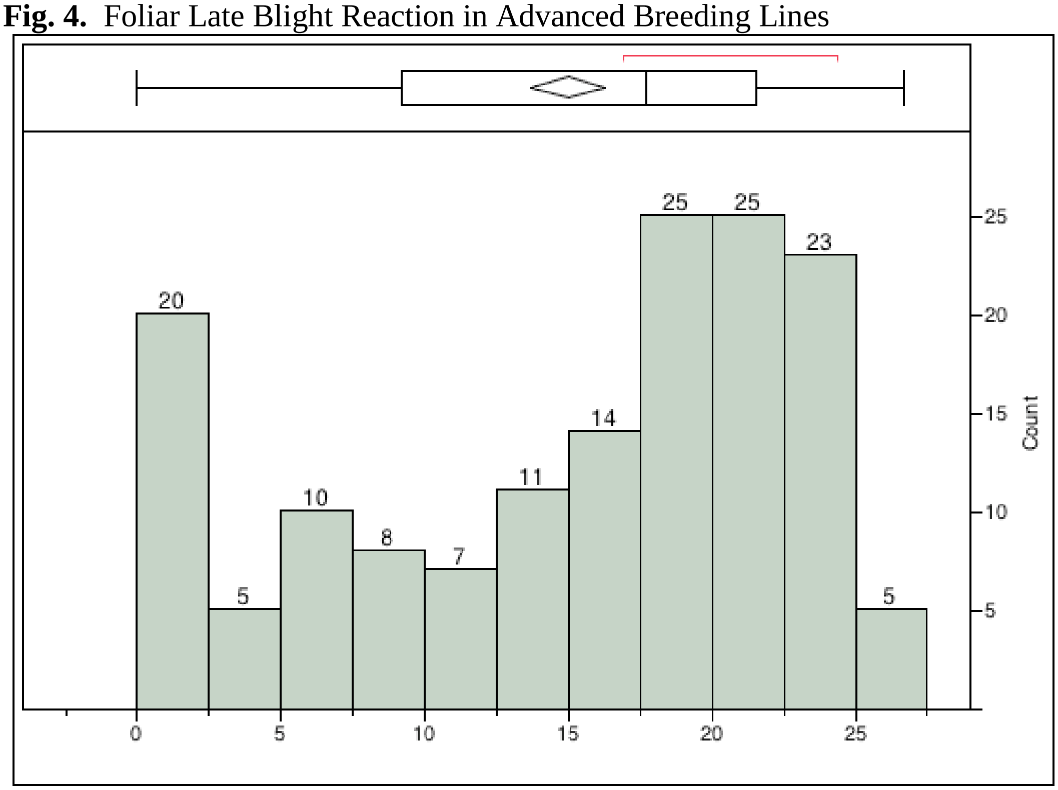


Fig. 4. Foliar Late Blight Reaction in Advanced Breeding Lines



McBride (MSJ126-9Y)

Parentage: Penta x OP
Developers: Michigan State University and the Michigan Agricultural Experiment Station
Plant Variety Protection: Trademark

Strengths: McBride is a chip-processing potato with an attractive round appearance with shallow eyes. McBride has a medium vine and an early to mid-season maturity. This variety has resistance to *Streptomyces scabies* (common scab) stronger than Pike. McBride also has excellent chip-processing long-term storage characteristics and better tolerance to blackspot bruise than Snowden.

Incentives for production: Excellent chip-processing quality with long-term storage characteristics, common scab resistance superior to Pike, and good tuber type.

Manistee (MSL292-A)

Parentage: Snowden x MSH098-2
Developers: Michigan State University and the Michigan Agricultural Experiment Station
Plant Variety Protection: Applied for.

Strengths: Manistee is a chip-processing potato with an attractive round appearance with shallow eyes. Manistee has a full-sized vine and an early to mid-season maturity. Manistee has above average yield potential and specific gravity similar to Snowden. This variety has excellent chip-processing long-term storage characteristics and a similar to better tolerance to blackspot bruise than Snowden.

Incentives for production: Excellent chip-processing quality with long-term storage characteristics, above average yield, specific gravity similar to Snowden, and good tuber type.

MSR061-1 (Saginaw Chipper)

Parentage: MegaChip x NY121
Developers: Michigan State University and the Michigan Agricultural Experiment Station
Plant Variety Protection: Trademark

Strengths: MSR061-1 is a chip-processing potato with resistance to common scab (*Streptomyces scabies*) and moderate foliar late blight (*Phytophthora infestans*) resistance. This variety has medium yield similar to Pike and a 1.079 (average) specific gravity and an attractive, uniform, round appearance. MSR061-1 has a medium vine and an early to mid-season maturity.

Incentives for production: Chip-processing quality with common scab resistance similar to Pike, moderate foliar late blight resistance (US8 genotype), and uniform, round tuber type.

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.

MSR127-2 (Spartan Chipper?)

Parentage: MSJ167-1 x MSG227-2
Developers: Michigan State University and the MSU AgBioResearch.
Plant Variety Protection: To Be Applied For.

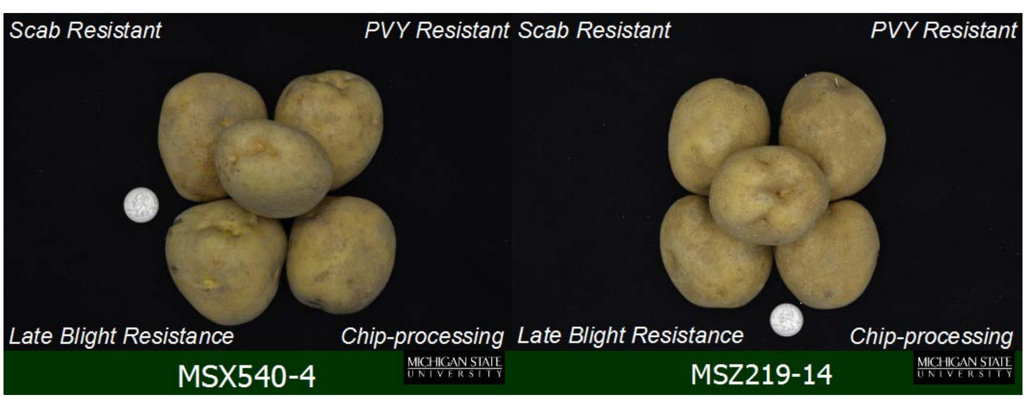
Strengths: MSR127-2 is a chip-processing potato with resistance to common scab (*Streptomyces scabies*). This variety yields greater than Atlantic and Snowden, has a 1.086 (average) specific gravity, and an attractive, uniform, round appearance. MSR127-2 has a strong vine and a full-season maturity, and has demonstrated excellent long-term storage chip-processing quality.

Incentives for production: Long-term chip-processing quality with common scab resistance similar to Pike, and uniform, round tuber type.

Purple Soul (MSX001-4WP)

Parentage: ARS10091 x MSL211-3
Developers: Michigan State University and the MSU AgBioResearch.
Plant Variety Protection: Trademark

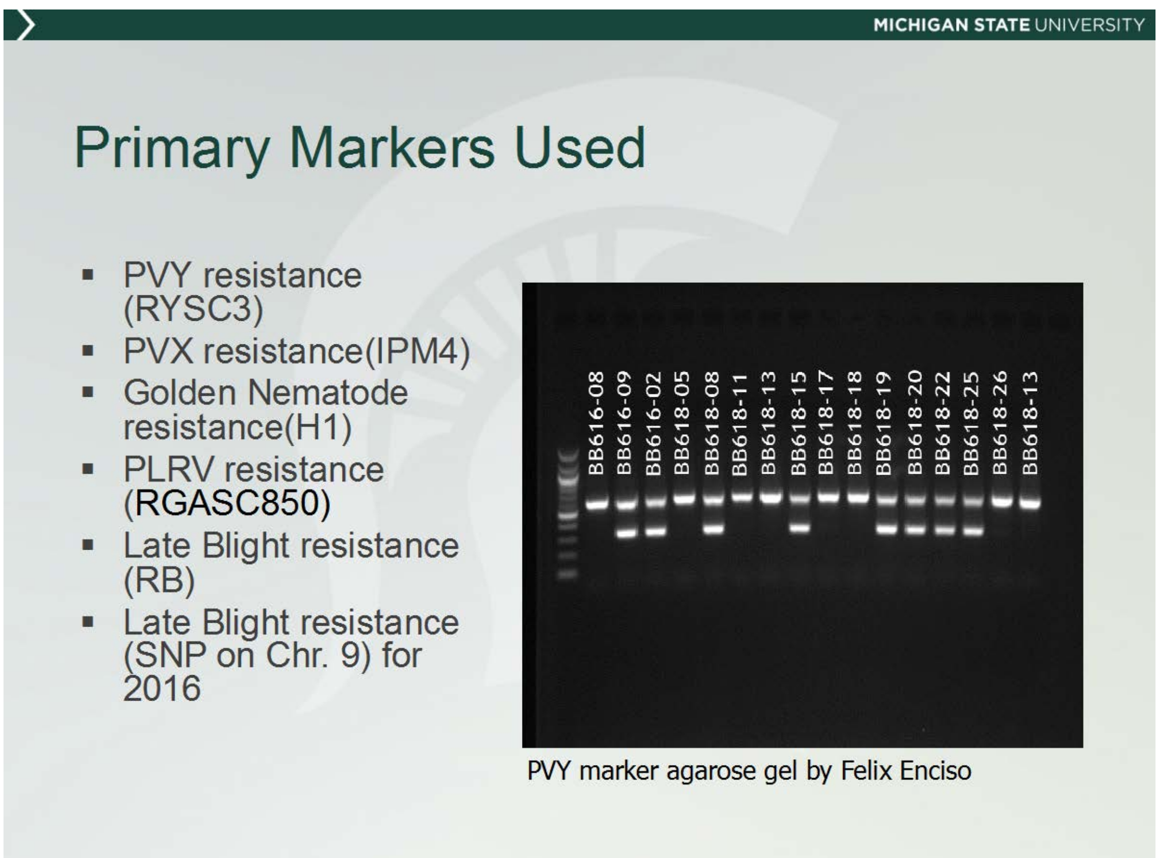
Strengths: Purple Heart is a very unique potato variety with a smooth, bright white skin and a surprisingly deep purple flesh. This line has excellent agronomic features for yield, tuber size, and maturity.



II. Germplasm Enhancement

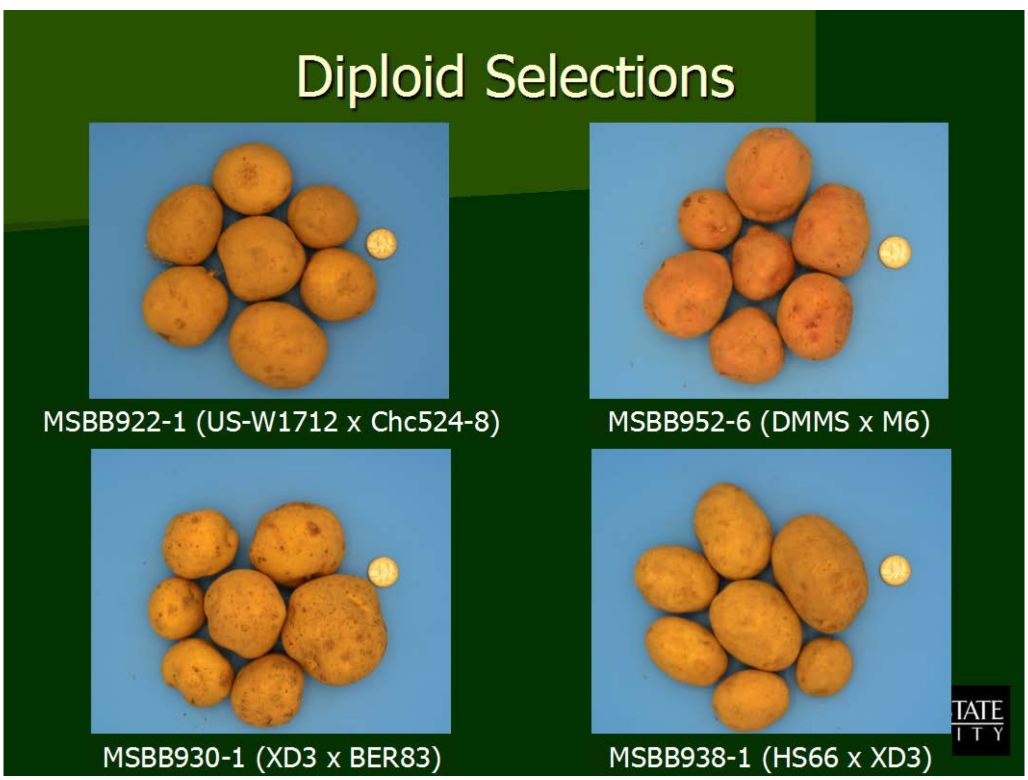
Since 2010 we developed four tetraploid genetic mapping populations and three diploid mapping populations) for late blight resistance, scab resistance, virus resistance and also for tuber quality traits. We have been characterizing these populations for their traits and have conducted the linkage analysis studies using the SNP fingerprinting array. The mapping populations have been a major research focus for us over the previous three 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.

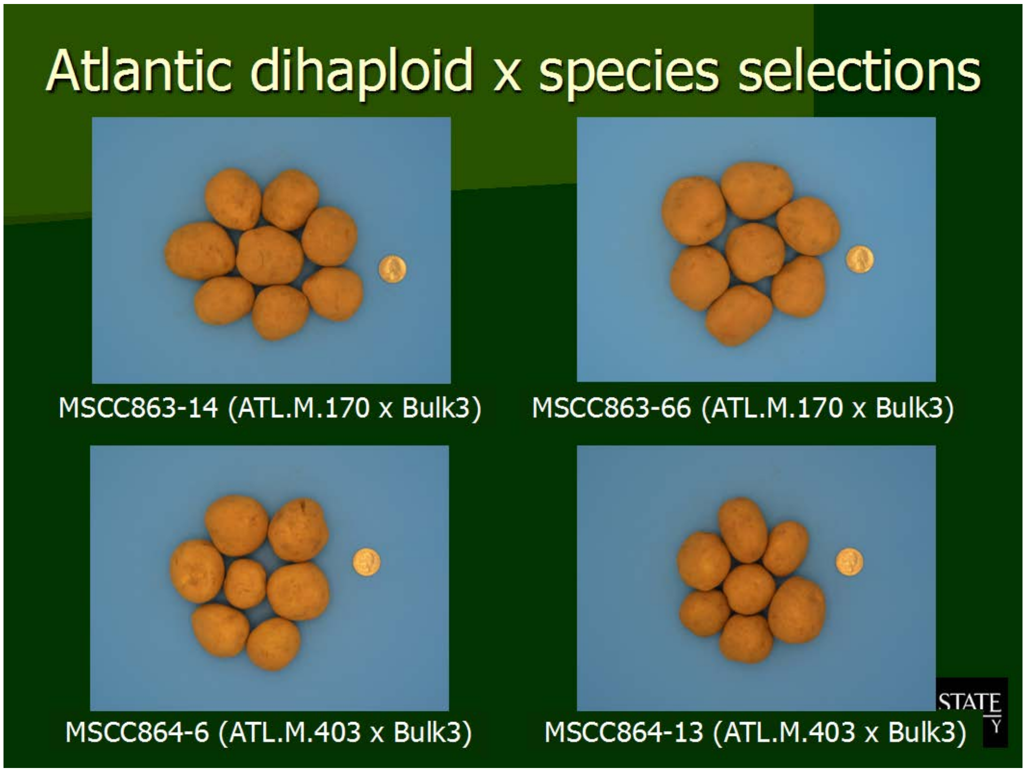
We are using PCR-based DNA markers to select potatoes resistant to PVY. The gene is located on Chromosome 11. We made crosses in 2013 to generate over 7,000 progeny segregating for PVY resistance. These crosses were planted in 2014 and 715 progeny were selected in the fall. DNA was isolated from those lines in the winter and 45% of the lines were positive for the DNA marker. In 2015 we planted these lines and selected 105 for further study. In the future we will continue to make more crosses to identify PVY resistant lines with commercial potential. We are also using DNA markers to also screen for PVX resistance, PLRV resistance, late blight resistance and Golden nematode resistance.



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 are cycling to make selections and we also selected Atlantic haploids (maternal progeny from Atlantic) to cross to this material 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. I am including some pictures to demonstrate the progress we have made in breeding diploid potatoes.

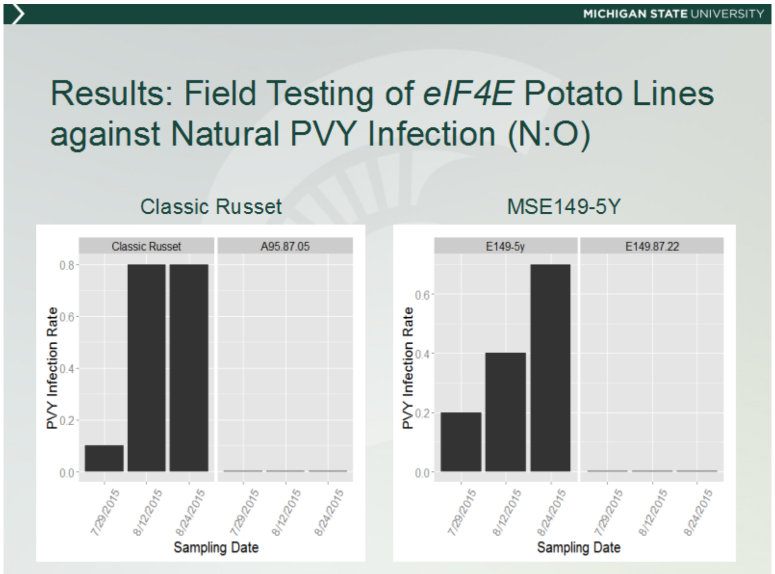
We have used lines with verticillium wilt resistance, PVY resistance, and cold chip-processing. We are monitoring the introgression of this germplasm through marker assisted selection. Through previous GREEEN funding, we were able to continue a breeding effort to introgress leptine-based insect resistance using new material selected from USDA/ARS material developed in Wisconsin. We will continue conducting field screening for resistance to Colorado potato beetle at the Montcalm Research Center. These lines are being used crosses to further transmit insect resistance.



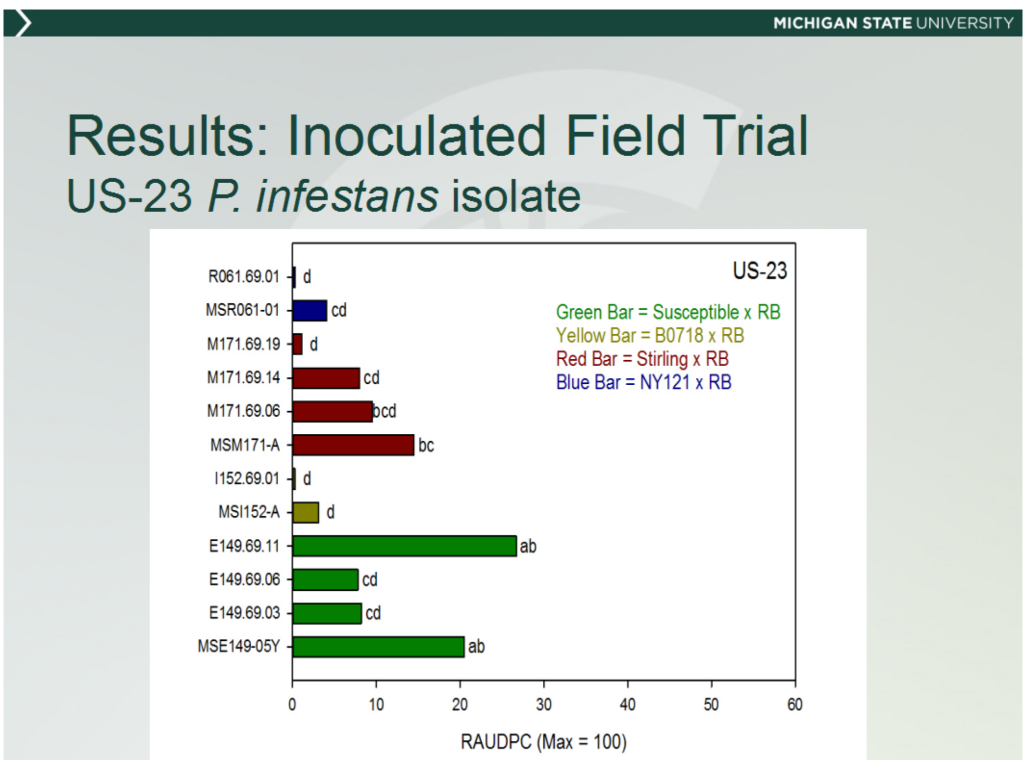


III. Integration of Genetic Engineering with Potato Breeding

PVY resistance to three PVY strains (O, N and NTN) of the MSE149-5Y, Classic Russet, Silverton Russet and Russet Norkotah lines were evaluated by Jonathan Whitworth over the past few years. A number of lines with PVY resistance were identified, seed produced and in 2015 we conducted a PVY resistance field test. In the inoculated field test at MSU the MSE149-5Y line was resistant to PVY as well as the Classic Russet line (see figure). We identified a number of Silverton Russet lines with increased PVY resistance but none with complete resistance to all three PVY strains. The Russet Norkotah lines were not highly resistant.



Regarding late blight resistance, we have many lines with the RB gene for late blight resistance transformed into MSU lines. The addition of the RB gene allows us to test the effect of multiple resistance genes on the strength of resistance. Our data supports the need to pyramid the late blight resistance R-genes to achieve the best levels of resistance (see figure).



We have also generated lines with the gene for nitrogen use efficiency (NUE) and water use efficiency (WUE). Field trials with reduced fertilizer and non-irrigated conditions were conducted for a subset of these lines in 2014 and 2015, for NEU and WUE, respectively. The best subset of lines will be re-tested in 2016. Lastly, we have some lines with the vacuolar acid invertase silencing that were field tested in 2014. There are three MSE149-5Y lines with good silencing that maintain low reducing sugars in 4C storage. We have generated a few Kalkaska invertase silencing lines and one line Kal91.03, seems to have resistance to accumulating reducing sugars in 40F storage. We plan to test the agronomic characteristics of Kal91.03 in 2016.

Funding: Fed. Grant/MPIC

2015 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 2015, we tested over 270 varieties and breeding lines in the replicated variety trials, plus over 170 lines in the National Chip Processing Trial (NCPT). The variety evaluation also includes disease testing in the scab nursery (Montcalm Research Center) and foliar and tuber late blight evaluation (Clarksville Research Center). The objectives of the evaluations are to identify superior varieties for fresh or chip-processing markets. The varieties were compared in groups according to market class, tuber type, skin color, and to the advancement in selection. We added a trial to focus on specialty market classes. Each season, total and marketable yields, specific gravity, tuber appearance, incidence of external and internal defects, chip color (from the field, 45°F (7.2°C) and 50°F (10°C) storage), as well as 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 Bruce Sackett, Aaron Yoder and the MSU Potato Breeding Team (especially N. Garrity, M. Alhashany, S. Islam, F. Enciso, and N. Kirkwyland) for getting the research done.

PROCEDURE

The field variety trials were conducted at the Montcalm Research Center in Entrican, MI. They were planted as randomized complete block designs with two to four replications. 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. The field experiments were conducted in a four-year rotation on a sandy loam soil on the Comden ground that was in corn the previous 3 years and in potatoes four years previously.

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 North Central, Russet, , Preliminary (chip-processors and tablestock), Preliminary Pigmented, Select Scab-Resistant MSZ-Lines, the NCPT and the early observational trials.

There were significant rains at the Montcalm Research Center in 2015 in the spring and the fall that flooding effected many plots, resulting in the loss of one or more replicate plots in various trials. The Preliminary Trials were some of the most effected, resulting in many single observation plots.

2015 was the fifth 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 in MN. For 2016, the scab trial will be conducted in Wisconsin instead of Minnesota.

In each of these trials, the yield was graded into four size classes, incidence of external and internal defects in >3.25 in. (8.25 cm) diameter (or 10 oz. (283.5 g) for Russet types) potatoes were recorded. Samples were taken for specific gravity, chip-processing, disease tests and bruising tests. Chip quality was assessed on 25-tuber composite sample from four replications, taking two slices from each tuber. Chips were fried at 365°F (185°C) for 2 minutes 15 seconds or until fully cooked. The chip color was measured visually with the SFA 1-5 color chart and a Hunter Colorimeter using crushed chips. 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. Advanced selections are also placed in the MPIC B.F. Burt Cargill Commercial Demonstration Storage in Entrican, MI for monthly sampling. 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 five years now. The 2015 late blight trial was conducted at the Clarksville Research Center. Maturity ratings (1 early - 5 late) were taken for all variety trial plots in late August to differentiate early and late maturing lines. The simulated blackspot bruise results for average spots per tuber have also been incorporated into the summary sheets.

RESULTS

A. Advanced and Chip-Processing Trial (Table 1)

A summary of the 33 entries evaluated in the trial results is given in **Table 1**. Overall, the yields for the Advanced trial (131 days) were average to above. The check varieties for this trial were Snowden, Atlantic, and FL1879. The highest yielding lines were NY154, MSV313-2, A01143-3C, and MSR127-2. Vascular discoloration and hollow heart were the predominant internal defects. Specific gravity was high with most lines above 1.080. All chip-processing entries in the trial had excellent chip-processing quality out of the field, with an SFA score of 1.0. Many of the MSU breeding lines have good scab resistance, including: MSR127-2, MSW509-5, MSW474-1, MSW394-1, and

MSV383-B.   MSR061-1 (late blight and PVY resistant) , MSX398-2, MSX540-4 (late blight and PVY resistant), and MSW360-18 (PVY resistant) showed resistance to late blight at the CRC trials. The promising MSU chip-processing lines are MSR127-2, MSV313-2, MSX540-4, MSV507-056, MSW509-5, and MSW474-1. MSR061-1 is being named Saginaw Chipper and is finding production in the Pacific Northwest.

B. North Central Regional Trial Entries (Table 2)

The North Central Trial is conducted in a wide range of environments (6 regional locations) to provide adaptability data for the release of new varieties from Michigan, Minnesota, North Dakota, Wisconsin, and Canada. The trial was reformatted to focus on table potatoes. The russet potato lines were included in the Russet trial. Twenty entries were tested in Michigan in 2015. The results are presented in **Table 2**. The reference varieties for this trial were Red Norland, Dark Red Norland, Red LaSoda, and Yukon Gold. The best performing MSU lines in the trial were MSV093-1Y, MST386-1P, and MSS576-5SPL. MSV093-1Y is a yellow-flesh tablestock line with high yield potential as seen in this trial and in on-farm trials. MSV093-1Y produces a high percentage of oversize tubers that with no internal defects moderate scab tolerance. Certified seed for this line is being produced in the greenhouse for larger commercial testing. Other MSU lines that looked promising were MSS576-5SPL (late blight resistant), MST386-1P (purple skin, white flesh, scab resistant) and MSX540-4 (scab and PVY resistant chipper). There are some promising red/purple-skinned entries from Minnesota, North Dakota, and Wisconsin. Yukon Gold had the highest incidence of internal defects with 70% hollow heart.

C. Russet Trial (Table 3)

We continue to increase our russet breeding efforts to reflect the growing interest in russet types in Michigan. In 2015, 20 lines were evaluated after 120 days. The results are summarized in **Table 3**. The Russet trial includes entries from the North Central Regional Trial (NCR). Russet Norkotah and Silverton Russet were the reference varieties used in the trial. In general, the yields were average for many russet lines while Russet Norkotah had a low yield. The highest yielding line was W10074-8Rus, however, it had 50% hollow heart. Reveille Russet (ATX91137-1Rus) and W94111-1Rus (NCR) were also high yielding this year and in 2014. There was incidence of hollow heart in W10074-8Rus, AW07791-2Rus, CO5068-1Rus, and MSW496-1Rus. Specific gravity measurements were average with Russet Norkotah at 1.072. Off type and cull tubers were found in nearly all lines tested, with the highest being W9742-3Rus and ND7882b-7Russ (NCR). Scab resistance was common among the lines but susceptibility was observed in a number of the russet lines. No late blight resistance was observed in these lines at the CRC trial.

D. Adaptation Trial (Table 4)

The Adaptation Trial of the tablestock lines was harvested after 123 days and the results are summarized in **Table 4**. The majority of the lines evaluated in the Adaptation

Trial were tested in the Preliminary Trial the previous year. Three reference cultivars (Reba, Red Norland, and Superior) and 20 advanced breeding lines are reported in the tablestock trial. In general, the yields were average and internal defects were low, but some lines had hollow heart incidence (MSW121-5R and Reba). The highest yielding lines were MSV093-1, MSW121-5R, MSW259-5, and MSW151-05. MSV093-1Y is an attractive yellow-fleshed table selection high yield potential and moderate scab tolerance. The challenge remains to combine scab and late blight resistance together. The lines with scab tolerance were MSV093-1Y, MSS576-5SPL, MSW075-1, MST252-1Y, MSW324-1P, and McBride. Other promising late blight resistant lines were MSW121-5R, MSW151-05, MSS576-5SPL, MSV396-4Y and MSV235-2PY. Although the yield was low in this trial, MSV235-2PY is an attractive specialty line with purple skin and a yellow flesh for the small potato market and has excellent late blight resistance. This line is being tested by Tasteful Selections.

E. Preliminary Trials (Tables 5, 6, 7, and 8)

The Preliminary trials (chip, table, pigmented, scab resistant Z-selections) are the first replicated 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 2015, there were 159 lines trialed in the three Preliminary trials.

The chip-processing Preliminary Trial (**Table 5**) had 68 entries was harvested after 123 days. Most lines chip-processed well from the field. Specific gravity values were average to high with Atlantic at 1.089 and Snowden at 1.084. Internal quality was predominantly hollow heart and vascular discoloration. Internal defects were lower than some years, with no hollow heart observed in Atlantic or Snowden. Promising MSU lines are MSX542-2, MST186-1Y, MSY008-3, MSX198-5, and MSX245-2Y combining yield, specific gravity, and chip quality. We continue to make progress selecting for chip-processing with scab resistance with 20 lines in the trial with scab ratings lower than Pike (1.5). We are also combing chip-processing quality and late blight resistance, with 9 selections demonstrating strong foliar late blight resistance, and 7 lines with moderate late blight resistance.

Table 6 summarizes 69 tablestock entries evaluated in the Preliminary Tablestock Trial. Reba and Superior were the check varieties. This tablestock trial was harvested and evaluated after 120 days. MSY111-1, QSMSU08-04, Soroya, VC1009-1W/Y, MSX156-1Y and MSV502-5 were the highest yielding lines. MSY111-1 combines high yield potential with scab resistance and good internal quality. This trial also had a low incidence of internal defects. The number of tablestock selections with scab resistance (21) and late blight resistance (13) continue to increase.

The interest in the specialty market continues to increase. A new trial was created to test 22 entries in a targeted Preliminary Pigmented Trial (**Table 7**), which was harvested at 123 days. This trial evaluated breeding lines with unique skin and flesh colors. These lines have commercial agronomic performance and specialty characteristics, as well as some scab and late blight resistances. The highest yielding lines were MSX517-3SPL (late blight resistant), Michigan Purple Sport I, MSZUNK-7, Dakota Ruby, and MSX507-1R (late blight resistant). Seven of the 22 lines also demonstrated scab resistance in the scab disease nursery.

A separate trial was conducted to evaluate select 'MSZ' chip-processing selections that were confirmed to be scab resistant over multiple years in on-farm testing under heavy scab disease pressure (**Table 8**). The trial had 47 entries, with Atlantic and Snowden as the reference varieties. The scab resistance in these clones have been evaluated on-farm. These selections combine agronomic performance, chip-processing quality, specific gravity, and scab resistance. There are over a dozen lines which have commercial promise and these lines were placed into tissue culture. The lines that are virus free are being seed increased. These include MSZ222-19 and three lines that also have PVY and late blight resistance: MSZ219-1, MSZ219-14 and MSZ219-46.

F. Potato Common Scab Evaluation (Tables 9 and 10)

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 five years. This location is being used for the early generation observational scab trial (479 lines) and the scab variety trial (230 lines).

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 2012-2014 scab ratings are based upon the Montcalm Research Center site. **Table 9** categorizes many of the varieties and advanced selections tested in 2015 over a three-year period. The varieties and breeding lines are placed into six 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% 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 (bolded in **Table 9**). The table is sorted in ascending order by 2015 scab rating. This year's results continue to indicate that we have been able to breed numerous lines with resistance to scab. A total of 71 lines, of the 230 tested, had a scab rating of 1.5 or lower in 2015. Most notable scab resistant MSU lines are MST386-1P, MSV092-2, MSX324-2R, MSX324-1P, MSU358-3, MSZ219-01, McBride, MSR061-1, MSR127-2, MSV301-2, MSV383-B, MSV179-1, MSW474-01, MSU379-1 and, MST252-1Y. The greater number of MSU lines in the resistant and moderately resistant categories indicates we are making progress in breeding more scab resistant lines for the chip-processing and tablestock markets.

Scab results from the disease nursery for the advanced selections are also found in the Trial Summaries (**Tables 1-8**).

There are also an increasing number of scab resistant lines that also have late blight resistance and PVY resistance such as MSR061-1, MSX540-4 and MSZ219-14. We also continue to conduct early generation scab screening on selections in the breeding program beginning after two years of selection. Of the 479 early generation selections that were evaluated, over 267 had scab resistance (scab rating of ≤ 1.5) (**Table 10**).

H. Late Blight Trial (Tables 11 and 12)

In 2015, the late blight trial was planted at the Clarksville Research Center. Over 250 entries were planted in early June for late blight evaluation. These include lines tested in a replicated manner from the agronomic variety trial (153 lines) and 114 entries in the early generation observation plots. The trials were inoculated in early August with the US-23 genotype of *P. infestans*. Late blight infection was identified in the plots within 2 weeks after inoculation. The plots were evaluated 1-2 times per week over a 50-day period following inoculation. In 2015 the replicated variety trial 62 lines had late blight resistance, while 41 lines in the early generation observation plots had late blight resistance. These were from various late blight resistance sources in the pedigree of the selections (LBR9, Malinche, Kenya Baraka, Monserrat, Torridon, Stirling, NY121, Tollocan, B0718-3, Chaposa, *S. bulbocastanum*, *S. microdontum*, Muruta, Muriranrara, Enfula, Perkoz, Basadre, etc.). Most notable lines with late blight resistance include MSR061-1, MSX540-4, MSZ219-01, MSZ219-14, MSS576-05SPL, MSW485-2, MSW121-2R and MSV235-2PY. **Tables 11 and 12** list the foliar late blight disease ratings for select lines based on percent disease over time (RAUDPC; Relative Area Under the Disease Progress Curve). Please note that because of the lower level of infection, our cutoff for resistance was a very low RAUDPC score so we did not include false positives.

I. Blackspot Bruise Susceptibility (Table 13)

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 13**. 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 2015 the bruise levels were higher than previous years. There are many lines with lower blackspot bruise potential across the trials. Some of our advanced selections are similar to Atlantic and Snowden is their level of bruising.

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

The United States Potato Board (USPB)-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 11 locations. Since the inception of the trial in 2010, over 900 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 North Carolina State University. More than 30 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 USPB/Snack Food Association trials. The data from all trials are available in a searchable, on-line database (https://potatoes.ncsu.edu/ncptsrch.php). We are using the NCPT trials to more effectively identify promising new selections. These are MSV301-2, MSV358-3, MSW485-2, MSW509-5, MSV030-4 and MSX540-4. Minituber production and/or commercial seed have been produced of these lines and will be tested in Michigan in 2015.

Table 1

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADVANCED CHIP-PROCESSING TRIAL
MONTCALM RESEARCH FARM
May 14 to September 22, 2015 (131 days)
DD Base 40°F 3130[8]

LINE	N	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	CHIP SCORE[2]	OTF SED[3]	PERCENT (%) TUBER QUALITY[4] HH	VD	IBS	BC	SCAB[5]	MAT[6]	BRUISE[7]	LB RAUDPC x100	3-YR AVG US#1 CWT/A
NY154	4	472	498	95	6	88	7	0	1.087	1.0	0.0	0	18	0	0	1.8	3.3	1.4	9.7	-
MSV313-2	3	452	461	98	1	53	45	1	1.082	1.0	1.0	0	13	0	0	-	4.0	2.2	-	-
A01143-3C	3	399	450	89	9	86	3	2	1.080	1.0	0.0	7	10	0	0	1.1	3.3	0.9	19.0	-
MSR127-2	4	380	402	95	5	72	23	1	1.084	1.0	0.0	3	8	0	0	1.3	3.8	1.7	-	395
CO02343-3W	4	371	395	94	6	62	32	1	1.076	1.0	2.0	3	5	0	0	2.5	3.3	1.0	22.9	-
Atlantic	**4**	**367**	**409**	**90**	**7**	**78**	**12**	**3**	**1.092**	**1.0**	**2.0**	**20**	**10**	**0**	**3**	**2.8**	**2.5**	**2.2**	**25.9**	**303**
MSV507-056	3	362	380	95	4	78	17	1	1.091	1.0	0.0	30	10	0	3	2.1	3.7	1.4	-	-
MSW509-5	3	362	399	90	9	75	16	1	1.082	1.5	4.0	0	43	0	0	1.4	2.7	0.8	19.6	-
MSV033-01	3	361	395	91	5	57	35	3	1.077	1.0	0.0	13	30	0	0	1.9	3.3	1.0	-	-
NY157	4	339	387	88	12	83	5	0	1.084	1.0	0.0	0	10	0	0	2.1	2.8	0.6	23.5	-
MSW474-01	3	331	424	78	22	77	1	0	1.085	1.0	1.0	0	3	0	0	1.0	3.0	2.0	-	-
AF4975-3	4	327	364	90	9	74	16	2	1.083	1.0	1.0	10	8	0	0	2.3	2.8	0.3	23.4	-
MSX398-2	3	325	342	95	5	81	13	0	1.078	1.0	1.0	0	7	7	0	2.0	3.0	0.8	0.2	-
MSR061-1	4	321	356	90	11	81	9	0	1.085	1.5	2.0	3	25	0	0	2.0	2.3	2.1	3.6	287
MSW394-1	4	320	349	91	8	84	7	1	1.077	1.0	1.0	0	25	0	0	1.5	2.5	1.5	10.8	-
MSV030-4	4	314	345	91	8	75	17	1	1.089	1.0	2.0	0	20	0	0	1.6	2.8	1.5	-	-
W5955-1	4	313	356	88	11	78	10	1	1.084	1.5	0.0	3	15	0	3	1.5	2.8	0.2	20.3	330*
AF4648-2	3	307	332	92	8	84	8	0	1.086	1.0	0.0	13	7	0	0	0.9	2.7	0.8	10.2	-
FL1879	**4**	**304**	**318**	**95**	**5**	**80**	**15**	**0**	**1.081**	**1.5**	**0.0**	**8**	**18**	**0**	**0**	**2.5**	**2.0**	**0.8**	**-**	**330**
NYK28-18	4	299	352	85	16	84	0	0	1.096	1.0	0.0	0	8	0	0	2.9	2.0	1.2	23.8	-
MSX540-4	4	296	326	91	5	72	19	4	1.088	1.0	1.0	0	33	0	3	2.0	3.8	2.8	4.6	-
Lamoka	3	295	321	92	7	85	7	1	1.084	1.0	0.0	0	10	0	0	1.8	2.7	0.6	21.4	299
Snowden	**3**	**292**	**353**	**83**	**15**	**77**	**6**	**2**	**1.087**	**1.0**	**1.0**	**0**	**27**	**0**	**0**	**2.8**	**2.3**	**1.6**	**18.0**	**275**
MSV358-3	3	291	341	85	8	73	12	6	1.081	1.0	0.0	0	3	0	0	1.6	2.0	0.6	-	-
MSV394-3	3	289	332	87	13	78	9	0	1.083	1.0	0.0	27	7	0	3	1.8	2.0	0.6	17.3	-
MSV393-1	3	269	332	81	19	80	1	0	1.082	1.0	1.0	7	7	0	0	1.8	3.3	0.9	20.0	-
MSV380-1	3	263	291	90	10	87	3	0	1.084	1.0	0.0	0	17	0	0	1.3	3.0	0.5	-	-
MSW163-03	2	258	273	94	3	73	22	3	1.079	-	-	5	0	5	0	1.4	3.0	-	18.9	-
MSV383-B	3	257	295	87	12	83	4	1	1.095	1.0	0.0	3	0	0	0	1.1	1.0	0.8	-	-
AF5320-1	3	246	314	78	19	74	4	3	1.081	1.0	0.0	7	23	0	0	1.1	2.3	0.2	23.2	-
MSW505-2	3	224	274	82	8	73	9	10	1.086	1.0	0.0	0	17	3	0	1.4	2.0	1.2	23.6	-
MSV440-6	3	122	152	57	43	55	2	0	1.066	2.0	0.0	0	3	0	0	2.1	2.0	-	-	-
MSW360-18	3	119	159	31	69	27	3	0	1.075	1.5	1.0	0	10	0	0	3.1	3.0	-	6	-
MEAN		310	348						1.083							1.8	2.7	1.1	16.6	315
$HSD_{0.05}$		135	131						0.006							1.4			10.8	

* Two-Year Average

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.
[2]CHIP SCORE: Snack Food Association 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 28, 2015; 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: 5/14/15
Vine Kill: 9/10/15
Days from planting to vine kill: 119

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

Table 2

NORTH CENTRAL REGIONAL TRIAL
MONTCALM RESEARCH FARM
May 14 to September 11, 2015 (120 days)
DD Base 40°F 3130[6]

										PERCENT (%)							LB	3-YR AVG
		CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]							RAUDPC	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]	x100	CWT/A
ND113300-3RSY	1	569	667	85	9	70	15	6	1.075	0	0	0	0	-	3.0	1.2	-	-
MSV093-1	1	437	467	94	4	62	32	2	1.076	0	0	0	0	1.7	3.0	0.4	16.9	-
Red LaSoda	**1**	**427**	**480**	**89**	**3**	**65**	**24**	**8**	**1.065**	**30**	**0**	**0**	**0**	**-**	**2.0**	**0.1**	**-**	**402***
MST386-1P	1	416	478	87	1	36	51	12	1.085	0	0	0	0	0.6	3.0	1.0	18.4	-
ND6961B-21PY	1	397	439	91	9	89	2	0	1.081	0	0	0	0	-	3.0	0.3	0.0	-
MSS576-5SPL	1	355	389	91	4	60	31	5	1.071	0	0	0	0	1.8	2.0	0.3	7.0	360
MN10003PLWR-06R	2	353	388	91	6	76	15	3	1.065	0	0	0	0	-	2.5	0.1	23.9	379*
Red Norland	**1**	**350**	**363**	**96**	**4**	**80**	**16**	**0**	**1.062**	**10**	**10**	**0**	**0**	**-**	**2.0**	**0.1**	**25.5**	**285**
MSX540-4^{PVYR}	1	336	397	85	10	79	5	6	1.090	0	0	0	0	2.0	3.0	2.0	4.6	325*
W10209-2R	1	329	401	82	18	79	3	0	1.070	0	0	0	0	-	1.0	0.4	21.6	-
Dark Red Norland	**1**	**329**	**374**	**88**	**11**	**80**	**8**	**1**	**1.063**	**10**	**0**	**0**	**0**	**-**	**1.0**	**0.2**	**-**	**-**
MSV235-2PY	1	328	395	83	16	83	0	1	1.077	0	0	0	0	2.6	1.0	0.2	0	-
Yukon Gold	**1**	**327**	**345**	**95**	**4**	**66**	**28**	**1**	**1.078**	**70**	**30**	**0**	**0**	**-**	**1.0**	**0.5**	**-**	**296***
ND7834-2P	1	322	362	89	10	89	0	1	1.076	0	0	0	0	-	1.0	0.0	-	-
MSW343-2R	2	316	337	94	6	84	10	0	1.059	0	5	0	0	-	1.5	0.1	-	-
ND7982-1R	1	275	387	71	26	71	0	3	1.073	0	0	0	0	-	1.0	0.6	-	-
W9432-4R	2	268	347	77	17	63	14	5	1.051	0	0	0	0	-	1.5	0.2	-	-
W10114-3R	1	254	297	85	8	45	40	7	1.058	0	0	10	0	-	3.0	0.1	-	-
MSX324-1P	1	242	313	77	20	74	3	3	1.083	0	0	0	0	1.1	1.0	0.6	19.2	-
ND7818-1Y	1	237	294	81	17	81	0	2	1.069	0	30	0	0	-	1.0	0.1	21.9	-
MEAN		343	396						1.071					1.6	1.9	0.4	14.5	322
$HSD_{0.05}$		NS	NS						0.025					1.4			10.8	

* Two-Year Average

[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 28, 2015; 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.

Plant Date: 5/14/14
Vine Kill: 9/10/14
Days from planting to vine kill: 119
[6]Enviroweather: Entrican Station. Planting to vine kill

Table 3

RUSSET TRIAL
MONTCALM RESEARCH FARM
May 14 to September 11, 2015 (120 days)
DD Base 40°F 3130[6]

LINE	N	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	PERCENT (%) TUBER QUALITY[2] HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]	LB RAUDPC x100	3-YR AVG US#1 CWT/A
W10074-8rus (NCR)	1	514	570	90	7	73	18	3	1.090	50	0	0	0	-	3.0	1.6	-	-
ATX91137-1Rus (Reveille Russet)	2	418	451	93	6	57	35	1	1.069	0	35	0	0	1.6	2.0	0.4	21.0	409*
W9433-1Rus	1	377	406	93	4	55	38	3	1.077	0	10	0	0	1.9	3.0	0.6	19.0	354*
W10043-1rus (NCR)	1	364	397	92	5	64	28	3	1.078	10	0	0	0	-	2.0	0.3	-	-
W9519-3Rus	1	354	388	91	9	86	5	0	1.069	0	10	0	0	1.1	2.0	-	22.0	-
ND7882b-7Russ (NCR)	1	338	451	75	9	39	36	17	1.076	0	0	0	0	-	2.0	0.8	15.4	275*
CW08071-2Rus	2	322	400	80	15	75	5	4	1.078	0	15	0	0	2.1	2.0	1.7	18.0	-
AW07791-2Rus	2	316	389	81	11	60	21	7	1.087	50	0	10	0	2.3	3.5	1.0	12.0	-
A01010-1 (Targhee Russet)	2	314	372	84	14	78	6	2	1.076	0	15	0	0	1.3	3.0	0.3	19.0	-
Silverton Russet	**2**	**291**	**310**	**94**	**6**	**77**	**17**	**0**	**1.070**	**0**	**40**	**0.0**	**0.0**	**0.9**	**2.0**	**0.4**	**23.0**	**340**
MSY573-3Rus	2	277	346	80	12	54	26	8	1.065	5	15	0	0	0.6	2.0	0.2	-	-
Russet Norkotah (NCR)	**1**	**274**	**323**	**85**	**15**	**61**	**24**	**0**	**1.072**	**10**	**0**	**10**	**0**	-	**2.0**	0.1	**21.9**	**-**
CO5068-1Rus	2	269	291	92	7	72	20	1	1.087	55	0	25.0	5.0	1.3	3.0	1.7	14.0	-
AFW5465-2rus (NCR)	1	263	318	83	8	60	23	9	1.067	0	0	0	0	-	2.0	0.8	-	-
AF3362-1Rus (Caribou Russet)	2	255	279	91	7	72	20	2	1.075	0	15	0.0	0.0	1.3	2.0	0.6	21.0	328*
AFW5472-1rus (NCR)	1	239	336	71	19	64	7	10	1.068	0	0	0	0	-	1.0	0.1	-	-
W9742-3Rus	2	226	316	72	6	55	18	22	1.096	5	30	0	0	2.0	2.0	-	19.0	-
MSW496-1Rus	2	213	269	80	10	51	29	10	1.068	30	10	0.0	0.0	2.0	4.0	1.2	-	-
Russet Norkotah	**2**	**170**	**259**	**65**	**35**	**63**	**2**	**0**	**1.070**	**0**	**25**	**0**	**0**	**2.1**	**1.0**	**0.3**	**22.0**	**161**
ND8068-5Rus	2	113	197	57	30	57	0	13	1.077	0	30	0	0	2.9	1.0	1.2	26.0	-
MEAN		295	353						1.076					1.7	2.2	0.7	19.5	250
$HSD_{0.05}$		225	248						0.012					1.4			10.8	

* 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 28, 2015; 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.

Plant Date: 5/14/15
Vine Kill: 9/10/15
Days from planting to vine kill: 119
[6]Enviroweather: Entrican Station. Planting to vine kill

Table 4

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADAPTATION TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 14 to September 14, 2015 (123 days)
DD Base 40°F 3130[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]							LB RAUDPC
LINE		US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]	x100
MSV093-1Y	3	491	533	92	7	76	16	1	1.073	3	0	0	3	1.7	3.0	0.4	16.9
MSW121-5R	1	430	467	92	8	82	10	0	1.068	40	30	30	0	2.6	3.0	nd	1.7
MSW259-5	3	429	447	96	4	71	25	0	1.079	17	7	3	0	2.5	3.0	1.1	14.6
MSW151-05	3	354	399	89	4	60	29	7	1.067	0	10	0	0	2.5	3.0	1.1	6.1
Reba	**3**	**353**	**371**	**95**	**5**	**71**	**24**	**0**	**1.074**	**20**	**7**	**0**	**0**	**2.1**	**2.7**	**1.4**	**21.4**
MSS576-5SPL	3	336	359	93	3	66	27	3	1.070	0	3	0	0	1.8	2.7	0.6	7.0
MSW239-03SPL	3	323	365	89	8	79	9	3	1.056	0	0	0	0	2.3	1.3	0.2	-
MSV179-1	3	321	338	95	3	59	36	1	1.060	0	7	0	0	1.9	2.7	0.5	23.3
Red Norland	**3**	**318**	**361**	**88**	**11**	**86**	**2**	**0**	**1.063**	**3**	**0**	**0**	**0**	**1.5**	**1.0**	**0.5**	**25.5**
MSW134-1	4	311	376	83	17	81	2	0	1.072	3	5	0	0	2.2	2.0	2.6	22.8
MSV434-1Y	3	297	336	88	11	77	11	1	1.073	7	3	7	0	1.9	2.7	1.1	-
Molli	3	297	381	78	17	75	3	5	1.068	0	20	0	0	2.3	2.0	0.9	18.0
Oneida Gold	3	294	333	88	12	87	1	0	1.079	0	3	0	0	1.8	2.3	0.8	19.2
MSW299-2	3	287	330	87	13	82	4	0	1.072	0	3	0	0	2.3	2.7	0.6	13.4
MSW075-1	3	280	368	76	24	76	1	0	1.081	0	17	0	0	1.6	2.3	1.4	-
Spartan Splash	4	272	313	87	13	81	6	1	1.072	0	10	0	0	2.0	1.5	0.7	-
MSV396-4Y	1	254	364	70	30	70	0	0	1.078	0	10	0	0	1.8	3.0	nd	9.4
Superior	**3**	**248**	**271**	**91**	**8**	**88**	**3**	**1**	**1.070**	**0**	**3**	**0**	**3**	**1.6**	**1.0**	**1.0**	**-**
MST252-1Y	3	245	320	76	16	68	8	8	1.069	0	17	0	7	1.5	1.3	0.7	-
McBride	4	239	276	87	12	77	10	1	1.080	3	8	0	0	1.1	2.0	0.4	-
MSX526-1	3	238	317	75	24	75	0	1	1.080	0	13	0	3	1.3	2.3	0.2	20.3
MSX324-1P	4	230	285	80	20	79	1	0	1.079	0	3	0	0	1.1	1.0	1.8	19.2
MSV235-2PY	3	189	262	72	23	72	0	5	1.075	0	10	0	0	2.6	1.0	2.3	0.0
MEAN		306	355						1.072					1.9	2.2	1.0	14.9
$HSD_{0.05}$		108	110						0.007					1.4			10.8

[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 28, 2015; 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.

Plant Date: 5/14/15
Vine Kill: 9/10/15
Days from planting to vine kill: 119
[6]Enviroweather: Entrican Station. Planting to vine kill

Table 5

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 14 to September 14, 2015 (123 days)
DD Base 40°F 3130[8]

		CWT/A		PERCENT OF TOTAL[1]						CHIP	OTF	PERCENT (%) TUBER QUALITY[4]							LB RAUDPC
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]	x100
MSX542-2	1	535	544	98	2	72	27	0.0	1.085	1.0	3.0	0	30	0	0	1.9	4.0	1.0	7.9
Dakota Diamond	1	504	516	98	2	69	28	0.0	1.084	1.5	3.0	20	10	0	0	2.1	3.0	1.0	-
MSV507-129	1	471	494	95	5	80	15	0.0	1.093	1.5	0.0	90	0	0	0	1.3	4.0	4.2	-
MST186-1Y	1	467	486	96	4	87	9	0.0	1.083	1.5	1.0	20	0	0	0	1.3	3.0	1.2	-
MSY008-3	2	455	490	93	8	84	10	0.0	1.079	1.5	1.0	0	5	0	0	1.5	3.5	0.9	14.7
Beacon Chipper	1	452	469	96	3	68	28	1.0	1.078	1.5	0.0	0	10	0	0	2.4	3.0	1.3	-
MSX198-5	1	445	474	94	5	79	15	1.0	1.079	1.0	3.0	0	20	0	0	2.5	2.5	0.3	0.5
MSX245-2Y	1	440	469	94	6	80	14	0.0	1.086	1.5	2.0	0	20	0	0	1.6	3.5	1.4	-
MSX196-1	1	432	437	99	1	68	31	1.0	1.072	1.5	1.0	0	0	0	0	1.4	3.0	0.4	15.0
MSY022-2	2	426	451	95	4	49	46	1.5	1.077	2.0	2.0	0	5	0	0	1.9	3.0	1.0	15.5
MSW399-2	1	413	478	86	14	84	3	0.0	1.087	1.5	2.0	0	10	0	0	1.9	4.0	2.3	9.2
MSZ280-7	1	383	392	98	2	70	28	0.0	1.078	1.5	2.0	90	0	0	0	1.8	2.0	1.3	-
MSZ222-19	1	370	402	92	8	80	12	0.0	1.091	1.0	1.0	10	0	0	0	1.3	2.5	0.8	-
MSZ057-5	1	368	391	94	6	67	27	0.0	1.075	-	-	30	0	0	0	2.6	3.0	-	8.6
MSX129-1	1	365	378	97	3	62	34	0.0	1.085	1.5	1.0	0	10	0	0	1.6	4.0	1.2	-
MSZ194-2	1	362	387	94	4	76	18	3.0	1.087	1.5	1.0	0	10	0	0	2.3	3.0	0.4	22.8
MSZ452-1	1	353	391	91	9	74	16	0.0	1.095	2.0	2.0	0	30	10	0	2.3	3.0	0.7	14.7
Atlantic	**1**	**349**	**372**	**94**	**6**	**88**	**6**	**0.0**	**1.089**	**1.5**	**3.0**	**0**	**20**	**0**	**0**	**2.8**	**2.5**	**1.0**	**25.9**
MSZ407-2Y	2	346	388	89	11	78	11	0.0	1.074	1.0	0.0	0	5	0	0	1.0	2.5	0.9	20.9
MSZ300-1	1	337	400	84	6	66	19	10.0	1.085	1.5	2.0	60	20	0	0	2.0	3.0	1.1	20.3
MSW064-1	1	328	346	95	5	90	5	0.0	1.082	1.5	1.0	0	0	0	0	1.4	4.0	1.2	9.2
MSX472-1	1	327	362	90	10	90	0	0.0	1.089	1.5	0.0	0	10	0	0	-	3.0	0.8	-
MSW464-3	1	319	330	97	3	84	13	0.0	1.082	1.5	1.0	0	0	0	0	1.9	3.5	0.5	0.3
MSW537-6	1	314	337	93	5	69	25	2.0	1.095	1.5	2.0	0	0	0	0	1.6	4.0	2.8	15.7
MSW248-02	1	312	340	92	6	62	29	3.0	1.087	1.5	1.0	10	0	0	10	2.0	3.5	0.4	-
MSX156-2	1	309	365	85	15	78	6	0.0	1.071	-	-	0	0	0	0	-	3.0	0.5	-
MSU383-A	2	306	334	93	7	77	15	1.5	1.074	1.0	4.0	20	40	5	0	1.1	2.0	1.1	20.3
MSW168-2	1	305	327	93	6	81	12	1.0	1.089	1.5	3.0	0	20	0	0	2.0	4.0	1.8	15.9
MSZ219-01	1	302	323	93	7	84	9	0.0	1.074	1.5	2.0	20	0	0	0	1.1	3.0	0.6	9.2
MSV335-1	1	300	318	94	6	69	25	0.0	1.077	1.0	0.0	10	10	0	0	1.8	2.0	1.2	-
MSW502-4	1	298	357	84	16	84	0	0.0	1.066	-	-	0	0	0	0	1.3	3.5	-	15.9
MSV241-2	1	295	347	85	9	73	12	6.0	1.088	-	-	50	0	0	0	1.5	1.5	-	-
MSW326-6	1	293	397	74	24	70	3	2.0	1.093	1.5	2.0	0	0	0	0	2.4	3.5	1.0	19.4
MSX221-2	1	293	318	92	8	88	4	0.0	1.080	1.5	2.0	0	10	0	0	1.9	4.0	2.8	18.2
MSZ025-5	1	287	312	92	8	92	0	0.0	1.091	1.0	1.0	0	10	10	0	2.0	3.5	0.8	-
MSZ159-3	2	282	387	73	25	69	5	2.0	1.081	1.0	0.0	0	10	0	0	1.9	2.0	1.3	-
MSX417-1	1	278	314	88	12	88	0	0.0	1.086	1.5	0.0	0	0	0	0	1.6	2.5	2.0	-
MSW485-2	1	276	369	75	25	73	1	0.0	1.089	1.5	2.0	0	30	0	0	2.0	3.0	0.3	6.7
MSX225-2	1	275	307	90	10	90	0	0.0	1.085	1.5	2.0	0	10	0	0	1.0	2.5	1.7	-
MSU379-1	1	272	284	96	4	82	14	0.0	1.081	1.5	2.0	0	0	20	0	1.3	2.0	1.4	20.5
MSV507-143	1	270	304	89	5	66	23	7.0	1.088	1.0	2.0	20	0	40	0	1.3	4.0	2.0	-
MSW294-1	1	266	334	80	20	80	0	0.0	1.097	-	-	0	0	0	0	2.1	2.0	-	-
MSW044-1	2	264	365	72	25	72	0	3.0	1.092	2.0	2.0	0	10	0	0	1.5	3.0	1.5	-
MSS164-1	1	262	306	86	14	86	0	0.0	1.088	1.5	1.0	0	0	0	10	1.3	2.0	0.4	0.2

Table 5

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 14 to September 14, 2015 (123 days)
DD Base 40°F 3130[8]

												PERCENT (%)							LB
		CWT/A		PERCENT OF TOTAL[1]						CHIP	OTF	TUBER QUALITY[4]							RAUDPC
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]	x100
MSV284-1	1	256	293	87	10	78	9	2.0	1.078	1.5	3.0	0	0	0	0	2.1	2.5	1.0	0.0
MSV092-2	2	255	277	92	9	87	5	0.0	1.086	-	-	0	0	0	0	0.9	3.0	0.7	-
MSV246-1	2	254	281	92	7	66	25	2.0	1.088	1.0	2.0	25	15	10	0	2.4	3.0	1.3	-
MSX472-2	2	254	336	75	25	68	8	0.0	1.081	-	-	0	0	0	5	1.6	2.0	-	9.5
Snowden	**1**	**254**	**308**	**83**	**17**	**83**	**0**	**0.0**	**1.084**	**1.0**	**1.0**	**0**	**10**	**0**	**0**	**2.8**	**2.5**	**1.6**	**18.0**
MSW164-2	1	250	281	89	11	89	0	0.0	1.076	-	-	0	0	0	0	2.5	2.0	-	-
MSZ507-2	2	248	323	77	22	73	4	2.0	1.083	1.0	0.0	0	15	0	0	2.5	1.5	1.2	2.4
MSX420-4Y	1	242	271	89	11	89	0	0.0	1.087	1.5	0.0	0	0	0	0	2.4	1.0	0.8	-
MSV307-2	1	236	282	84	16	84	0	0.0	1.085	1.0	2.0	0	10	0	0	1.8	1.5	1.0	-
MSW502-3	1	234	242	97	3	78	19	0.0	1.079	1.0	1.0	0	10	0	0	1.6	2.5	0.7	-
Pike	**1**	**225**	**266**	**84**	**12**	**84**	**0**	**3.0**	**1.089**	**1.0**	**0.0**	**0**	**0**	**0**	**0**	**1.5**	**2.5**	**0.8**	**22.5**
QSMSU10-15	1	224	287	78	20	70	8	2.0	1.092	1.0	1.0	0	10	0	10	1.6	2.0	0.8	21.0
MSY193-1	1	220	260	85	15	85	0	0.0	1.087	-	-	0	0	0	0	1.5	2.5	-	-
MSX495-2	1	212	271	78	17	76	3	5.0	1.084	1.0	0.0	0	20	0	0	1.8	1.5	0.8	23.4
MSX345-6Y	1	210	229	92	8	71	21	0.0	1.088	1.5	1.0	0	30	0	0	1.9	3.0	0.6	-
MSW509-1	1	206	343	60	40	57	4	0.0	1.081	-	-	0	20	0	0	1.6	2.5	-	-
MSZ119-1	1	202	278	72	28	72	0	0.0	1.081	1.0	0.0	0	0	0	0	2.1	2.0	0.8	-
MSW324-01	1	200	291	69	31	69	0	0.0	1.090	1.5	1.0	0	10	0	0	1.8	4.0	1.2	1.0
MSW100-1	1	189	296	64	36	64	0	0.0	1.086	-	-	0	40	0	0	1.1	2.5	-	3.1
MSZ282-6	1	185	211	88	12	88	0	0.0	1.077	-	-	0	0	0	0	1.4	2.0	-	-
MSW078-1	2	165	240	69	32	69	0	0.0	1.089	-	-	0	10	0	0	-	2.5	-	0.7
MSX410-12Y	1	158	281	56	44	56	0	0.0	1.086	1.5	0.0	0	0	0	0	1.8	1.5	0.9	-
MSZ157-3	1	135	192	70	30	70	0	0.0	1.073	-	-	0	0	0	0	2.3	1.5	-	4.1
MSW182-1Y	2	104	319	31	69	31	0	0.0	1.086	-	-	0	5	25	0	2.1	2.0	-	15.1
MEAN		300	346						1.084							1.8	2.7	1.1	12.4
$HSD_{0.05}$		245	273						0.029							1.4			10.8

[1]SIZE: B: < 2 in.; A: 2-3.25 in.; OV: > 3.25 in.; PO: Pickouts.
[2]CHIP SCORE: Snack Food Association 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 28, 2015; 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: 5/14/15
Vine Kill: 9/10/15
Days from planting to vine kill: 119

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

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 14 to September 10, 2015 (120 days)
DD Base 40°F 3130[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]							LB RAUDPC
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]	x100
MSY111-1	1	512	535	96	4	63	33	0	1.076	0	0	10	0	1.5	3.0	0.8	-
QSMSU08-4	1	475	494	96	4	85	11	0	1.082	0	20	0	0	1.8	2.0	0.4	22.8
Soraya	2	462	513	90	7	87	4	3	1.062	0	15	0	0	1.6	2.0	0.3	21.7
VC1009-1W/Y	2	456	495	93	6	74	19	2	1.072	15	0	0	0	2.3	4.0	0.5	12.5
MSX156-1Y	1	448	476	94	3	65	29	3	1.068	0	0	0	0	2.3	3.0	0.6	-
MSV502-5	2	439	452	97	3	75	22	1	1.076	5	0	0	5	1.9	3.0	0.5	-
MSW126-1	1	439	458	96	4	70	26	0	1.078	10	10	0	0	1.5	3.0	1.0	18.9
MSW236-3	1	433	451	96	4	74	22	0	1.078	10	0	0	0	2.8	3.0	0.6	18.5
MSW125-3	2	407	444	92	5	63	29	3	1.059	5	15	0	0	1.1	1.0	0.2	20.6
MST094-1	1	402	433	93	4	81	12	3	1.080	0	60	0	0	1.6	3.0	2.0	-
A05182-7Y	1	399	450	89	11	78	10	0	1.076	0	20	0	0	-	3.0	1.3	-
MSW353-3	2	371	389	95	5	84	12	0	1.076	0	45	0	0	0.9	2.5	0.3	17.6
Maris Bard	1	363	387	94	2	78	16	4	1.070	70	40	0	0	2.6	2.0	-	21.5
Granola	1	360	479	75	21	72	3	4	1.067	0	10	0	0	1.1	4.0	0.4	14.8
QSMSU10-02	2	359	384	94	5	72	22	2	1.074	0	5	0	0	1.4	1.0	0.7	1.9
MSX506-3	1	358	388	92	8	69	23	0	1.075	0	0	0	0	1.5	2.0	0.7	19.6
MSU016-2	1	348	374	93	7	85	8	0	1.090	10	0	0	10	2.1	3.0	1.3	5.6
MSY491-2Y	1	346	399	87	13	84	3	0	1.072	0	0	0	0	1.5	2.0	0.5	5.0
MSU161-1	1	344	370	93	7	86	7	0	1.075	0	0	0	0	2.3	3.0	1.1	6.5
MSW556-1	1	343	499	69	21	69	0	10	1.073	0	0	0	0	2.4	2.0	0.4	-
MST191-2Y	1	339	379	89	11	79	10	0	1.085	0	0	0	0	2.5	3.0	0.6	-
MSV111-1	1	339	395	86	14	82	4	0	1.073	0	10	0	10	1.4	2.0	0.0	15.2
MSW042-1	1	338	400	84	16	83	1	0	1.077	0	0	0	0	2.4	3.0	0.6	1.6
MST148-3	1	336	362	93	7	73	20	0	1.077	0	0	0	0	2.5	3.0	0.5	-
MSX137-6	2	336	374	90	10	87	3	0	1.073	0	10	5	0	1.8	1.5	1.1	22.6
W9577-6Y	1	326	379	86	14	82	4	0	1.075	0	0	0	0	2.1	4.0	0.2	18.9
MST145-2	1	320	408	79	10	62	17	11	1.074	0	0	0	0	-	3.0	0.9	-
Reba	**1**	**320**	**334**	**96**	**4**	**80**	**16**	**0**	**1.078**	**0**	**10**	**0**	**0**	**2.1**	**1.0**	**1.0**	**21.4**
MSV397-2	1	317	343	92	4	89	4	4	1.076	0	0	0	0	1.4	2.0	1.0	19.9
MSX009-2	1	309	365	85	15	80	4	0	1.083	0	10	0	0	1.9	3.0	1.7	11.3
MSW068-4	1	303	360	84	10	83	2	5	1.074	0	0	0	0	2.8	2.0	0.4	-
MSV127-1	1	301	332	91	9	91	0	0	1.088	0	20	0	0	2.1	2.0	1.7	-
W9576-13Y	1	300	328	91	7	73	18	2	1.072	0	0	0	0	1.4	2.0	0.2	22.5
MSX172-7	1	298	363	82	18	81	2	0	1.084	0	10	0	0	1.8	3.0	1.0	-
MSY042-1	1	296	330	90	6	73	16	4	1.079	0	10	0	0	1.8	3.0	0.6	-
CalWhite	**1**	**292**	**335**	**87**	**9**	**74**	**13**	**4**	**1.071**	**0**	**10**	**0**	**0**	**2.8**	**2.0**	**0.9**	**-**
MSX503-5	1	290	312	93	7	90	3	0	1.075	0	10	0	0	1.0	1.0	1.1	21.7
MST441-1	1	288	343	84	16	78	6	0	1.079	0	0	0	0	1.1	1.0	0.6	-
MSW123-3	2	288	310	92	5	61	32	3	1.062	0	0	0	10	1.3	1.5	0.5	18.6
MSU245-1	1	287	332	86	14	74	12	0	1.090	0	0	0	0	2.5	2.0	1.1	10.3
MSV301-2	1	284	310	92	6	64	27	2	1.080	20	0	0	0	1.5	3.0	0.4	24.3
A02267-1Y	1	283	342	83	14	77	6	3	1.060	0	40	0	0	2.0	3.0	0.5	17.0
MSV016-2	1	283	309	92	8	78	13	0	1.090	0	0	0	0	2.1	3.0	1.2	-
MSW437-9	1	279	308	90	10	85	6	0	1.070	0	0	0	0	2.6	2.0	0.4	17.7

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 14 to September 10, 2015 (120 days)
DD Base 40°F 3130[6]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]							LB RAUDPC
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]	x100
Barbara	1	277	382	73	22	71	2	5	1.076	10	50	0	0	1.0	3.0	1.1	17.4
MSW500-04	1	274	301	91	9	88	3	0	1.074	0	0	0	0	2.0	3.0	0.5	-
MSV282-4Y	1	273	316	86	14	81	5	0	1.083	0	0	0	0	2.1	2.0	1.6	0.0
MSV292-1Y	1	270	292	93	5	72	20	3	1.065	0	10	0	0	2.0	2.0	0.5	-
MSX293-1Y	1	269	329	82	18	82	0	0	1.079	0	0	0	0	1.6	2.0	0.8	0.6
MSW237-4Y	1	266	297	89	11	89	0	0	1.082	0	0	0	0	1.8	3.0	2.5	14.8
MSW270-1	1	265	337	79	21	79	0	0	1.074	0	0	0	0	1.9	1.0	0.4	-
W9576-11Y	1	251	314	80	19	77	4	1	1.058	0	10	0	0	1.4	1.0	0.3	23.4
MSW569-2	1	250	275	91	9	80	12	0	1.077	0	0	0	0	1.9	2.0	0.4	-
MSX497-6	2	245	264	93	7	93	0	0	1.069	0	0	0	0	2.9	2.0	0.3	1.6
MSY452-1	2	244	293	84	11	58	26	6	1.062	0	5	0	0	1.4	2.0	0.6	6.5
MSV089-2	1	243	277	88	12	82	6	0	1.077	0	0	0	0	1.8	2.0	0.9	-
MST229-1	1	233	258	90	10	84	6	0	1.081	0	10	0	0	1.8	3.0	1.5	-
Superior	**2**	**231**	**253**	**91**	**9**	**81**	**11**	**0**	**1.072**	**5**	**0**	**0**	**0**	**1.6**	**1.0**	**1.2**	**-**
MSW298-4Y	2	230	315	73	27	72	2	0	1.076	0	5	10	0	2.3	1.0	0.6	12.1
MSW119-2	2	228	283	81	20	78	3	0	1.075	0	5	0	0	1.1	2.5	0.6	13.0
MSX011-4	1	226	287	79	21	79	0	0	1.090	10	0	0	0	3.0	2.0	1.5	18.9
MSX010-3	2	208	264	79	21	77	2	0	1.078	0	0	0	0	2.5	1.5	1.2	24.6
MSW242-5Y	1	185	311	59	41	59	0	0	1.077	0	10	0	0	2.9	1.0	1.8	0.0
MSW500-10	2	177	221	76	24	74	2	0	1.072	5	5	0	0	-	2.0	0.2	22.8
CO07370-1W/Y	1	165	307	54	46	54	0	0	1.062	0	20	0	0	2.1	4.0	0.6	12.7
MSX255-1	1	153	245	62	38	62	0	0	1.089	0	10	0	0	1.4	2.0	0.5	22.4
MSY520-1	1	118	172	69	31	69	0	0	1.068	0	30	0	0	1.4	1.0	0.1	5.4
CO05037-3W/Y	1	95	181	53	47	53	0	0	1.073	0	10	0	0	2.0	1.0	0.4	26.7
MSW092-1	1	0	106	0	100	0	0	0	-	0	0	0	0	2.4	4.0	-	0.2
MEAN		301	349						1.075					1.9	2.3	0.8	14.6
$HSD_{0.05}$		NS	NS						0.009					1.4			10.8

[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 28, 2015; 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.

Plant Date: 5/14/15
Vine Kill: 9/10/15
Days from planting to vine kill: 119
[6]Enviroweather: Entrican Station. Planting to vine kill

Table 7

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, PIGMENTED LINES
MONTCALM RESEARCH FARM
May 14 to September 14, 2015 (123 days)
DD Base 40°F 3130[5]

		CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]						LB
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	RAUDPC x100
MSX517-3SPL	1	494	536	92	8	84	8	0	1.075	0	10	0	0	2.4	2.0	4.0
Michigan Purple Sport I	1	484	520	93	3	67	26	4	1.069	0	0	0	0	2.6	2.0	-
MSZUNK-7	1	399	423	94	5	62	33	0	1.048	0	0	0	0	1.6	2.0	21.0
Dakota Ruby	1	391	471	83	17	83	0	0	1.068	0	10	0	0	2.0	2.0	22.0
MSX507-1R	1	362	387	93	7	76	18	0	1.060	0	0	0	0	2.4	1.0	5.0
MSU198-01SPL	1	348	407	86	4	58	28	10	1.061	0	0	0	0	1.6	2.0	16.0
MST075-1R	1	348	382	91	9	91	0	0	1.069	0	0	0	0	1.9	2.0	24.0
MSX148-1WP	1	347	376	92	8	84	8	0	1.075	0	0	0	0	1.5	3.0	-
MSU202-1P	1	347	372	93	7	75	18	0	1.064	0	0	0	0	1.4	1.0	22.0
MSX569-1R	1	347	383	90	10	88	3	0	1.059	0	0	0	10	2.0	1.0	-
MSU316-3PY	1	313	362	86	14	86	0	0	1.060	0	10	0	0	1.8	2.0	20.0
MSZ107-6PP	1	306	365	84	16	81	3	0	1.074	0	0	0	0	1.8	2.0	-
Merlot	1	304	449	68	32	68	0	0	1.070	0	10	0	0	2.4	2.0	14.0
Red Norland	**2**	**297**	**322**	**92**	**8**	**88**	**4**	**0**	**1.060**	**5**	**5**	**0**	**0**	**1.5**	**1.0**	**26.0**
MSU616-3PP	1	277	350	79	21	77	2	0	1.069	10	0	0	0	2.0	1.0	-
MSY544-5R	1	262	355	74	23	74	0	3	1.062	0	0	0	0	2.0	1.0	-
MSX324-2R	1	229	255	90	7	87	2	3	1.070	0	10	0	0	1.0	2.0	19.0
MSY480-3RY	1	227	285	80	16	71	9	5	1.064	0	0	0	0	1.8	3.0	-
Purple Surprise 3	1	213	244	87	13	77	10	0	1.063	0	0	0	0	1.6	1.0	24.0
MSX001-4WP	1	175	201	87	13	82	6	0	1.064	0	0	0	0	1.8	1.0	22.0
CO07102-1R	1	168	229	73	27	73	0	0	1.059	0	0	0	0	2.6	1.0	27.0
MSZ109-07PP	1	130	208	62	38	62	0	0	1.059	0	0	0	0	1.4	3.0	-
MEAN		308	358						1.065					1.9	1.7	19.0
$HSD_{0.05}$		NS	NS						NS					1.4		10.8

[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 28, 2015; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]Enviroweather: Entrican Station. Planting to vine kill

Plant Date: 5/14/15
Vine Kill: 9/10/15
Days from planting to vine kill: 119

Table 8

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL: Scab resistant "MSZ" LINES
MONTCALM RESEARCH FARM
May 18 to September 16, 2015 (121 days)
DD Base 40°F 3048[6]

		CWT/A		PERCENT OF TOTAL[1]								PERCENT (%) TUBER QUALITY[2]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SFA OTF	SED OTF	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]
MSZ096-02	2	394	416	95	5	86	9	0	1.088	1.0	2.0	0	0	0	0	1.8	3.5	1.6
MSZ020-04	2	393	456	86	14	74	12	0	1.090	1.5	2.0	10	10	0	0	nd	0.0	0.7
MSZ045-09	2	362	399	91	7	71	19	2	1.074	1.0	1.0	10	10	0	0	1.5	4.0	0.2
MSZ118-02	2	354	416	85	15	84	1	0	1.089	1.0	2.0	0	0	10	0	nd	0.0	0.4
MSZ120-04	1	347	403	86	13	84	1	1	1.089	1.5	1.0	0	10	0	0	2.0	4.0	0.6
Atlantic	2	**333**	**370**	**89**	**11**	**87**	**2**	**0**	**1.095**	**1.5**	**0.0**	**10**	**5**	**10**	**0**	**2.8**	**2.0**	**1.8**
MSZ219-14	2	326	358	91	9	82	9	0	1.089	1.0	1.0	20	20	0	0	0.5	3.5	1.3
MSZ096-03	2	321	359	89	11	82	7	0	1.081	1.5	2.0	0	30	5	0	1.0	3.5	1.6
MSZ022-19	2	308	337	91	9	79	12	0	1.086	1.5	0.0	0	10	0	0	1.8	3.0	0.5
MSZ062-18	2	307	371	82	18	77	5	0	1.077	1.5	2.0	0	5	0	5	0.5	2.5	0.6
MSZ022-16	2	303	335	91	9	87	4	0	1.089	1.0	1.0	10	25	10	0	0.8	3.0	1.3
MSZ026-08	2	302	334	91	9	82	9	0	1.083	1.0	1.0	0	10	0	0	2.3	3.0	0.8
Snowden	2	**298**	**368**	**81**	**18**	**79**	**2**	**1**	**1.090**	**1.0**	**1.0**	**0**	**30**	**0**	**0**	**3.2**	**2.0**	**1.7**
MSZ062-31Y	2	291	353	83	17	81	1	0	1.073	1.0	1.0	0	0	0	0	1.0	3.0	0.6
MSZ219-29	2	280	298	94	6	89	5	0	1.079	1.0	0.0	10	25	5	0	0.5	2.0	1.2
MSZ219-46	2	273	279	98	2	69	29	0	1.087	1.5	4.0	10	15	0	0	0.3	3.0	0.7
MSZ052-13	2	271	306	88	12	87	1	0	1.089	1.0	1.0	0	15	0	0	0.3	2.5	1.8
MSZ118-19	2	269	302	89	11	78	11	0	1.093	1.0	2.0	0	15	0	0	0.5	3.0	2.2
MSZ062-50	2	266	294	91	9	75	16	0	1.089	1.0	1.0	0	5	0	0	0.5	4.0	1.8
MSZ022-07	2	263	301	87	13	84	3	0	1.083	1.0	1.0	10	10	0	0	0.8	2.0	0.8
MSZ101-07	2	251	301	83	15	76	7	2	1.086	1.0	2.0	15	5	0	0	2.0	3.5	1.1
MSZ022-14	2	248	281	88	12	82	6	0	1.079	1.5	3.0	0	5	0	0	1.0	3.0	0.8
MSZ020-08	2	244	265	92	8	91	1	0	1.082	1.0	0.0	0	5	0	0	0.5	2.0	0.6
MSZ052-31	2	231	242	95	5	93	2	0	1.083	1.0	1.0	5	0	20	5	0.5	2.5	0.8
MSZ062-06	2	231	276	84	14	74	10	3	1.082	1.0	0.0	10	0	5	0	1.3	3.0	0.8
MSZ020-10	2	231	259	89	11	72	17	0	1.087	1.5	0.0	15	10	0	5	2.5	2.5	0.7
MSZ101-06	2	218	288	76	24	75	1	0	1.081	1.0	1.0	0	0	0	0	2.0	3.0	0.8
MSZ242-03	2	209	276	76	23	75	1	1	1.094	1.0	2.0	5	5	5	0	0.8	2.5	0.5
MSZ052-14	2	206	262	78	22	74	4	0	1.085	1.0	2.0	0	15	0	0	1.0	3.0	1.6
MSZ118-08	1	203	302	67	33	67	0	0	1.088	1.0	2.0	0	0	0	0	0.5	3.0	0.4
MSZ103-02Y	2	198	233	85	15	80	5	1	1.087	1.5	2.0	0	5	0	0	1.0	2.5	1.2
MSZ242-15Y	2	197	223	87	13	82	5	0	1.093	1.5	0.0	10	0	0	0	0.8	2.5	1.0
MSZ242-14Y	2	193	227	84	15	83	1	1	1.083	1.5	1.0	0	0	0	0	1.3	1.5	0.3
MSZ062-42	2	181	230	82	17	76	6	1	1.084	1.5	3.0	0	5	0	0	0.5	2.5	0.5
MSZ242-13	2	179	220	81	19	78	3	0	1.100	1.0	0.0	0	5	0	0	0.8	3.0	1.0
MSZ242-09	2	170	227	75	25	70	5	0	1.093	1.0	1.0	0	10	0	0	1.3	2.0	0.8
MSZ222-15	2	166	212	77	20	74	3	3	1.078	1.5	1.0	5	0	0	0	1.0	2.5	0.8
MSZ242-12	2	164	208	78	20	74	4	2	1.092	1.0	0.0	5	0	5	0	1.5	3.0	1.4

Table 8

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL: Scab resistant "MSZ" LINES
MONTCALM RESEARCH FARM
May 18 to September 16, 2015 (121 days)
DD Base 40°F 3048[6]

		CWT/A		PERCENT OF TOTAL[1]								PERCENT (%) TUBER QUALITY[2]						
LINE	N	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SFA OTF	SED OTF	HH	VD	IBS	BC	SCAB[3]	MAT[4]	BRUISE[5]
MSZ052-40	2	151	216	69	30	69	0	1	1.092	1.0	1.0	0	5	0	0	1.0	3.0	0.8
MSZ222-18	2	147	237	62	25	58	4	12	1.069	0.0	0.0	55	0	0	0	2.0	3.0	-
MSZ242-07	2	137	149	93	7	72	21	0	1.101	1.5	0.0	0	5	0	0	1.5	3.0	0.9
MSZ062-10	2	137	162	85	15	79	6	0	1.092	1.0	1.0	0	10	10	0	0.5	2.5	0.3
MSZ169-01	2	125	137	90	9	78	12	2	1.077	1.0	3.0	0	15	0	0	0.8	3.5	0.1
MSZ052-11	2	113	210	54	43	54	0	3	1.082	1.0	1.0	0	15	0	0	0.8	2.0	0.3
MSZ062-46	2	110	209	51	49	51	0	0	1.081	1.0	1.0	0	5	0	5	1.0	2.0	0.5
MSZ118-20	2	103	179	53	47	53	0	0	1.081	1.5	0.0	0	0	0	0	0.8	2.5	0.4
MSZ052-38	2	80	87	92	6	85	7	2	1.085	1.0	1.0	0	15	10	0	0.5	3.5	-
MEAN		236	280						1.086							1.1	2.7	0.9
$HSD_{0.05}$		220	234						0.012							1.4		

[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: 2014 On Farm Scab Trial; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[4]MATURITY RATING: August 28, 2015; 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.

Plant Date: 5/18/15
Vine Kill: 9/10/15
Days from planting to vine kill: 115
[6]Enviroweather: Entrican Station. Planting to vine kill

Table 9

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2013-2015 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2015 RATING	2015 WORST	2015 N	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N
Sorted by ascending 2015 Average Rating;										
MST386-1P	0.8*	0.6	1.5	4	1.0	1.5	4	-	-	-
MSY573-3Rus	-	0.6	1.0	4	-	-	-	-	-	-
AF4648-2[PVYR]	-	0.9	1.0	4	-	-	-	-	-	-
MSV092-2	-	0.9	1.0	4	-	-	-	-	-	-
MSW353-3	-	0.9	1.0	4	-	-	-	-	-	-
Silverton Russet	**1.2**	**0.9**	**1.0**	**4**	**1.6**	**2.0**	**4**	**1.1**	**2**	**4**
Barbara	-	1.0	1.5	4	-	-	-	-	-	-
MSW474-01	-	1.0	1.5	4	-	-	-	-	-	-
MSX225-2	-	1.0	1.5	4	-	-	-	-	-	-
MSX324-2R	-	1.0	1.5	4	-	-	-	-	-	-
MSX503-5	-	1.0	2.0	4	-	-	-	-	-	-
MSZ407-2Y	-	1.0	1.5	4	-	-	-	-	-	-
A01143-3C	-	1.1	1.5	4	-	-	-	-	-	-
AF5320-1	-	1.1	1.5	4	-	-	-	-	-	-
Granola	0.9*	1.1	1.5	4	0.8	1.0	4	-	-	-
McBride	1.0	1.1	1.5	4	1.1	1.5	4	0.8	1.5	4
MST441-1	1.0*	1.1	1.5	4	0.9	1.5	4	-	-	-
MSU383-A	-	1.1	2.0	4	-	-	-	-	-	-
MSV081-04	-	1.1	1.5	4	-	-	-	-	-	-
MSV383-B	-	1.1	1.5	4	-	-	-	-	-	-
MSW100-1[LBR]	-	1.1	1.5	4	-	-	-	-	-	-
MSW119-2	-	1.1	1.5	4	-	-	-	-	-	-
MSW125-3	1.3*	1.1	1.5	4	-	-	-	1.4	1.5	4
MSX324-1P	-	1.1	2.0	8	-	-	-	-	-	-
MSZ219-01[PVYR]	-	1.1	1.5	4	-	-	-	-	-	-
MSZ263-4	-	1.1	1.5	4	-	-	-	-	-	-
W9519-3Rus	-	1.1	1.5	4	-	-	-	-	-	-
A01010-1 (Targhee Russet)	1.5*	1.3	2.0	4	-	-	-	1.75	2.5	4
AF3362-1Rus (Caribou Russet)	1.1*	1.3	1.5	4	1.0	1.0	4	-	-	-
CO5068-1Rus[LBMS]	1.3*	1.3	2.0	4	-	-	-	1.25	1.5	4
MSR127-2	1.2	1.3	1.5	4	1.4	2.0	4	1.0	1.5	4
MSS164-1[LBR]	1.3*	1.3	1.5	4	1.3	1.5	4	-	-	-
MST186-1Y	1.4*	1.3	1.5	4	1.6	2.0	4	-	-	-
MSU379-1	-	1.3	1.5	4	-	-	-	-	-	-
MSV380-1	1.1*	1.3	1.5	4	0.9	1.5	4	-	-	-
MSV507-129	1.1*	1.3	2.0	4	0.9	1.0	4	-	-	-
MSV507-143	-	1.3	1.5	4	-	-	-	-	-	-
MSW123-3	-	1.3	1.5	4	-	-	-	-	-	-
MSW502-4	-	1.3	1.5	4	-	-	-	-	-	-
MSX526-1	-	1.3	1.5	4	-	-	-	-	-	-
MSZ222-19	-	1.3	2.0	4	-	-	-	-	-	-
MSU202-1P	1.3*	1.4	1.5	4	1.1	1.5	4	-	-	-
MSV111-1[LBMR]	1.6	1.4	2.0	4	1.6	2.0	4	1.9	2	4
MSV397-2	-	1.4	2.0	4	-	-	-	-	-	-
MSW064-1	-	1.4	2.0	4	-	-	-	-	-	-
MSW163-03	-	1.4	1.5	4	-	-	-	-	-	-
MSW229-5P[LBR]	-	1.4	2.0	4	-	-	-	-	-	-
MSW505-2	-	1.4	1.5	4	-	-	-	-	-	-
MSW509-5	1.1*	1.4	2.0	4	-	-	-	0.8	1.5	4
MSX156-2	-	1.4	2.0	4	-	-	-	-	-	-
MSX196-1	-	1.4	2.0	4	-	-	-	-	-	-
MSX255-1	-	1.4	1.5	4	-	-	-	-	-	-
MSY452-1	-	1.4	1.5	4	-	-	-	-	-	-
MSY520-1	-	1.4	2.0	4	-	-	-	-	-	-
MSZ109-07PP	-	1.4	2.0	4	-	-	-	-	-	-
MSZ282-6	-	1.4	1.5	4	-	-	-	-	-	-
QSMSU10-02[LBR]	1.2*	1.4	1.5	4	1.0	1.0	4	-	-	-
W9576-11Y	-	1.4	1.5	4	-	-	-	-	-	-

2013-2015 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2015 RATING	2015 WORST	2015 N	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N
W9576-13Y	-	1.4	2.5	4	-	-	-	-	-	-
MST252-1Y	1.3	1.5	2.0	4	0.8	1.0	4	1.5	2	4
MSV241-2	-	1.5	2.0	4	-	-	-	-	-	-
MSV301-2	1.5*	1.5	2.0	4	1.5	2.0	4	-	-	-
MSW044-1	-	1.5	2.0	4	-	-	-	-	-	-
MSW126-1	-	1.5	2.0	4	-	-	-	-	-	-
MSW394-1	-	1.5	2.0	4	-	-	-	-	-	-
MSX148-1WP	-	1.5	2.0	4	-	-	-	-	-	-
MSX506-3	-	1.5	1.5	4	-	-	-	-	-	-
MSY008-3	-	1.5	2.0	4	-	-	-	-	-	-
MSY111-1	-	1.5	1.5	4	-	-	-	-	-	-
MSY193-1	-	1.5	2.0	4	-	-	-	-	-	-
MSY491-2Y	-	1.5	2.0	4	-	-	-	-	-	-
Pike	**1.4**	**1.5**	**1.5**	**4**	**1.3**	**1.5**	**4**	**1.4**	**2**	**4**
Red Norland	**1.6**	**1.5**	**2.0**	**8**	**1.4**	**2.0**	**9**	**2.0**	**2.5**	**4**
W5955-1	1.5	1.5	2.0	4	1.6	2.0	4	1.5	2	4
MSX472-2	-	1.6	2.0	8	-	-	-	-	-	-
ATX91137-1Rus (Reveille Russet)	1.4*	1.6	2.0	4	1.1	2.0	4	-	-	-
MST094-1	1.6*	1.6	2.0	4	1.6	2.0	4	-	-	-
MSU198-01SPL	-	1.6	2.0	4	-	-	-	-	-	-
MSV030-4	1.8*	1.6	2.0	4	1.9	2.0	4	-	-	-
MSV358-3	1.6*	1.6	2.0	4	1.5	2.5	3	-	-	-
MSV505-2	1.3*	1.6	2.0	4	0.9	1.0	4	-	-	-
MSW075-1	-	1.6	2.0	4	-	-	-	-	-	-
MSW502-3	-	1.6	2.0	4	-	-	-	-	-	-
MSW509-1	-	1.6	2.0	8	-	-	-	-	-	-
MSW537-6	-	1.6	2.0	4	-	-	-	-	-	-
MSX129-1	-	1.6	2.0	4	-	-	-	-	-	-
MSX245-2Y	-	1.6	2.0	4	-	-	-	-	-	-
MSX293-1Y[LBR]	-	1.6	2.0	4	-	-	-	-	-	-
MSX417-1	-	1.6	2.0	4	-	-	-	-	-	-
MSZUNK-7	-	1.6	2.0	4	-	-	-	-	-	-
Purple Surprise 3	-	1.6	2.0	4	-	-	-	-	-	-
QSMSU10-15	1.5	1.6	2.0	4	1.8	2.5	4	1.1	2	4
Soraya	-	1.6	2.0	4	-	-	-	-	-	-
Superior	-	**1.6**	**2.0**	**4**	-	-	-	-	-	-
MSV093-1[LBMR]	1.4	1.7	2.0	8	1.4	2.0	4	1.3	2	4
Lamoka	**1.6**	**1.8**	**2.0**	**4**	**1.5**	**2.0**	**4**	**1.5**	**2**	**4**
MSS576-05SPL[LBR]	1.8	1.8	2.5	4	1.6	2.0	8	2.2	2.5	8
MST229-1	-	1.8	2.0	4	-	-	-	-	-	-
MSU316-3PY	-	1.8	2.0	4	-	-	-	-	-	-
MSV089-2	-	1.8	2.0	4	-	-	-	-	-	-
MSV266-3P	-	1.8	2.0	4	-	-	-	-	-	-
MSV307-02	1.6*	1.8	2.0	4	1.5	2.0	4	-	-	-
MSV335-1	-	1.8	2.0	4	-	-	-	-	-	-
MSV393-1	-	1.8	2.0	4	-	-	-	-	-	-
MSV394-3	1.7*	1.8	2.0	4	1.6	2.0	4	-	-	-
MSV396-4Y[LBMR]	1.8*	1.8	2.0	4	1.8	2.5	4	-	-	-
MSW237-4Y	-	1.8	2.0	4	-	-	-	-	-	-
MSW324-01[LBR]	-	1.8	2.0	4	-	-	-	-	-	-
MSX001-4WP	-	1.8	2.0	4	-	-	-	-	-	-
MSX137-6	-	1.8	2.0	4	-	-	-	-	-	-
MSX172-7	-	1.8	2.5	4	-	-	-	-	-	-
MSX410-12Y	-	1.8	2.0	4	-	-	-	-	-	-
MSX495-2	-	1.8	2.0	4	-	-	-	-	-	-
MSY042-1	-	1.8	2.0	4	-	-	-	-	-	-
MSY480-3RY	-	1.8	2.0	4	-	-	-	-	-	-
MSZ107-6PP	-	1.8	2.0	4	-	-	-	-	-	-
MSZ280-7	-	1.8	2.0	4	-	-	-	-	-	-
NY154[LBMS]	1.7*	1.8	2.0	4	1.6	2.0	4	-	-	-

Table 9

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2013-2015 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2015 RATING	2015 WORST	2015 N	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N
Oneida Gold	-	1.8	2.5	4	-	-	-	-	-	-
QSMSU08-04	1.8	1.8	2.0	4	1.6	2.0	4	2.0	2.5	4
MST075-1R	-	1.9	2.5	4	-	-	-	-	-	-
MSV033-1	1.9*	1.9	2.0	4	2.0	2.5	4	-	-	-
MSV179-1	1.5*	1.9	2.0	4	-	-	-	1.1	1.5	4
MSV434-1Y	1.7*	1.9	2.0	4	1.5	2.0	4	-	-	-
MSV502-5	-	1.9	2.0	4	-	-	-	-	-	-
MSW270-1	-	1.9	2.0	4	-	-	-	-	-	-
MSW399-2	-	1.9	2.0	4	-	-	-	-	-	-
MSW464-3[LBR]	-	1.9	2.5	4	-	-	-	-	-	-
MSW569-2	-	1.9	2.5	4	-	-	-	-	-	-
MSX009-2	-	1.9	2.0	4	-	-	-	-	-	-
MSX221-2	-	1.9	2.5	4	-	-	-	-	-	-
MSX345-6Y	-	1.9	2.5	4	-	-	-	-	-	-
MSX542-2	-	1.9	2.0	4	-	-	-	-	-	-
MSY022-2	-	1.9	2.0	4	-	-	-	-	-	-
MSZ159-3	-	1.9	2.0	4	-	-	-	-	-	-
W9433-1Rus	1.6*	1.9	2.0	4	1.3	2.0	4	-	-	-
A02267-1Y	-	2.0	2.0	4	-	-	-	-	-	-
CO05037-3W/Y	-	2.0	2.0	4	-	-	-	-	-	-
Dakota Ruby	-	2.0	2.0	4	-	-	-	-	-	-
MSR061-1[LBMR,PVYR]	1.7	2.0	2.0	3	1.0	1.5	4	2.0	2	4
MSU616-3PP	-	2.0	2.5	4	-	-	-	-	-	-
MSV292-1Y	1.8*	2.0	2.5	4	-	-	-	1.5	2.5	4
MSW168-2	-	2.0	2.0	4	-	-	-	-	-	-
MSW248-02	-	2.0	2.5	4	-	-	-	-	-	-
MSW485-2	-	2.0	2.0	4	-	-	-	-	-	-
MSW496-1Rus	-	2.0	2.0	2	-	-	-	-	-	-
MSW500-04	-	2.0	2.5	4	-	-	-	-	-	-
MSX398-2[LBR]	-	2.0	2.5	4	-	-	-	-	-	-
MSX540-4[PVYR, LBR]	1.4*	2.0	2.5	4	0.9	1.0	4	-	-	-
MSX569-1R	-	2.0	2.0	2	-	-	-	-	-	-
MSY544-5R	-	2.0	2.0	4	-	-	-	-	-	-
MSZ025-5	-	2.0	3.0	4	-	-	-	-	-	-
MSZ030-4	-	2.0	2.0	4	-	-	-	-	-	-
MSZ300-1	-	2.0	2.5	4	-	-	-	-	-	-
Spartan Splash	2.2*	2.0	2.0	4	-	-	-	2.4	3	4
W9742-3Rus	-	2.0	3.5	4	-	-	-	-	-	-
BNC182-5	1.9*	2.1	2.5	4	1.6	2.0	4	-	-	-
CO07370-1W/Y	-	2.1	3.0	4	-	-	-	-	-	-
CW08071-2Rus	-	2.1	3.0	4	-	-	-	-	-	-
Dakota Diamond	2.1*	2.1	3.0	4	2.0	2.5	4	-	-	-
Manistee	2.4	2.1	2.5	4	1.9	2.0	4	3.3	3.5	4
MSS487-2[LBR]	2.7	2.1	3.0	4	2.6	3.0	4	3.3	3.5	4
MSU016-2	-	2.1	2.5	4	-	-	-	-	-	-
MSV016-2	-	2.1	2.5	4	-	-	-	-	-	-
MSV127-1	-	2.1	2.5	4	-	-	-	-	-	-
MSV282-4Y[LBR]	-	2.1	2.5	4	-	-	-	-	-	-
MSV284-1[LBR]	-	2.1	2.5	4	-	-	-	-	-	-
MSV440-6[LBMR]	2.3*	2.1	2.5	4	2.4	2.5	4	-	-	-
MSV507-056	2.3*	2.1	2.5	4	2.4	3.0	5	-	-	-
MSW182-1Y	2.4*	2.1	2.5	4	-	-	-	2.6	3	4
MSW294-1	-	2.1	2.5	4	-	-	-	-	-	-
MSZ119-1	-	2.1	2.5	4	-	-	-	-	-	-
NY157	-	2.1	2.5	4	-	-	-	-	-	-
Reba	**2.3**	**2.1**	**3.0**	**8**	**2.3**	**2.5**	**6**	**2.6**	**3**	**4**
Russet Norkotah	**2.1**	**2.1**	**2.5**	**4**	**1.8**	**2.5**	**7**	**2.5**	**3**	**4**
W9577-6Y	2.1*	2.1	2.5	4	2.0	2.0	3	-	-	-
MSW134-1	-	2.2	2.5	3	-	-	-	-	-	-
AF4975-3	-	2.3	3.0	4	-	-	-	-	-	-

Table 9

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POTATO BREEDING and GENETICS

2013-2015 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2015 RATING	2015 WORST	2015 N	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N
AW07791-2Rus	-	2.3	2.5	4	-	-	-	-	-	-
MSU161-1[LBMR, PVYR]	2.0*	2.3	2.5	4	1.8	2.0	4	-	-	-
MSW239-3SPL	2.3	2.3	3.0	4	2.4	3.0	4	2.3	3	4
MSW298-4Y	-	2.3	2.5	4	-	-	-	-	-	-
MSW299-2	-	2.3	2.5	4	-	-	-	-	-	-
MSX156-1Y	-	2.3	2.5	4	-	-	-	-	-	-
MSZ157-3[LBR]	-	2.3	3.0	4	-	-	-	-	-	-
MSZ194-2	-	2.3	2.5	2	-	-	-	-	-	-
MSZ452-1	-	2.3	2.5	4	-	-	-	-	-	-
VC1009-1W/Y	-	2.3	2.5	4	-	-	-	-	-	-
Molli	-	2.3	2.5	3	-	-	-	-	-	-
A05182-7Y	-	2.4	3.0	4	-	-	-	-	-	-
Beacon Chipper	2.1*	2.4	3.0	4	1.8	2.0	4	-	-	-
Merlot	-	2.4	3.0	4	-	-	-	-	-	-
MSV246-1	-	2.4	3.0	4	-	-	-	-	-	-
MSW042-1[LBR]	-	2.4	2.5	4	-	-	-	-	-	-
MSW092-1[LBR]	-	2.4	3.0	4	-	-	-	-	-	-
MSW326-6	-	2.4	3.0	4	-	-	-	-	-	-
MSW556-1	-	2.4	3.0	4	-	-	-	-	-	-
MSX420-4Y	-	2.4	3.0	4	-	-	-	-	-	-
MSX507-1R[LBR]	-	2.4	3.0	4	-	-	-	-	-	-
MSX517-3SPL[LBR]	-	2.4	3.0	4	-	-	-	-	-	-
CO02343-3W	-	2.5	3.0	4	-	-	-	-	-	-
FL1879	**2.5***	**2.5**	**3.0**	**4**	**2.5**	**3.0**	**4**	**-**	**-**	**-**
MST148-3	2.5	2.5	3.0	4	2.4	3.0	4	2.6	4	4
MST191-2Y	2.7*	2.5	3.0	4	2.9	3.0	4	-	-	-
MSU245-1	-	2.5	2.5	4	-	-	-	-	-	-
MSW151-05	-	2.5	3.0	4	-	-	-	-	-	-
MSW164-2	-	2.5	2.5	4	-	-	-	-	-	-
MSW259-5	-	2.5	3.0	4	-	-	-	-	-	-
MSX010-3	-	2.5	3.0	4	-	-	-	-	-	-
MSX198-5[LBR]	-	2.5	2.5	4	-	-	-	-	-	-
MSZ507-2[LBR]	-	2.5	3.0	4	-	-	-	-	-	-
CO07102-1R	-	2.6	3.0	4	-	-	-	-	-	-
Maris Bard	-	2.6	3.0	4	-	-	-	-	-	-
Michigan Purple Sport I	2.3	2.6	3.0	4	1.5	2.0	4	2.6	3	4
MSV235-2PY[LBR]	2.8	2.6	3.0	4	2.8	3.0	4	3.1	3.5	4
MSW121-5R[LBR]	-	2.6	3.5	4	-	-	-	-	-	-
MSW437-9	2.8*	2.6	3.0	4	-	-	-	2.8	3	4
MSZ057-5	-	2.6	3.0	4	-	-	-	-	-	-
CalWhite	-	2.8	3.5	4	-	-	-	-	-	-
MSW068-4	-	2.8	3.0	4	-	-	-	-	-	-
MSW236-3	-	2.8	3.5	4	-	-	-	-	-	-
Snowden	**2.8**	**2.8**	**3.5**	**8**	**2.6**	**3.0**	**8**	**3.1**	**3.5**	**12**
Atlantic	**2.8**	**2.8**	**3.5**	**8**	**2.6**	**3.0**	**8**	**3.2**	**3.5**	**12**
MSW242-5Y[LBR]	-	2.9	3.5	4	-	-	-	-	-	-
MSX497-6[LBR]	-	2.9	3.5	4	-	-	-	-	-	-
ND8068-5Rus	-	2.9	3.0	4	-	-	-	-	-	-
NYK28-18	-	2.9	3.5	4	-	-	-	-	-	-
MSX011-4	-	3.0	3.0	4	-	-	-	-	-	-
MSW360-18[PVYR]	-	3.1	3.5	4	-	-	-	-	-	-
$HSD_{0.05}$ =		**1.4**			**1.5**			**1.5**		

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 10

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2015 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSAA055-13	0.0	1	MSP239-1	MSV383-B
MSAA205-1	0.0	1	AO008-1TE	Silverton Russet
MSAA035-1	0.5	1	MSL007-B	MSR169-8Y
MSAA036-01	0.5	1	Manistee	MSR127-2
MSAA049-1	0.5	1	MegaChip	McBride
MSAA067-4	0.5	1	MSR061-1	MSR127-2
MSAA101-1RR	0.5	1	Adirondack Blue	Colonial Purple
MSAA103-1RR	0.5	1	Adirondack Blue	MSR214-2P
MSAA110-1	0.5	1	Colonial Purple	MSR217-1R
MSAA151-1	0.5	1	MSS544-1R	Colonial Purple
MSAA156-1	0.5	1	Spartan Splash	Colonial Purple
MSAA161-1PY	0.5	1	MST386-1P	MN02616RY
MSAA161-4RY	0.5	1	MST386-1P	MN02616RY
MSAA163-3	0.5	1	MST386-1P	MSR214-2P
MSAA203-2	0.5	1	AO008-1TE	Goldrush Russet
MSAA214-2	0.5	1	Elkton	Pike
MSAA313-2	0.5	1	Elkton	Lamoka
MSAA392-3	0.5	1	MSP239-1	McBride
MSAA481-1	0.5	1	MSS927-1	MSV241-2
MSAA498-18	0.5	1	MSV092-2	Elkton
MSAA502-3	0.5	1	MSV092-2	Manistee
MSAA507-10	0.5	1	MSV092-2	MSR127-2
MSAA571-4	0.5	1	MSV313-1	MSR169-8Y
MSAA720-1	0.5	1	Silverton Russet	A01124-3Rus
MSX245-2Y	0.5	1	Manistee	McBride
MSX324-1P	0.5	1	MSN105-1	Colonial Purple
MSY507-2	0.5	1	Superior	MSL211-3
MSY573-3Rus	0.5	1	Canela	Goldrush Russet
MSY713-1	0.5	1	MSS703-5	MCR150
MSY741-1	0.5	1	MSA133-16Y	MSP055-1Y
MSZ107-1PP	0.5	1	COMN07-W112BG1	MSR127-2
MSZ109-05RR	0.5	1	COMN07-W112BG1	MSU200-5PP
MSZ213-2P	0.5	1	MSQ279-1	Colonial Purple
MSZ223-2	0.5	1	MSR148-4	MSS297-3
MSZ412-2RR	0.5	1	Colonial Purple	MST406-2RR
MSZ427-3R	0.5	1	MSQ440-2	NDTX4271-5R
MSAA006-2	1.0	1	Beacon Chipper	Elkton
MSAA012-11	1.0	1	Beacon Chipper	MSR169-8Y
MSAA014-2	1.0	1	Beacon Chipper	MSS297-3
MSAA036-10	1.0	1	Manistee	MSR127-2
MSAA055-10	1.0	1	MSP239-1	MSV383-B
MSAA056-8	1.0	1	MSP270-1	McBride
MSAA072-2	1.0	1	MSR127-2	Lamoka
MSAA072-4	1.0	1	MSR127-2	Lamoka
MSAA076-15	1.0	1	MSR127-2	MSS297-3
MSAA076-06	1.0	1	MSR127-2	MSS297-3
MSAA076-07	1.0	1	MSR127-2	MSS297-3
MSAA081-1	1.0	1	MSR169-8Y	MSQ086-3
MSAA086-2	1.0	1	MSR169-8Y	W6609-3
MSAA100-1	1.0	1	Snowden	MSR061-1

2015 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSAA143-1	1.0	1	MSR606-2	MSL211-3
MSAA161-3RY	1.0	1	MST386-1P	MN02616RY
MSAA166-2P	1.0	1	MST386-1P	MSU200-5PP
MSAA170-3	1.0	1	MSU016-2	MSR157-1Y
MSAA194-2	1.0	1	MSW151-5	MSL211-3
MSAA208-1	1.0	1	AF4130-3	Lamoka
MSAA217-3	1.0	1	Beacon Chipper	Atlantic
MSAA228-1	1.0	1	CO22188-4W	MSR169-8Y
MSAA230-4	1.0	1	MSL007-B	McBride
MSAA241-1	1.0	1	MSM246-B	MSR127-2
MSAA242-2	1.0	1	MSM246-B	MSS297-3
MSAA250-1	1.0	1	NY140	MSR169-8Y
MSAA252-7	1.0	1	NY148	MSQ089-1
MSAA253-1	1.0	1	NY148	MSV241-2
MSAA253-2	1.0	1	NY148	MSV241-2
MSAA253-5	1.0	1	NY148	MSV241-2
MSAA254-4	1.0	1	MSP239-1	Lamoka
MSAA260-3	1.0	1	MSQ086-3	Atlantic
MSAA261-2	1.0	1	MSQ086-3	McBride
MSAA261-3	1.0	1	MSQ086-3	McBride
MSAA263-3	1.0	1	MSQ089-1	Lamoka
MSAA265-2	1.0	1	MSQ089-1	W6609-3
MSAA265-4	1.0	1	MSQ089-1	W6609-3
MSAA266-1	1.0	1	MSQ279-1	Manistee
MSAA271-5	1.0	1	MSS927-1	Lamoka
MSAA289-1	1.0	1	MSU379-1	MegaChip
MSAA290-2	1.0	1	MSU379-1	Tundra
MSAA311-3	1.0	1	Elkton	Atlantic
MSAA324-4	1.0	1	Boulder	Lamoka
MSAA328-06	1.0	1	Boulder	MSR169-8Y
MSAA342-11Y	1.0	1	MSJ042-3Y	MSR169-8Y
MSAA342-07Y	1.0	1	MSJ042-3Y	MSR169-8Y
MSAA376-1	1.0	1	NY148	MSQ086-3
MSAA376-3	1.0	1	NY148	MSQ086-3
MSAA392-5	1.0	1	MSP239-1	McBride
MSAA478-2	1.0	1	MSS927-1	Atlantic
MSAA481-2	1.0	1	MSS927-1	MSV241-2
MSAA498-17	1.0	1	MSV092-2	Elkton
MSAA498-07	1.0	1	MSV092-2	Elkton
MSAA498-09	1.0	1	MSV092-2	Elkton
MSAA502-5	1.0	1	MSV092-2	Manistee
MSAA507-11	1.0	1	MSV092-2	MSR127-2
MSAA509-2	1.0	1	MSV092-2	MSS165-2Y
MSAA523-1	1.0	1	MSV127-1	Lamoka
MSAA526-1	1.0	1	MSV127-1	MSS165-2Y
MSAA530-2	1.0	1	MSV158-2	McBride
MSAA570-15	1.0	1	MSV313-1	Lamoka
MSAA570-19	1.0	1	MSV313-1	Lamoka
MSAA578-4	1.0	1	MSV358-3	Pike
MSAA578-7	1.0	1	MSV358-3	Pike

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2015 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSAA588-3	1.0	1	MSV383-B	Lamoka
MSAA603-5	1.0	1	MSV434-4	Lamoka
MSAA678-1	1.0	1	W5015-12	Lamoka
MSAA690-2	1.0	1	W6609-3	Lamoka
MSAA708-1PP	1.0	1	Spartan Splash	MSU200-5PP
MSAA739-5	1.0	1	NYG86-1	MSS165-2Y
MSAA743-1	1.0	1	MSQ070-1	McBride
MSAA743-3	1.0	1	MSQ070-1	McBride
MSM269-1Y	1.0	1	84SD22	USDA8380-1
MSM270-BY	1.0	1	84SD22	W5337.3
Pike	**1.0**	**2**	**Allegany**	**Atlantic**
Purple Surprise	1.0	1		
MSQ341-BY	1.0	1	McBride	NY120
MSR127-2	1.0	1	MSJ167-1	MSG227-2
MSV383-B	1.0	1	Pike	MSN238-A
MSV407-2	1.0	1	MSQ070-1	MSP239-1
MSX105-1	1.0	1	Dakota Crisp	McBride
MSX172-7	1.0	1	McBride	Nicolet
MSX225-2	1.0	1	MSK061-4	Nicolet
MSX469-2	1.0	1	MSQ070-1	
MSX472-2	1.0	1	MSQ070-1	MSP292-7
MSX501-5	1.0	1	MSQ176-5	McBride
MSX503-5	1.0	1	MSQ176-5	MSL268-D
MSY027-2	1.0	1	MST096-2Y	Pike
MSY041-1	1.0	1	Dakota Diamond	MSP368-1
MSY044-1	1.0	1	MSK061-4	MST096-2Y
MSY111-1	1.0	1	MSQ086-3	McBride
MSY468-16	1.0	1	NYL235-4	MSL211-3
MSY480-3RY	1.0	1	MN96013-1RY	MSS544-1R
MSY520-1	1.0	1	MSQ440-2	MSN105-1
MSZ097-1	1.0	1	Boulder	Lamoka
MSZ109-10PP	1.0	1	COMN07-W112BG1	MSU200-5PP
MSZ144-04Y	1.0	1	M5	McBride
MSZ172-3	1.0	1	MSP270-1	W6609-3
MSZ205-1	1.0	1	MSQ070-1	MSU383-A
MSZ218-5	1.0	1	MSR061-1	MSQ086-3
MSZ246-1	1.0	1	Snowden	Dakota Diamond
MSZ248-02	1.0	1	Snowden	MSV229-2
MSZ251-1	1.0	1	MSS070-B	Lamoka
MSZ263-4	1.0	1	MSU088-1	McBride
MSZ282-6	1.0	1	MSV502-3	Kalkaska
MSZ407-2Y	1.0	1	Montanosa	Colonial Purple
MSZ413-6P	1.0	1	Colonial Purple	MSU200-5PP
MSZ416-8RY	1.0	1	MSN230-1RY	NDTX4271-5R
MSZ427-1R	1.0	1	MSQ440-2	NDTX4271-5R
MSZ436-2SPL	1.0	1	MSS576-05SPL	MSQ440-2
MSZ464-3	1.0	1	MSQ070-1	Alca Tarma
MSZ571-3R	1.0	1	NDTX4271-5R	Colonial Purple
MSZ590-1	1.0	1	Superior	Picasso
MSZ609-1P	1.0	1	386056.17	Colonial Purple

2015 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSZ622-1	1.0	1	Satina	MSL211-3
MSZ709-01Y	1.0	1	MSM269-HORG	84SD22
MSZ744-1	1.0	1	MSM185-1	MSP091-1
McBride	1.1	4	Penta	OP
MSAA003-6	1.5	1	Atlantic	MSS165-2Y
MSAA011-1	1.5	1	Beacon Chipper	MSR159-2
MSAA012-01	1.5	1	Beacon Chipper	MSR169-8Y
MSAA034-2	1.5	1	MSL007-B	MSR127-2
MSAA036-03	1.5	1	Manistee	MSR127-2
MSAA036-07	1.5	1	Manistee	MSR127-2
MSAA036-09	1.5	1	Manistee	MSR127-2
MSAA055-01	1.5	1	MSP239-1	MSV383-B
MSAA056-5	1.5	1	MSP270-1	McBride
MSAA061-7	1.5	1	Pike	MSS297-3
MSAA072-5	1.5	1	MSR127-2	Lamoka
MSAA076-04	1.5	1	MSR127-2	MSS297-3
MSAA079-5	1.5	1	MSR169-8Y	Lamoka
MSAA083-4Y	1.5	1	MSR169-8Y	MSS165-2Y
MSAA091-1	1.5	1	MSS165-2Y	Lamoka
MSAA127-1	1.5	1	Purple Heart	MSV200-5PP
MSAA127-7	1.5	1	Purple Heart	MSV200-5PP
MSAA131-2	1.5	1	MSQ341-BY	MSQ176-5
MSAA139-1	1.5	1	MSR214-2P	Purple Heart
MSAA144-4	1.5	1	MSR606-2	MSQ086-3
MSAA168-1	1.5	1	MSU016-2	MSL211-3
MSAA168-3	1.5	1	MSU016-2	MSL211-3
MSAA169-3	1.5	1	MSU016-2	MSQ086-2
MSAA173-2	1.5	1	MSU161-1	MSQ086-3
MSAA176-3	1.5	1	MSU161-1	MSU016-2
MSAA177-3	1.5	1	MSU161-1	MSW126-1
MSAA182-3R	1.5	1	MSU200-5PP	MSS544-1R
MSAA185-1Y	1.5	1	MSV205-4	MSL211-3
MSAA196-1	1.5	1	MSW151-5	MSQ440-2
MSAA233-2	1.5	1	Lamoka	Pike
MSAA237-1	1.5	1	Lelah	MSR169-8Y
MSAA244-1	1.5	1	Missaukee	Lamoka
MSAA255-03	1.5	1	MSQ035-3	Lamoka
MSAA257-1	1.5	1	MSQ070-1	MSR127-2
MSAA260-2	1.5	1	MSQ086-3	Atlantic
MSAA267-2	1.5	1	MSQ279-1	Lamoka
MSAA275-5	1.5	1	Snowden	MSS297-3
MSAA283-2	1.5	1	Tundra	MSR127-2
MSAA309-15	1.5	1	Atlantic	Lamoka
MSAA311-1	1.5	1	Elkton	Atlantic
MSAA315-1	1.5	1	Beacon Chipper	McBride
MSAA328-11	1.5	1	Boulder	MSR169-8Y
MSAA328-04	1.5	1	Boulder	MSR169-8Y
MSAA328-09	1.5	1	Boulder	MSR169-8Y
MSAA335-7	1.5	1	CO00188-4W	Elkton
MSAA335-9	1.5	1	CO00188-4W	Elkton

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2015 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSAA372-3	1.5	1	NY140	Lamoka
MSAA373-3	1.5	1	NY148	McBride
MSAA468-4	1.5	1	MSR297-A	MSQ086-3
MSAA470-6	1.5	1	MSR297-A	W6609-3
MSAA474-8	1.5	1	MSS297-3	MSR127-2
MSAA498-01	1.5	1	MSV092-2	Elkton
MSAA498-11	1.5	1	MSV092-2	Elkton
MSAA503-2	1.5	1	MSV092-2	Lamoka
MSAA689-2	1.5	1	W6609-3	McBride
MSAA741-3	1.5	1	MSQ035-3	McBride
MSAA745-1	1.5	1	MSQ086-3	Kalkaska
ARS102400-2CPB	1.5	1		
MSL517-6	1.5	1	Atlantic	8380-1 chc, 4x
MSS543-2	1.5	1	Boulder	MSK214-1R
MST154-3	1.5	1	MSJ033-10Y	McBride
MSW111-1	1.5	1	MSL505-3	MSR061-1
MSW485-2	1.5	1	MSQ070-1	MSR156-7
MSX035-WP	1.5	1	Beacon Chipper	ARS10091WP
MSX042-3	1.5	1	Beacon Chipper	NY121
MSX142-2	1.5	1	Eva	MSQ176-5
MSX221-2	1.5	1	MSK061-4	MSR036-5
MSX255-1	1.5	1	MSM171-A	ARS10342-4
MSX506-3	1.5	1	MSQ176-5	MSR169-8Y
MSY022-2	1.5	1	MSS176-1	MST096-2Y
MSY042-1	1.5	1	MSJ147-1	Nicolet
MSY089-2	1.5	1	MSS176-1	B2731-2
MSY156-2	1.5	1	MSK061-4	Kalkaska
MSY434-1Y	1.5	1	Reba	MSQ440-2
MSY452-1	1.5	1	MSQ176-5	MSL211-3
MSY483-3	1.5	1	MSL505-3	MSN105-1
MSY517-8YSPL	1.5	1	Spartan Splash	Bison
MSY728-1	1.5	1	523-3-S7	84SD22
MSY733-1	1.5	1	MSL316-EY	84SD22
MSZ004-1	1.5	1	Atlantic	MSL211-3
MSZ063-02	1.5	1	MSR148-4	McBride
MSZ063-07Y	1.5	1	MSR148-4	McBride
MSZ069-11	1.5	1	Snowden	MSS297-3
MSZ092-2	1.5	1	Elkton	MSQ086-3
MSZ109-08PP	1.5	1	COMN07-W112BG1	MSU200-5PP
MSZ119-1	1.5	1	Kalkaska	M5
MSZ144-10Y	1.5	1	M5	McBride
MSZ189-3	1.5	1	Pike	MSS297-3
MSZ200-3	1.5	1	MSQ070-1	Lamoka
MSZ200-6	1.5	1	MSQ070-1	Lamoka
MSZ215-2	1.5	1	MSR058-1	MSQ086-3
MSZ268-1	1.5	1	MSU278-1Y	Pike
MSZ269-17	1.5	1	MSU278-1Y	MSR127-2
MSZ269-18	1.5	1	MSU278-1Y	MSR127-2
MSZ296-1Y	1.5	1	W6609-3	MSR127-2
MSZ407-7	1.5	1	Montanosa	Colonial Purple

2015 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSZ428-1PP	1.5	1	MSQ461-2PP	MSS544-1R
MSZ433-3P	1.5	1	MSS483-1	MSU200-5PP
MSZ437-9RR	1.5	1	MSS576-05SPL	MST406-2RR
MSZ443-1PP	1.5	1	MSU200-5PP	NDTX4271-5R
MSZ513-2	1.5	1	MSL268-D	MSL211-3
MSZ537-4	1.5	1	MSL211-3	Chaposa
MSZ551-1	1.5	1	MSM182-1	MSL268-D
MSZ552-2P	1.5	1	MSM182-1	Colonial Purple
MSZ578-1Y	1.5	1	Nicola	Santa Ana
MSZ598-2	1.5	1	MSS576-05SPL	Superior
MSZ615-2	1.5	1	Sieglinde	MSL211-3
MSZ620-3	1.5	1	Muziranzara	MSL211-3
MSZ708-6	1.5	1	MSL316-EY	84SD22
MSZ709-03Y	1.5	1	MSM269-HORG	84SD22
MSZ709-04	1.5	1	MSM269-HORG	84SD22
MSZ749-3	1.5	1	MSP102-5	MSL505-3
MSZ502-7PP	1.5	1		
Manistee	1.8	5	Snowden	H098-2
MSAA014-1	2.0	1	Beacon Chipper	MSS297-3
MSAA018-2	2.0	1	MSJ147-1	Atlantic
MSAA057-2	2.0	1	MSP270-1	Lamoka
MSAA058-1	2.0	1	MSP270-1	MSS165-2Y
MSAA073-4	2.0	1	MSR127-2	MSM246-B
MSAA077-1	2.0	1	MSR169-8Y	AF4130-3
MSAA079-7Y	2.0	1	MSR169-8Y	Lamoka
MSAA079-8Y	2.0	1	MSR169-8Y	Lamoka
MSAA085-1	2.0	1	MSR169-8Y	MSV383-B
MSAA157-3PYPSpl	2.0	1	Spartan Splash	Purple Heart
MSAA168-8	2.0	1	MSU016-2	MSL211-3
MSAA169-6	2.0	1	MSU016-2	MSQ086-2
MSAA172-5	2.0	1	MSU016-2	MSV198-2Y
MSAA174-1	2.0	1	MSU161-1	MSQ440-2
MSAA193-3	2.0	1	MSW111-1	MSS297-3
MSAA196-6	2.0	1	MSW151-5	MSQ440-2
MSAA211-3	2.0	1	Atlantic	Kalkaska
MSAA218-5	2.0	1	Beacon Chipper	MSV313-1
MSAA231-1	2.0	1	Lamoka	Kalkaska
MSAA232-4	2.0	1	Lamoka	Manistee
MSAA240-3	2.0	1	MSM246-B	MSQ086-3
MSAA240-5	2.0	1	MSM246-B	MSQ086-3
MSAA252-1	2.0	1	NY148	MSQ089-1
MSAA255-10	2.0	1	MSQ035-3	Lamoka
MSAA256-3	2.0	1	MSQ070-1	Lamoka
MSAA267-4	2.0	1	MSQ279-1	Lamoka
MSAA277-3	2.0	1	Snowden	W6609-3
MSAA294-3	2.0	1	Accumulator	MSR127-2
MSAA342-02	2.0	1	MSJ042-3Y	MSR169-8Y
MSAA342-03	2.0	1	MSJ042-3Y	MSR169-8Y
MSAA460-2Y	2.0	1	MSR159-2	MSS165-2Y
MSAA472-1	2.0	1	MSS165-2Y	MSV358-3

Table 10

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SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2015 RATING	2015 N	FEMALE	MALE
Sorted by ascending 2015 Rating;				
MSAA513-1	2.0	1	MSV117-1	Lamoka
MSAA523-2	2.0	1	MSV127-1	Lamoka
MSAA541-4	2.0	1	MSV198-2Y	Pike
MSAA556-2	2.0	1	MSV284-1	McBride
MSAA556-3Y	2.0	1	MSV284-1	McBride
MSAA556-4Y	2.0	1	MSV284-1	McBride
MSAA570-03	2.0	1	MSV313-1	Lamoka
MSAA571-3Y	2.0	1	MSV313-1	MSR169-8Y
MSAA725-3	2.0	1	BNC182-5	MSS165-2Y
MSAA739-1	2.0	1	NYG86-1	MSS165-2Y
MSAA742-6	2.0	1	MSQ035-3	MSR127-2
Barbara	2.0	1		
Chloe Anwd	2.0	1		
MSL007-B	2.0	1	MSA105-1	MSG227-2
LT-7	2.0	1		
MSQ558-2RR	2.0	1	Rose Gold	POORPG2-16
MSR061-1	2.0	1	W1201	NY121
MSR186-3P	2.0	1	MN19525R	MSK034-1
MSS805-8	2.0	1	Atlantic	Mcr1-150
MSW128-2	2.0	1	MSM171-A	MSQ176-5
MSW501-5	2.0	1	Boulder	White Pearl
MSX009-2	2.0	1	ARS10241-2	Missaukee
MSX010-3	2.0	1	ARS10241-2	MSL211-3
MSX018-2	2.0	1	ARS10342-4	Pike
MSX050-1	2.0	1	Beacon Chipper	Nicolet
MSX137-6	2.0	1	Eva	MSL211-3
MSX150-1	2.0	1	MSH228-6	MSM246-B
MSX156-1Y	2.0	1	MSI005-20Y	Boulder
MSX293-1Y	2.0	1	MSM288-2Y	MSQ176-5
MSX324-2R	2.0	1	MSN105-1	Colonial Purple
MSX345-6Y	2.0	1	MSN191-2Y	McBride
MSX389-2	2.0	1	Lamoka	MSL268-D
MSX495-2	2.0	2	MSQ131-A	Kalkaska
MSX517-3SPL	2.0	1	Spartan Splash	MSQ176-5
MSX540-4	2.0	1	MSR061-1	Lamoka
MSX542-2	2.0	1	MSR102-3	Megachip
MSY008-3	2.0	1	MSP515-2	Manistee
MSY192-2PP	2.0	1	MSQ405-1PP	MSQ461-2PP
MSY193-1	2.0	1	MSQ279-1	B2731-2
MSY209-1	2.0	1	Pike	MSN170-A
MSY491-2Y	2.0	1	MSL183-AY	MSL211-3
MSY515-1	2.0	1	Reba	Haig Ind 98
MSY544-5R	2.0	1	Bison	MSS544-1R
MSY712-2Y	2.0	1	MSS703-5	84SD22

Table 11

2015 MSU LATE BLIGHT VARIETY TRIAL
CLARKSVILLE RESEARCH CENTER, MI

Line Sort:			***RAUDPC Sort:***				
		RAUDPC[1]			RAUDPC[1]	*Pedigrees go w/ RAUDPC Sort*	
LINE	N	MEAN	LINE	N	MEAN	Female	Male
A01010-1 (Targhee Russet)	3	19.3	MSS487-2	3	0.0	Stirling	Missaukee
A01143-3C	3	19.0	MSV235-2PY	3	0.0	Malinche	Colonial Purple
A02267-1Y	3	17.0	MSV282-4Y	3	0.0	Monserrat	MSN105-1
A05182-7Y	3	11.5	MSV284-1	3	0.0	Monserrat	MSP239-1
AF3362-1Rus (Caribou Russet)	3	20.7	MSZ562-4	3	0.0	Muruta	MSL211-3
AF4648-2	3	10.2	MSZ609-1P	3	0.0	386056.17	Colonial Purple
AF4975-3	3	23.4	MSW242-5Y	3	0.0	NY121	Malinche
AF5320-1	3	23.2	ND6961B-21PY	3	0.0		
Atlantic	**4**	**25.9**	MSX398-2	2	0.2	Lamoka	Stirling
ATX91137-1Rus (Reveille Russet)	2	20.6	MSW092-1	3	0.2	MSL106-AY	Montserrat
AW07791-2Rus	2	12.0	MSS164-1	3	0.2	MSM188-1	Missaukee
Barbara	2	17.4	MSW464-3	3	0.3	MSM246-B	MSR102-3
BNC182-5	3	23.1	MSX198-5	3	0.5	Missaukee	OP
CO02343-3W	2	22.9	MSX293-1Y	2	0.6	MSM288-2Y	MSQ176-5
CO05037-3W/Y	2	26.7	MSW229-5P	3	0.6	Michigan Purple	MSN105-1
CO07102-1R	3	26.5	MSZ610-3	3	0.6	Chaposa	MSQ176-5
CO07370-1W/Y	3	12.7	MSW078-1	2	0.7	MSK409-1	Malinche
CO5068-1Rus	3	14.1	MSZ551-1	2	1.0	MSM182-1	MSL268-D
CW08071-2Rus	2	18.4	MSW324-01	3	1.0	MSQ070-1	Marcy
Dakota Ruby	3	22.3	MSZ219-46	3	1.1	MSR061-1	MSR127-2
Granola	3	14.8	MSZ454-1Y	3	1.4	Atlantic	Enfula
Lamoka	3	21.4	MSZ552-2P	2	1.5	MSM182-1	Colonial Purple
Maris Bard	3	21.5	MSX497-6	3	1.6	MSQ131-A	MSL268-D
Merlot	3	14.3	MSW042-1	3	1.6	MSI152-A	MSL211-3
MN10003PLWR-06R	3	23.9	MSW121-5R	3	1.7	MSM182-1	NDTX4271-5R
Molli	3	18.0	MSZ219-14	3	1.8	MSR061-1	MSR127-2
MSR061-1	3	3.6	MSZ436-2SPL	2	1.8	MSS576-05SPL	MSQ440-2
MSS164-1	3	0.2	MSZ702-1	3	1.8	CIP575045	84SD22
MSS487-2	3	0.0	QSMSU10-02	3	1.9	MSN106-2	MSL211-3
MSS576-5SPL	2	7.0	MSZ706-1	2	2.0	J138K6A22	MSV020-2
MST075-1R	2	24.0	MSZ409-1R	3	2.3	Muruta	MSR217-1R
MST386-1P	3	18.4	MSZ507-2	3	2.4	MSL211-3	NY121
MSU016-2	3	5.6	MSW100-1	3	3.1	LBR9	MSP292-7
MSU161-1	3	6.5	MSZ578-1Y	2	3.3	Nicola	Santa Ana
MSU198-01SPL	3	15.8	MSZ210-08	3	3.4	MSQ131-A	MSL211-3
MSU202-1P	3	22.4	MSR061-1	3	3.6	W1201	NY121
MSU245-1	3	10.3	MSX517-3SPL	3	3.6	Spartan Splash	MSQ176-5
MSU316-3PY	3	19.8	MSZ464-3	3	3.7	MSQ070-1	Alca Tarma
MSU379-1	3	20.5	MSZ157-3	3	4.1	NDU030-1	Missaukee
MSU383-A	2	20.3	MSZ513-2	6	4.3	MSL268-D	MSL211-3
MSV093-1	6	16.9	MSX540-4	3	4.6	MSR061-1	Lamoka
MSV111-1	3	15.2	MSZ705-3	2	4.7	HS66	BER83
MSV179-1	2	23.3	MSX507-1R	2	5.0	MSQ176-5	MSR219-2R
MSV235-2PY	3	0.0	MSY491-2Y	3	5.0	MSL183-AY	MSL211-3
MSV282-4Y	3	0.0	MSY520-1	3	5.4	MSQ440-2	MSN105-1
MSV284-1	3	0.0	MSZ218-5	3	5.6	MSR061-1	MSQ086-3
MSV301-2	3	24.3	MSU016-2	3	5.6	Boulder	MSN105-1
MSV393-1	2	20.0	MSW151-05	3	6.1	Montanosa	MSL211-3
MSV394-3	2	17.3	MSW360-18	3	6.1	MSR061-1	MSN238-A
MSV396-4Y	3	9.4	MSU161-1	3	6.5	MSM182-1	MSL211-3
MSV397-2	3	19.9	MSY452-1	3	6.5	MSQ176-5	MSL211-3
MSV505-2	1	16.9	MSW485-2	3	6.7	MSQ070-1	MSR156-7
MSW042-1	3	1.6	MSZ251-1	3	6.8	MSS070-B	Lamoka
MSW064-1	3	9.2	MSZ219-44	3	7.0	MSR061-1	MSR127-2
MSW078-1	2	0.7	MSS576-5SPL	2	7.0	MSI005-20Y	MSL211-3
MSW092-1	3	0.2	MSZ004-1	3	7.2	Atlantic	MSL211-3
MSW100-1	3	3.1	MSZ424-1R	2	7.6	NY121	MSR217-1R
MSW119-2	3	13.0	MSZ620-1	2	7.9	Muziranzara	MSL211-3
MSW121-5R	3	1.7	MSX542-2	3	7.9	MSR102-3	Megachip
MSW123-3	3	18.6	MSZ091-3	2	8.3	B1992-106	MSL211-3
MSW125-3	3	20.6	MSZ570-1	2	8.5	ND8331cb-3	MSL211-3

2015 MSU LATE BLIGHT VARIETY TRIAL
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Line Sort:			***RAUDPC Sort:***				
		RAUDPC[1]			RAUDPC[1]	*Pedigrees go w/ RAUDPC Sort*	
LINE	N	MEAN	LINE	N	MEAN	Female	Male
MSW126-1	2	18.9	MSZ057-5	2	8.6	MSQ070-1	ND8334Cb-3
MSW134-1	2	22.8	MSW064-1	3	9.2	MSK061-4	MSR036-5
MSW151-05	3	6.1	MSW399-2	3	9.2	MSW2133-1	MSR036-5
MSW163-03	3	18.9	MSZ219-01	3	9.2	MSR061-1	MSR127-2
MSW168-2	3	15.9	MSZ547-3	3	9.2	MSL505-3	MSL211-3
MSW182-1Y	3	15.1	MSV396-4Y	3	9.4	MSQ070-1	McBride
MSW229-5P	3	0.6	MSX472-2	3	9.5	MSQ070-1	MSP292-7
MSW236-3	3	18.5	MSZ706-5	3	9.7	J138K6A22	MSV020-2
MSW237-4Y	3	14.8	NY154	3	9.7		
MSW242-5Y	3	0.0	AF4648-2	3	10.2		
MSW259-5	3	14.6	MSU245-1	3	10.3	NY132	MSP542-4
MSW298-4Y	1	12.1	MSW394-1	3	10.8	W2133-1	MSJ319-1
MSW299-2	3	13.4	MSZ616-1	3	10.9	Nicola	MSL211-3
MSW324-01	3	1.0	MSZ453-1	3	11.2	McBride	Alca Tarma
MSW326-6	3	19.4	MSX009-2	2	11.3	ARS10241-2	Missaukee
MSW353-3	3	17.6	A05182-7Y	3	11.5		
MSW360-18	3	6.1	AW07791-2Rus	2	12.0		
MSW394-1	3	10.8	MSW298-4Y	1	12.1	MSP102-5	MSL505-3
MSW399-2	3	9.2	VC1009-1W/Y	3	12.5		
MSW437-9	3	17.7	CO07370-1W/Y	3	12.7		
MSW464-3	3	0.3	MSW119-2	3	13.0	MSM171-A	MSR036-5
MSW485-2	3	6.7	MSZ219-29	3	13.1	MSR061-1	MSR127-2
MSW500-10	3	22.8	MSZ433-3P	3	13.2	MSS483-1	MSU200-5PP
MSW502-4	3	15.9	MSW299-2	3	13.4	MSP516-A	MSR061-1
MSW505-2	3	23.6	MSZ427-1R	2	14.0	MSQ440-2	NDTX4271-5R
MSW509-5	3	19.6	MSZ407-7	3	14.0	Montanosa	Colonial Purple
MSW537-6	3	15.7	CO5068-1Rus	3	14.1		
MSX001-4WP	2	22.3	Merlot	3	14.3		
MSX009-2	2	11.3	MSZ708-6	3	14.5	MSL316-EY	84SD22
MSX010-3	3	24.6	MSW259-5	3	14.6	MSN073-2	MSR159-2
MSX011-4	3	18.9	MSY008-3	3	14.7	MSP515-2	Manistee
MSX137-6	3	22.6	MSZ452-1	2	14.7	Atlantic	Chaposa
MSX196-1	3	15.0	Granola	3	14.8		
MSX198-5	3	0.5	MSW237-4Y	3	14.8	Montserrat	MSN191-2Y
MSX221-2	3	18.2	MSX196-1	3	15.0	Missaukee	Manistee
MSX255-1	2	22.4	MSW182-1Y	3	15.1	MSI005-20Y	POR02PG7-5
MSX293-1Y	2	0.6	MSV111-1	3	15.2	MSJ316-A	MSN105-1
MSX324-1P	5	19.2	ND7882b-7Russ	3	15.4		
MSX324-2R	1	18.8	MSY022-2	3	15.5	MSS176-1	MST096-2Y
MSX398-2	2	0.2	MSZ200-3	3	15.6	MSQ070-1	Lamoka
MSX472-2	3	9.5	MSW537-6	3	15.7	MSM070-1	MSP516-A
MSX495-2	2	23.4	MSU198-01SPL	3	15.8	MSN111-4PP	MSN105-1
MSX497-6	3	1.6	MSW168-2	3	15.9	Beacon Chipper	MSR159-2
MSX503-5	3	21.7	MSW502-4	3	15.9	CO95051-7W	Kalkaska
MSX506-3	3	19.6	MSV093-1	6	16.9	McBride	MSP408-14Y
MSX507-1R	2	5.0	MSV505-2	1	16.9	W2310-3	Missaukee
MSX517-3SPL	3	3.6	A02267-1Y	3	17.0		
MSX526-1	3	20.3	MSV394-3	2	17.3	MSQ070-1	MSH228-6
MSX540-4	3	4.6	Barbara	2	17.4		
MSX542-2	3	7.9	MSW353-3	3	17.6	MSR036-5	Marcy
MSY008-3	3	14.7	MSW437-9	3	17.7	Boulder	MSR036-5
MSY022-2	3	15.5	MSZ154-1	2	17.9	NDU022-1	MSQ086-3
MSY452-1	3	6.5	Molli	3	18.0		
MSY491-2Y	3	5.0	**Snowden**	**6**	**18.0**	**Lenape**	**Wischip**
MSY520-1	3	5.4	MSX221-2	3	18.2	MSK061-4	MSR036-5
MSZ004-1	3	7.2	CW08071-2Rus	2	18.4		
MSZ057-5	2	8.6	MST386-1P	3	18.4	Michigan Purple	Liberator
MSZ091-3	2	8.3	MSW236-3	3	18.5	Montanosa	MSR036-5
MSZ100-3	2	19.3	MSW123-3	3	18.6	MSM171-A	Dakota Diamond
MSZ154-1	2	17.9	MSZ615-1	3	18.7	386056.17	MSL211-3
MSZ157-3	3	4.1	MSX324-2R	1	18.8	MSN105-1	Colonial Purple
MSZ194-2	3	22.8	MSW126-1	2	18.9	MSM171-A	MSL268-D
MSZ200-3	3	15.6	MSW163-03	3	18.9	Atlantic	MSR036-5
MSZ210-08	3	3.4	MSX011-4	3	18.9	ARS10241-2	MSN105-1

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Line Sort:

LINE	N	RAUDPC[1] MEAN
MSZ218-5	3	5.6
MSZ219-01	3	9.2
MSZ219-11	3	19.2
MSZ219-14	3	1.8
MSZ219-29	3	13.1
MSZ219-44	3	7.0
MSZ219-46	3	1.1
MSZ251-1	3	6.8
MSZ300-1	3	20.3
MSZ407-2Y	2	20.9
MSZ407-7	3	14.0
MSZ409-1R	3	2.3
MSZ424-1R	2	7.6
MSZ427-1R	2	14.0
MSZ433-3P	3	13.2
MSZ436-2SPL	2	1.8
MSZ452-1	2	14.7
MSZ453-1	3	11.2
MSZ454-1Y	3	1.4
MSZ464-3	3	3.7
MSZ507-2	3	2.4
MSZ513-2	6	4.3
MSZ547-3	3	9.2
MSZ551-1	2	1.0
MSZ552-2P	2	1.5
MSZ562-4	3	0.0
MSZ570-1	2	8.5
MSZ578-1Y	2	3.3
MSZ609-1P	3	0.0
MSZ610-3	3	0.6
MSZ615-1	3	18.7
MSZ616-1	3	10.9
MSZ620-1	2	7.9
MSZ702-1	3	1.8
MSZ705-3	2	4.7
MSZ706-1	2	2.0
MSZ706-5	3	9.7
MSZ708-6	3	14.5
MSZUNK-7	3	21.3
ND6961B-21PY	3	0.0
ND7818-1Y	3	21.9
ND7882b-7Russ	3	15.4
ND8068-5Rus	2	25.5
NY154	3	9.7
NY157	3	23.5
NYK28-18	3	23.8
Oneida Gold	3	19.2
Pike	**2**	**22.5**
Purple Surprise 3	3	24.4
QSMSU08-4	3	22.8
QSMSU10-02	3	1.9
QSMSU10-15	3	21.0
Reba	6	21.4
Red Norland	**3**	**25.5**
Russet Norkotah	**3**	**21.9**
Silverton Russet	**3**	**22.9**
Snowden	**6**	**18.0**
Soraya	3	21.7
VC1009-1W/Y	3	12.5
W10209-2R	2	21.6
W5955-1	3	20.3
W9433-1Rus	2	19.3
W9519-3Rus	3	22.4
W9576-11Y	3	23.4

RAUDPC Sort:

LINE	N	RAUDPC[1] MEAN	*Pedigrees go w/ RAUDPC Sort* Female	Male
W9577-6Y	2	18.9		
A01143-3C	3	19.0		
MSZ219-11	3	19.2	MSR061-1	MSR127-2
MSX324-1P	5	19.2	MSN105-1	Colonial Purple
W9742-3Rus	2	19.2		
Oneida Gold	3	19.2		
W9433-1Rus	2	19.3		
MSZ100-3	2	19.3	Boulder	MSV477-5
A01010-1 (Targhee Russett)	3	19.3		
MSW326-6	3	19.4	MSQ070-1	MSN190-2
MSW509-5	3	19.6	Kalkaska	Marcy
MSX506-3	3	19.6	MSQ176-5	MSR169-8Y
MSU316-3PY	3	19.8	Liberator	MSL766-1
MSV397-2	3	19.9	MSQ070-1	MSJ147-1
MSV393-1	2	20.0	MSQ070-1	MSG227-2
MSU383-A	2	20.3	MSP292-7	MSG227-2
MSZ300-1	3	20.3	W6822-3	MSU205-4
W5955-1	3	20.3		
MSX526-1	3	20.3	MSR036-5	Lamoka
MSU379-1	3	20.5	MSP238-1	Missaukee
ATX91137-1Rus (Reveille Russet)	2	20.6		
MSW125-3	3	20.6	MSM171-A	MSL211-3
AF3362-1Rus (Caribou Russet)	3	20.7		
MSZ407-2Y	2	20.9	Montanosa	Colonial Purple
QSMSU10-15	3	21.0	MSN106-2	MSL211-3
MSZUNK-7	3	21.3		
Lamoka	3	21.4		
Reba	6	21.4		
Maris Bard	3	21.5		
W10209-2R	2	21.6		
MSX503-5	3	21.7	MSQ176-5	MSL268-D
Soraya	3	21.7		
ND7818-1Y	3	21.9		
Russet Norkotah	**3**	**21.9**		
MSX001-4WP	2	22.3	ARS10091WP	MSL211-3
Dakota Ruby	3	22.3		
MSU202-1P	3	22.4	Colonial Purple	MSL211-3
W9519-3Rus	3	22.4		
MSX255-1	2	22.4	M171-A	ARS10342-4
Pike	**2**	**22.5**	**Allegany**	**Atlantic**
W9576-13Y	3	22.5		
MSX137-6	3	22.6	Eva	MSL211-3
MSW134-1	2	22.8	Marcy	Dakota Diamond
MSW500-10	3	22.8	Boulder	MSP516-A
MSZ194-2	3	22.8	MSQ035-3	MSU383-A
QSMSU08-4	3	22.8	MSM037-3	MSL211-3
CO02343-3W	2	22.9		
Silverton Russet	**3**	**22.9**		
BNC182-5	3	23.1		
AF5320-1	3	23.2		
MSV179-1	2	23.3	LBR8	MSL211-3
MSX495-2	2	23.4	MSQ131-A	Kalkaska
W9576-11Y	3	23.4		
AF4975-3	3	23.4		
NY157	3	23.5		
MSW505-2	3	23.6	MSI005-20Y	MSL766-1
NYK28-18	3	23.8		
MN10003PLWR-06R	3	23.9		
MST075-1R	2	24.0	Dakota Jewel	MSL211-3
MSV301-2	3	24.3	MSN105-1	MSP197-1
Purple Surprise 3	3	24.4		
MSX010-3	3	24.6	ARS10241-2	MSL211-3
ND8068-5Rus	2	25.5		
Red Norland	**3**	**25.5**		

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Line Sort:			***RAUDPC Sort:***				
		RAUDPC[1]			RAUDPC[1]	*Pedigrees go w/ RAUDPC Sort*	
LINE	N	MEAN	LINE	N	MEAN	Female	Male
W9576-13Y	3	22.5	**Atlantic**	**4**	**25.9**	**Waueson**	**Lenape**
W9577-6Y	2	18.9	CO07102-1R	3	26.5		
W9742-3Rus	2	19.2	CO05037-3W/Y	2	26.7		
$HSD_{0.05}$		10.8			10.8		

[1]Ratings indicate the average plot RAUDPC (Relative Area Under the Disease Progress Curve).
LB Isolate used: US-23

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Line Sort:			*RAUDPC Sort:*				
LINE	N	RAUDPC[1] MEAN	LINE	N	RAUDPC[1] MEAN	*Pedigrees go w/ RAUDPC Sort* Female	Male
Atlantic	1	25.4	MSAA172-5	1	0.0	MSU016-2	MSV198-2Y
Atlantic	1	27.6	MSAA196-1	1	0.0	MSW151-5	MSQ440-2
Barbara	1	13.6	Chloe Anwd	1	0.0		
Chloe Anwd	1	0.0	VSB2186F-302-8	1	0.0		
LT-7	1	13.5	MSZ414-1RY	1	0.0	MSN230-1RY	Colonial Purple
MSAA011-1	1	20.4	MSZ436-2SPL	1	0.0	MSS576-05SPL	MSQ440-2
MSAA110-1	1	18.8	MSZ551-1	1	0.0	MSM182-1	MSL268-D
MSAA143-1	1	18.8	MSZ562-4	1	0.0	Muruta	MSL211-3
MSAA144-2	1	11.4	MSZ609-1P	1	0.0	386056.17	Colonial Purple
MSAA144-4	1	13.2	MSZ537-4	1	0.5	MSL211-3	Chaposa
MSAA169-3	1	15.8	MSZ210-08	1	0.7	MSQ131-A	MSL211-3
MSAA170-3Y	1	6.1	MSZ454-1Y	1	0.8	Atlantic	Enfula
MSAA172-5	1	0.0	MSZ513-2	1	1.3	MSL268-D	MSL211-3
MSAA173-3	1	3.1	MSZ552-2P	1	1.4	MSM182-1	Colonial Purple
MSAA194-2	1	25.2	NY121	1	1.7		
MSAA195-3	1	8.3	MSX293-1Y	1	1.7	MSM288-2Y	MSQ176-5
MSAA196-1	1	0.0	MSY515-1	1	1.7	Reba	Haig Ind 98
MSAA196-6	1	5.7	MSZ620-3	1	1.7	Muziranzara	MSL211-3
MSAA460-2Y	1	24.1	MSZ702-01	1	1.7	CIP575045	84SD22
MSAA468-4	1	26.0	MSZ578-1Y	1	2.2	Nicola	Santa Ana
MSAA513-1	1	16.2	MSZ215-2	1	2.4	MSR058-1	MSQ086-3
MSAA556-2	1	17.1	MSZ464-3	1	2.7	MSQ070-1	Alca Tarma
MSAA556-3Y	1	2.7	MSAA556-3Y	1	2.7	MSV284-1	McBride
MSAA556-4Y	1	20.3	MSZ610-3	1	2.9	Chaposa	MSQ176-5
MSV407-2	1	19.5	MSAA173-3	1	3.1	MSU161-1	MSQ086-3
MSW128-2	1	7.7	MSZ409-1R	1	3.3	Muruta	MSR217-1R
MSX196-1	1	14.3	MSZ263-4	1	3.6	MSU088-1	McBride
MSX221-2	1	18.9	MSZ705-3	1	3.9	HS66	BER83
MSX255-1	1	22.2	MSZ057-5	1	4.1	MSQ070-1	ND8334Cb-3
MSX293-1Y	1	1.7	MSZ510-4	1	4.6	MSL211-3	MSQ440-2
MSX324-1P	1	18.2	MSY507-2	1	4.9	Superior	MSL211-3
MSX324-2R	1	18.0	MSX496-2	1	5.6	MSQ131-A	MSL211-3
MSX495-2	1	6.1	MSAA196-6	1	5.7	MSW151-5	MSQ440-2
MSX496-2	1	5.6	MSAA170-3Y	1	6.1	MSU016-2	MSR157-1Y
MSY022-2	1	18.7	MSX495-2	1	6.1	MSQ131-A	Kalkaska
MSY041-1	1	30.0	MSZ706-1	1	6.3	J138K6A22	MSV020-2
MSY089-2	1	18.6	VSB16LBR8	1	6.5		
MSY452-1	1	12.8	MSZ547-3	1	6.8	MSL505-3	MSL211-3
MSY491-2Y	1	11.7	MSZ004-1	1	7.0	Atlantic	MSL211-3
MSY507-2	1	4.9	MSZ706-5	1	7.1	J138K6A22	MSV020-2
MSY515-1	1	1.7	Olalla	1	7.4		
MSY520-1	1	11.8	MSW128-2	1	7.7	MSM171-A	MSQ176-5
MSZ001-1	1	17.6	MSZ091-3	1	8.3	Elkton	MSL211-3
MSZ004-1	1	7.0	MSAA195-3	1	8.3	MSW151-5	MSQ176-5
MSZ057-5	1	4.1	MSZ218-5	1	8.6	MSR061-1	MSQ086-3
MSZ091-3	1	8.3	MSZ159-3	1	9.1	NDU030-1	MSV477-5
MSZ092-2	1	33.5	MSZ616-1	1	9.9	Nicola	MSL211-3

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Line Sort:

LINE	N	RAUDPC[1] MEAN
MSZ100-3	1	17.3
MSZ154-1	1	17.1
MSZ159-3	1	9.1
MSZ200-6	1	14.3
MSZ210-08	1	0.7
MSZ215-2	1	2.4
MSZ218-5	1	8.6
MSZ251-1	1	10.4
MSZ263-4	1	3.6
MSZ268-1	1	15.2
MSZ269-17	1	24.3
MSZ300-1	1	17.3
MSZ405-1PP	1	17.4
MSZ407-2Y	1	19.5
MSZ407-7	1	14.3
MSZ409-1R	1	3.3
MSZ414-1RY	1	0.0
MSZ416-8RY	1	19.9
MSZ424-1	1	11.2
MSZ427-1R	1	15.2
MSZ427-6R	1	25.9
MSZ433-3P	1	10.4
MSZ436-2SPL	1	0.0
MSZ452-1	1	14.1
MSZ454-1Y	1	0.8
MSZ464-3	1	2.7
MSZ507-2	1	12.4
MSZ510-4	1	4.6
MSZ513-2	1	1.3
MSZ537-4	1	0.5
MSZ547-3	1	6.8
MSZ551-1	1	0.0
MSZ552-2P	1	1.4
MSZ562-4	1	0.0
MSZ570-1	1	14.5
MSZ578-1Y	1	2.2
MSZ609-1P	1	0.0
MSZ610-3	1	2.9
MSZ613-1	1	16.5
MSZ615-2	1	20.9
MSZ616-1	1	9.9
MSZ620-3	1	1.7
MSZ622-1	1	20.1
MSZ702-01	1	1.7
MSZ705-3	1	3.9
MSZ706-1	1	6.3
MSZ706-5	1	7.1
MSZ708-6	1	15.4
MSZ738-2	1	25.7
NY121	1	1.7

RAUDPC Sort:

LINE	N	RAUDPC[1] MEAN	*Pedigrees go w/ RAUDPC Sort* Female	Male
MSZ251-1	1	10.4	MSS070-B	Lamoka
MSZ433-3P	1	10.4	MSS483-1	MSU200-5PP
MSZ424-1	1	11.2	NY121	MSR217-1R
MSAA144-2	1	11.4	MSR606-2	MSQ086-3
MSY491-2Y	1	11.7	MSL183-AY	MSL211-3
MSY520-1	1	11.8	MSQ440-2	MSN105-1
MSZ507-2	1	12.4	MSL211-3	NY121
MSY452-1	1	12.8	MSQ176-5	MSL211-3
MSAA144-4	1	13.2	MSR606-2	MSQ086-3
LT-7	1	13.5		
Barbara	1	13.6		
MSZ452-1	1	14.1	Atlantic	Chaposa
MSZ200-6	1	14.3	MSQ070-1	Lamoka
MSX196-1	1	14.3	Missaukee	Manistee
MSZ407-7	1	14.3	Montanosa	Colonial Purple
MSZ570-1	1	14.5	ND8331cb-3	MSL211-3
MSZ427-1R	1	15.2	MSQ440-2	NDTX4271-5R
MSZ268-1	1	15.2	MSU278-1Y	Pike
MSZ708-6	1	15.4	MSL316-EY	84SD22
MSAA169-3	1	15.8	MSU016-2	MSQ086-2
MSAA513-1	1	16.2	MSV117-1	Lamoka
MSZ613-1	1	16.5	386056.17	MSL211-3
MSZ154-1	1	17.1	NDU022-1	MSQ086-3
MSAA556-2	1	17.1	MSV284-1	McBride
MSZ300-1	1	17.3	W6822-3	MSU205-4
MSZ100-3	1	17.3	Boulder	MSV477-5
MSZ405-1PP	1	17.4	MSM182-1	MSU200-5PP
MSZ001-1	1	17.6	1989-86061	Manistee
MSX324-2R	1	18.0	MSN105-1	Colonial Purple
MSX324-1P	1	18.2	MSN105-1	Colonial Purple
MSY089-2	1	18.6	MSS176-1	B2731-2
MSY022-2	1	18.7	MSS176-1	MST096-2Y
MSAA143-1	1	18.8	MSR606-2	MSL211-3
MSAA110-1	1	18.8	Colonial Purple	MSR217-1R
MSX221-2	1	18.9	MSK061-4	MSR036-5
MSV407-2	1	19.5	MSQ070-1	MSP239-1
MSZ407-2Y	1	19.5	Montanosa	Colonial Purple
MSZ416-8RY	1	19.9	MSN230-1RY	NDTX4271-5R
MSZ622-1	1	20.1	Satina	MSL211-3
MSAA556-4Y	1	20.3	MSV284-1	McBride
MSAA011-1	1	20.4	Beacon Chipper	MSR159-2
MSZ615-2	1	20.9	Sieglinde	MSL211-3
MSX255-1	1	22.2	MSM171-A	ARS10342-4
MSAA460-2Y	1	24.1	MSR159-2	MSS165-2Y
MSZ269-17	1	24.3	MSU278-1Y	MSR127-2
MSAA194-2	1	25.2	MSW151-5	MSL211-3
Atlantic	**1**	**25.4**	**Wauseon**	**Lenape**
MSZ738-2	1	25.7	MSL316-EY	MSP091-1
MSZ427-6R	1	25.9	MSQ440-2	NDTX4271-5R
MSAA468-4	1	26.0	MSR297-A	MSQ086-3

2015 LATE BLIGHT EARLY GENERATION TRIAL
CLARKSVILLE RESEARCH CENTER, MI

Line Sort:				***RAUDPC Sort:***				
		RAUDPC[1]				RAUDPC[1]	*Pedigrees go w/ RAUDPC Sort*	
LINE	N	MEAN		LINE	N	MEAN	Female	Male
Olalla	1	7.4		**Atlantic**	**1**	**27.6**	**Wauseon**	**Lenape**
VSB16LBR8	1	6.5		MSY041-1	1	30.0	Dakota Diamond	MSP368-1
VSB2186F-302-8	1	0.0		MSZ092-2	1	33.5	Elkton	MSQ086-3

[1] Ratings indicate the average plot RAUDPC (Relative Area Under the Disease Progress Curve).
LB Isolate used: US-23

2015 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
ADAPTATION TRIAL, CHIP-PROCESSING LINES									
W5955-1	1.084	22	2	1	0	0	0	88	0.2
AF5320-1	1.081	20	4	1	0	0	0	80	0.2
AF4975-3	1.083	18	7	0	0	0	0	72	0.3
MSV380-1	1.084	17	5	2	1	0	0	68	0.5
Lamoka	1.084	11	13	1	0	0	0	44	0.6
MSV358-3	1.081	14	7	4	0	0	0	56	0.6
NY157	1.084	15	7	2	0	1	0	60	0.6
MSV394-3	1.083	13	9	2	1	0	0	52	0.6
AF4648-2	1.086	12	9	2	2	0	0	48	0.8
MSV383-B	1.095	10	12	2	1	0	0	40	0.8
MSW509-5	1.082	12	7	6	0	0	0	48	0.8
FL1879	**1.081**	**9**	**12**	**4**	**0**	**0**	**0**	**36**	**0.8**
MSX398-2	1.078	11	10	1	3	0	0	44	0.8
MSV393-1	1.082	9	12	2	2	0	0	36	0.9
A01143-3C	1.080	10	8	6	1	0	0	40	0.9
MSV033-01	1.077	6	14	3	1	0	0	25	1.0
CO02343-3W	1.076	8	10	5	2	0	0	32	1.0
NYK28-18	1.096	5	12	7	1	0	0	20	1.2
MSW505-2	1.086	6	10	6	1	1	0	25	1.2
MSV507-056	1.091	5	10	7	2	1	0	20	1.4
NY154	1.087	8	6	6	3	1	1	32	1.4
MSW394-1	1.077	2	13	6	4	0	0	8	1.5
MSV030-4	1.089	3	5	6	3	0	0	18	1.5
Snowden	**1.087**	**4**	**7**	**9**	**3**	**1**	**0**	**17**	**1.6**
MSR127-2	1.084	6	7	6	2	2	2	24	1.7
MSW474-01	1.085	4	6	6	5	2	2	16	2.0
MSR061-1	1.085	4	4	7	7	2	1	16	2.1
Atlantic	**1.092**	**1**	**9**	**5**	**6**	**3**	**1**	**4**	**2.2**
MSV313-2	1.082	2	5	8	6	4	0	8	2.2
MSX540-4	1.088	0	5	6	6	4	4	0	2.8
RUSSET TRIAL									
MSY573-3Rus	1.065	19	6	0	0	0	0	**76**	**0.2**
A01010-1 (Targhee Russet)	1.076	19	5	1	0	0	0	76	0.3
Russet Norkotah	**1.070**	**17**	**8**	**0**	**0**	**0**	**0**	**68**	**0.3**
Silverton Russet	**1.070**	**17**	**7**	**1**	**0**	**0**	**0**	**68**	**0.4**
ATX91137-1Rus (Reveille)	1.069	16	8	1	0	0	0	64	0.4
AF3362-1Rus (Caribou)	1.075	14	8	2	1	0	0	56	0.6
W9433-1Rus	1.077	14	7	3	1	0	0	56	0.6
AW07791-2Rus	1.087	7	11	6	1	0	0	28	1.0
ND8068-5Rus	1.077	4	15	4	2	0	0	16	1.2
MSW496-1Rus	1.068	7	9	7	1	1	0	28	1.2
CO5068-1Rus	1.087	4	6	9	5	1	0	16	1.7
CW08071-2Rus	1.078	3	7	10	4	1	0	12	1.7
NCR									
ND7834-2P	1.076	25	0	0	0	0	0	100	0.0
ND7818-1Y	1.069	13	1	0	0	0	0	93	0.1
MN10003PLWR-06R	1.065	23	2	0	0	0	0	92	0.1
Russet Norkotah	**1.072**	**23**	**2**	**0**	**0**	**0**	**0**	**92**	**0.1**
MSW343-2R	1.059	23	0	1	0	0	0	96	0.1
AFW5472-1rus	1.068	22	3	0	0	0	0	88	0.1
Red LaSoda	**1.065**	**23**	**1**	**1**	**0**	**0**	**0**	**92**	**0.1**
Red Norland	**1.062**	**22**	**3**	**0**	**0**	**0**	**0**	**88**	**0.1**
W10114-3R	1.058	20	3	0	0	0	0	87	0.1

2015 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
Dark Red Norland	**1.063**	**21**	**4**	**0**	**0**	**0**	**0**	**84**	**0.2**
W9432-4R	1.051	21	4	0	0	0	0	84	0.2
MSV235-2PY	1.077	19	6	0	0	0	0	76	0.2
ND6961B-21PY	1.081	20	3	2	0	0	0	80	0.3
W10043-1rus	1.078	19	5	1	0	0	0	76	0.3
MSS576-5SPL	1.071	17	8	0	0	0	0	68	0.3
MSV093-1	1.076	17	7	1	0	0	0	68	0.4
W10209-2R	1.070	14	7	1	0	0	0	64	0.4
Yukon Gold	**1.078**	**15**	**7**	**2**	**0**	**0**	**0**	**63**	**0.5**
MSX324-1P	1.083	11	12	2	0	0	0	44	0.6
ND7982-1R	1.073	14	7	3	1	0	0	56	0.6
AFW5465-2rus	1.067	12	4	6	1	0	0	52	0.8
ND7882b-7Russ	1.076	11	8	5	1	0	0	44	0.8
MST386-1P	1.085	7	11	6	1	0	0	28	1.0
ND113300-3RSY	1.075	7	9	5	4	0	0	28	1.2
W10074-8rus	1.090	5	10	3	5	2	0	20	1.6
MSX540-4	1.090	4	6	6	5	4	0	16	2.0
ADAPTATION TRIAL, TABLESTOCK LINES									
MSW239-03SPL	1.056	21	4	0	0	0	0	84	0.2
MSX526-1	1.080	20	5	0	0	0	0	80	0.2
MSV093-1	1.073	16	9	0	0	0	0	64	0.4
McBride	1.080	16	8	1	0	0	0	64	0.4
MSV179-1	1.060	14	10	1	0	0	0	56	0.5
Red Norland	**1.063**	**15**	**8**	**2**	**0**	**0**	**0**	**60**	**0.5**
MSS576-5SPL	1.070	14	9	1	1	0	0	56	0.6
MSW299-2	1.072	17	3	3	1	1	0	68	0.6
MST252-1Y	1.069	10	14	0	1	0	0	40	0.7
Spartan Splash	1.072	12	8	5	0	0	0	48	0.7
Oneida Gold	1.079	10	12	1	2	0	0	40	0.8
Molli	1.068	7	13	5	0	0	0	28	0.9
Superior	**1.070**	**10**	**8**	**4**	**3**	**0**	**0**	**40**	**1.0**
MSV434-1Y	1.073	8	11	4	1	0	1	32	1.1
MSW151-05	1.067	7	10	7	1	0	0	28	1.1
MSW259-5	1.079	8	10	3	2	0	1	33	1.1
MSW075-1	1.081	6	8	8	2	0	1	24	1.4
Reba	**1.074**	**3**	**11**	**8**	**3**	**0**	**0**	**12**	**1.4**
MSX324-1P	1.079	5	7	7	3	1	2	20	1.8
MSV235-2PY	1.075	0	4	13	3	2	1	0	2.3
MSW134-1	1.072	1	5	5	7	3	3	4	2.6
PRELIMINARY TRIAL, CHIP-PROCESSING LINES									
MSW485-2	1.089	18	4	1	0	0	0	78	0.3
MSX198-5	1.079	18	7	0	0	0	0	**72**	**0.3**
MSS164-1	1.088	18	5	2	0	0	0	72	0.4
MSW248-02	1.087	17	7	1	0	0	0	68	0.4
MSZ194-2	1.087	18	5	1	1	0	0	72	0.4
MSX196-1	1.072	16	7	2	0	0	0	64	0.4
MSX156-2	1.071	15	8	2	0	0	0	60	0.5
MSW464-3	1.082	16	5	4	0	0	0	64	0.5
MSZ219-01	1.074	15	7	2	1	0	0	60	0.6
MSX345-6Y	1.088	11	12	2	0	0	0	44	0.6
MSV092-2	1.086	11	10	3	0	0	0	46	0.7
MSZ452-1	1.095	11	11	3	0	0	0	44	0.7
MSW502-3	1.079	12	8	5	0	0	0	48	0.7
MSX420-4Y	1.087	11	10	3	1	0	0	44	0.8
MSX495-2	1.084	13	6	5	1	0	0	52	0.8

Table 13

2015 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

		NUMBER OF SPOTS PER TUBER						PERCENT (%) BRUISE	AVERAGE
ENTRY	SP GR	0	1	2	3	4	5+	FREE	SPOTS/TUBER
QSMSU10-15	1.092	11	9	5	0	0	0	44	0.8
MSX472-1	1.089	12	6	5	1	0	0	50	0.8
MSZ222-19	1.091	9	12	2	1	0	0	38	0.8
MSZ119-1	1.081	11	9	4	1	0	0	44	0.8
MSZ025-5	1.091	12	8	4	0	0	1	48	0.8
Pike	**1.089**	**10**	**10**	**4**	**1**	**0**	**0**	**40**	**0.8**
MSX410-12Y	1.086	8	13	3	0	1	0	32	0.9
MSY008-3	1.079	8	11	6	0	0	0	32	0.9
MSZ407-2Y	1.074	8	12	4	1	0	0	32	0.9
MSV284-1	1.078	10	7	7	0	1	0	40	1.0
MSV307-2	1.085	7	12	5	1	0	0	28	1.0
D. Diamond	1.084	9	10	4	0	2	0	36	1.0
MSW326-6	1.093	7	12	4	2	0	0	28	1.0
MSY022-2	1.077	11	8	2	3	0	1	44	1.0
Atlantic	**1.089**	**9**	**8**	**4**	**1**	**0**	**1**	**39**	**1.0**
MSX542-2	1.085	7	11	2	3	0	0	30	1.0
MSU383-A	1.074	12	5	4	3	0	1	48	1.1
MSZ300-1	1.085	10	7	5	1	2	0	40	1.1
MST186-1Y	1.083	6	10	8	1	0	0	24	1.2
MSW324-01	1.090	7	8	9	1	0	0	28	1.2
MSV335-1	1.077	7	10	5	2	1	0	28	1.2
MSW064-1	1.082	9	6	7	2	1	0	36	1.2
MSZ507-2	1.083	7	9	6	3	0	0	28	1.2
MSX129-1	1.085	4	13	6	2	0	0	16	1.2
MSZ159-3	1.081	6	8	9	2	0	0	24	1.3
MSZ280-7	1.078	8	7	6	3	1	0	32	1.3
MSV246-1	1.088	6	7	9	2	0	0	25	1.3
Beacon Chipper	1.078	5	10	7	3	0	0	20	1.3
MSU379-1	1.081	5	0	4	3	0	0	42	1.4
MSX245-2Y	1.086	3	13	6	2	0	1	12	1.4
MSW044-1	1.092	2	11	10	2	0	0	8	1.5
Snowden	**1.084**	**5**	**8**	**8**	**2**	**1**	**1**	**20**	**1.6**
MSX225-2	1.085	2	8	12	2	0	1	8	1.7
MSW168-2	1.089	4	10	5	1	3	2	16	1.8
MSX417-1	1.086	0	9	10	3	3	0	0	2.0
MSV507-143	1.088	3	5	8	7	1	1	12	2.0
MSW399-2	1.087	1	4	10	7	2	1	4	2.3
MSW537-6	1.095	0	5	6	7	3	4	0	2.8
MSX221-2	1.080	1	4	6	7	2	5	4	2.8
MSV507-129	1.093	0	1	0	5	6	13	0	4.2
PRELIMINARY TRIAL, TABLESTOCK LINES									
MSV111-1	1.073	24	0	0	0	0	0	100	0.0
MSY520-1	1.068	22	3	0	0	0	0	88	0.1
MSW500-10	1.072	22	2	1	0	0	0	88	0.2
MSW125-3	1.059	20	4	1	0	0	0	80	0.2
W9576-13Y	1.072	20	4	1	0	0	0	80	0.2
W9577-6Y	1.075	20	4	1	0	0	0	80	0.2
MSW353-3	1.076	18	7	0	0	0	0	72	0.3
Soraya	1.062	19	5	1	0	0	0	76	0.3
W9576-11Y	1.058	19	5	1	0	0	0	76	0.3
MSX497-6	1.069	16	8	0	0	0	0	67	0.3
Granola	1.067	16	9	0	0	0	0	64	0.4
MSW437-9	1.070	16	9	0	0	0	0	64	0.4
MSW068-4	1.074	15	9	0	0	0	0	63	0.4
MSV301-2	1.080	17	6	2	0	0	0	68	0.4
MSW556-1	1.073	16	8	1	0	0	0	64	0.4

Table 13

2015 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
MSW569-2	1.077	16	8	1	0	0	0	64	0.4
MSW270-1	1.074	14	7	1	0	0	0	64	0.4
CO05037-3W/Y	1.073	14	10	0	0	0	0	58	0.4
QSMSU08-4	1.082	15	6	2	0	0	0	65	0.4
MSW123-3	1.062	16	5	3	0	0	0	67	0.5
VC1009-1W/Y	1.072	13	9	1	0	0	0	57	0.5
MSV502-5	1.076	14	10	1	0	0	0	56	0.5
MSW500-04	1.074	14	8	2	0	0	0	58	0.5
A02267-1Y	1.060	15	7	3	0	0	0	60	0.5
MST148-3	1.077	14	9	2	0	0	0	56	0.5
MSV292-1Y	1.065	14	9	2	0	0	0	56	0.5
MSX255-1	1.089	14	9	2	0	0	0	56	0.5
MSY491-2Y	1.072	14	7	3	0	0	0	58	0.5
CO07370-1W/Y	1.062	14	8	3	0	0	0	56	0.6
MSW119-2	1.075	13	10	2	0	0	0	52	0.6
MSW236-3	1.078	12	12	1	0	0	0	48	0.6
MST191-2Y	1.085	12	10	2	0	0	0	50	0.6
MST441-1	1.079	12	11	2	0	0	0	48	0.6
MSW042-1	1.077	14	7	4	0	0	0	56	0.6
MSW298-4Y	1.076	12	11	2	0	0	0	48	0.6
MSX156-1Y	1.068	16	6	0	3	0	0	64	0.6
MSY042-1	1.079	12	11	1	1	0	0	48	0.6
MSY452-1	1.062	10	14	1	0	0	0	40	0.6
MSX506-3	1.075	12	9	4	0	0	0	48	0.7
QSMSU10-02	1.074	12	9	3	1	0	0	48	0.7
MSX293-1Y	1.079	10	5	4	1	0	0	50	0.8
MSY111-1	1.076	8	14	2	1	0	0	32	0.8
MSV089-2	1.077	8	13	3	1	0	0	32	0.9
CalWhite	**1.071**	**9**	**11**	**3**	**2**	**0**	**0**	**36**	**0.9**
MST145-2	1.074	9	11	4	0	1	0	36	0.9
MSW126-1	1.078	3	5	3	0	0	0	27	1.0
MSV397-2	1.076	7	11	6	1	0	0	28	1.0
MSX172-7	1.084	8	9	7	1	0	0	32	1.0
Reba	**1.078**	**7**	**11**	**6**	**1**	**0**	**0**	**28**	**1.0**
Barbara	1.076	4	15	6	0	0	0	16	1.1
MSX137-6	1.073	6	11	8	0	0	0	24	1.1
MSU161-1	1.075	7	10	6	2	0	0	28	1.1
MSU245-1	1.090	6	12	5	2	0	0	24	1.1
MSX503-5	1.075	7	10	6	2	0	0	28	1.1
MSV016-2	1.090	9	7	6	2	1	0	36	1.2
MSX010-3	1.078	7	10	5	3	0	0	28	1.2
Superior	**1.072**	**8**	**8**	**7**	**1**	**1**	**0**	**32**	**1.2**
MSU016-2	1.090	8	7	5	3	1	0	33	1.3
A05182-7Y	1.076	8	6	4	6	0	0	33	1.3
MSX011-4	1.090	2	10	12	1	0	0	8	1.5
MST229-1	1.081	5	6	9	3	1	0	21	1.5
MSV282-4Y	1.083	2	10	10	3	0	0	8	1.6
MSV127-1	1.088	5	8	7	2	0	3	20	1.7
MSX009-2	1.083	3	8	9	4	0	1	12	1.7
MSW242-5Y	1.077	3	6	7	4	2	0	14	1.8
MST094-1	1.080	1	8	7	8	1	0	4	2.0
MSW237-4Y	1.082	0	6	6	9	1	2	0	2.5

USPB/SFA TRIAL CHECK SAMPLES (Not bruised)

AF4648-2	1.079	20	1	0	0	0	0	95	0.0
CO03243-3W	1.070	22	2	0	0	0	0	92	0.1
Lamoka	**1.077**	**21**	**3**	**0**	**0**	**0**	**0**	**88**	**0.1**

2015 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

		NUMBER OF SPOTS PER TUBER						PERCENT (%) BRUISE	AVERAGE
ENTRY	SP GR	0	1	2	3	4	5+	FREE	SPOTS/TUBER
A00188-3C	1.079	21	2	1	0	0	0	88	0.2
AC01151-5W	1.072	20	4	0	0	0	0	83	0.2
AC03433-1W	1.068	20	4	0	0	0	0	83	0.2
Atlantic	**1.081**	**20**	**3**	**1**	**0**	**0**	**0**	**83**	**0.2**
Snowden	**1.079**	**19**	**5**	**0**	**0**	**0**	**0**	**79**	**0.2**
W6822-3	1.079	19	6	0	0	0	0	76	0.2
NY152	1.074	14	9	1	0	0	0	58	0.5
USPB/SFA TRIAL BRUISE SAMPLES									
A00188-3C	1.079	20	4	0	0	0	0	83	0.2
AF4648-2	1.079	19	5	0	0	0	0	79	0.2
AC03433-1W	1.068	18	6	0	0	0	0	75	0.3
AC01151-5W	1.072	16	7	1	0	0	0	67	0.4
CO03243-3W	1.07	14	10	0	0	0	0	58	0.4
Lamoka	**1.077**	**10**	**9**	**3**	**1**	**0**	**0**	**43**	**0.8**
Atlantic	**1.081**	**10**	**10**	**3**	**0**	**0**	**1**	**42**	**0.9**
NY152	1.074	10	9	3	2	0	0	42	0.9
Snowden	**1.079**	**9**	**9**	**6**	**1**	**0**	**0**	**36**	**1.0**
W6822-3	1.079	1	5	9	2	2	5	4	2.6
MSZ selections 2 x 20									
MSZ169-01	1.077	22	3	0	0	0	0	88	0.1
MSZ045-09	1.074	21	4	0	0	0	0	84	0.2
MSZ052-11	1.082	20	3	2	0	0	0	80	0.3
MSZ242-14	1.083	18	6	1	0	0	0	72	0.3
MSZ062-10	1.092	15	8	0	0	0	0	65	0.3
MSZ118-02	1.089	17	7	1	0	0	0	68	0.4
MSZ118-20	1.081	8	5	0	0	0	0	62	0.4
MSZ118-08	1.088	18	5	0	2	0	0	72	0.4
MSZ062-46	1.081	15	8	2	0	0	0	60	0.5
MSZ242-03	1.094	13	10	1	0	0	0	54	0.5
MSZ022-19	1.086	15	8	1	1	0	0	60	0.5
MSZ062-42	1.084	16	6	2	1	0	0	64	0.5
MSZ020-08	1.082	15	7	2	1	0	0	60	0.6
MSZ062-31	1.073	13	9	1	1	0	0	54	0.6
MSZ062-18	1.077	7	5	0	1	0	0	54	0.6
MSZ120-04	1.089	6	6	1	0	0	0	46	0.6
MSZ020-04	1.090	12	9	4	0	0	0	48	0.7
MSZ219-46	1.087	13	7	5	0	0	0	52	0.7
MSZ020-10	1.087	13	7	4	1	0	0	52	0.7
MSZ026-08	1.083	12	7	6	0	0	0	48	0.8
MSZ062-06	1.082	13	7	3	2	0	0	52	0.8
MSZ022-14	1.079	10	11	2	0	1	0	42	0.8
MSZ022-07	1.083	10	12	1	2	0	0	40	0.8
MSZ052-31	1.083	11	8	6	0	0	0	44	0.8
MSZ052-40	1.092	12	8	3	2	0	0	48	0.8
MSZ222-15	1.078	10	10	5	0	0	0	40	0.8
MSZ101-06	1.081	13	5	5	2	0	0	52	0.8
MSZ242-09	1.093	10	10	4	1	0	0	40	0.8
MSZ242-07	1.101	5	5	2	1	0	0	38	0.9
MSZ242-13	1.100	10	8	5	2	0	0	40	1.0
MSZ242-15	1.093	9	8	8	0	0	0	36	1.0
MSZ101-07	1.086	8	8	7	2	0	0	32	1.1
MSZ103-02	1.087	10	6	4	4	1	0	40	1.2
MSZ219-29	1.079	4	5	1	3	0	0	31	1.2
MSZ219-14	1.089	7	9	5	3	1	0	28	1.3
MSZ022-16	1.089	5	8	11	1	0	0	20	1.3

2015 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
MSZ242-12	1.092	6	7	8	4	0	0	24	1.4
MSZ052-14	1.085	3	10	6	6	0	0	12	1.6
MSZ096-02	1.088	5	10	3	3	4	0	20	1.6
MSZ096-03	1.081	2	9	11	2	1	0	8	1.6
Snowden	**1.090**	**5**	**7**	**5**	**6**	**2**	**0**	**20**	**1.7**
MSZ052-13	1.089	3	8	8	4	2	0	12	1.8
Atlantic	**1.095**	**2**	**8**	**9**	**4**	**2**	**0**	**8**	**1.8**
MSZ062-50	1.089	5	6	6	5	2	1	20	1.8
MSZ118-19	1.093	1	7	7	7	1	2	4	2.2

* Twenty to twenty-five 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 10/28-29/2015. The table is presented in ascending order of average number of spots per tuber.

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2015 On-Farm Potato Variety Trials

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Introduction

On-farm potato variety trials were conducted with 16 growers in 2015 at a total of 27 locations. Ten of the locations evaluated processing entries and seventeen evaluated fresh market entries. The processing cooperators were: Crooks Farms, Inc. (Montcalm), Walther Farms, Inc. (St. Joseph), Lennard Ag. Co. (St. Joseph), County Line Potato Farms, Inc. (Allegan), Main Farms (Montcalm), Sandyland Farms (Montcalm) and at the Michigan State University (MSU) Montcalm Research Center (Montcalm). The United States Potato Board/Snack Food Association (USPB / SFA) chip trial was at Sandyland Farms, LLC (Montcalm). Fresh market trial cooperators were: Crawford Farms, Inc. (Montcalm), Elmaple Farms (Kalkaska), Erke Farms (Presque Isle), Kitchen Farms, Inc. (Antrim), Horkey Bros. (Monroe), Lippens Potato Farm (Delta), R&E Farms (Presque Isle), T.J.J. VanDamme Farms (Delta), Walther Farms, Inc. (St. Joseph), Lennard Ag. Co. (St. Joseph), at the MSU Montcalm Research Center (Montcalm) and L. Yoder Farms (St. Joseph).

Procedure

There were six types of processing trials conducted this year. The first type contained 8 entries which were compared with the check varieties ‘Snowden’, ‘Pike’, ‘Lamoka’ and ‘FL1879’. This trial type was conducted at Main Farms, Lennard Ag. Co. and County Line Farms. Varieties in these trials were planted in 75-95’ strip plots out of which 23’ was harvested and graded. In-row seed spacing in each trial was 10 inches. Similar to these trials was a strip trial at Sandyland Farms, LLC in which a subset of the 8 processing lines were evaluated with using data collected from a single replicate, dug within a longer planted strip. The second type of processing trial, referred to as a “Select” trial, contained seven lines which were compared to the variety in the field. In these trials, each variety was planted in a 15’ row plot. Seed spacing and row width were 10” and 34”, respectively. These trials were conducted on Crooks Farms, Inc. (Montcalm County) and were intended to evaluate new chipping lines in early, mid and late season planting environments. The third type was a processing variety trial where each plot consisted of three, 34” wide rows which were 15’ long. Only the center row was harvested for the yield evaluation from each of four replications. This trial was conducted at Walther Farms, Inc. (St. Joseph). At Walther’s, 13 varieties were compared to the check varieties ‘Snowden’, ‘Pike’, ‘Lamoka’ and ‘FL1879’. The plots were planted at 10” in-row seed spacing. The fourth type was the Box Bin trial at the Montcalm Research Center in Montcalm County, MI. This trial contained 12 varieties compared against the check varieties ‘Snowden’ and ‘Lamoka’. Each of the 12 varieties were planted in a single 34” wide row, 600’ long with 10” in-row seed spacing. A single 23’ yield check was taken to evaluate each clone. The fifth type of chip trial consisted of large multiple acreage block plantings of a promising, non-commercialized variety, AF4648-2. Agronomic and production practices for these varieties were based on each individual grower's production system. The growers were: Sandyland Farms (Montcalm) and Walther Farms (St. Joseph). The USPB / SFA chip trial was the sixth chip processing trial type and was conducted at Sandyland Farms (Montcalm County). For procedural details on this trial, reference the 2015 annual report published by the United States Potato Board.

Within the fresh market trials, there were 44 primary entries evaluated (this is not including entries from USPB/NFPT trial) of which 21 were russet types and, 23 were non-russet table-stock lines. For russet trials, check varieties included 'Silverton Russet', 'Russet Norkotah' and 'Goldrush Russet'. Other check varieties included, 'Dark Red Norland' (Red), 'Reba' and 'Onaway' (round white), and 'Molli' and 'Lehigh' (yellow). Trials were conducted in the following counties: Antrim, Delta, Kalkaska, Monroe, Montcalm, Presque Isle, St. Joseph, Cass, Van Buren, and LaGrange (IN). The varieties in each trial ranged from entirely non-russet type varieties to exclusively russet varieties. These varieties were generally planted in 100' strip plots. A single 23' yield check was taken to evaluate each clone in these strip trials. Seed spacing varied from 8 to 12 inches depending upon grower production practices and tuber type. Trials which only evaluated russet lines were conducted at three locations Elmaple Farm (Kalkaska), Montcalm Research Center (Montcalm), Lennard Ag. Co. (LaGrange) and Walther Farms (St. Joseph). At Elmaple Farms, each russet variety was planted in one, three row plot, that was thirty feet long with 34" wide rows and 10" in-row spacing. A yield determination was made on 23 feet of the center row. At Walther Farms, Inc. (St. Joseph), three row plots, replicated four times were evaluated. The plots were 15' long by 34" wide and seed spacing was 10". This trial was performed twice, once under Silverton management practices and the other with Norkotah management. Only the center rows were harvested and evaluated.

Results

A. Processing Variety Trial Results

A description of the processing varieties, their pedigree and scab ratings are listed in Table 1. The overall averages from ten locations from Montcalm and St. Joseph counties are given in Table 2. The varieties listed below in the highlights section are listed in yield and trial performance order, highest to lowest. Not all varieties are listed, including those in which seed availability limited the number of trials in which they could be evaluated.

<u>Processing Variety Highlights</u>

NY154; this is a Cornell University developed clone with high yield potential. Trialed in 9 locations in 2015, this clone had the highest overall yield, with a low incidence of common scab (Table 2). The specific gravity was also excellent, averaging 1.083, above the trial average of 1.081. Internal quality was good overall, with some incidence of hollow heart (3%) and vascular discoloration (31%) observed. This variety had a vine maturity that was slightly later than Snowden. Tuber type was oval shaped and chip quality was good out-of-the-field. This represents the second consecutive year that NY154 has yielded well broadly throughout the state in these trials.

NY157; this is another Cornell University clone that was trialed in Michigan for the first time in 2015. The clone had excellent yields, a good size profile, a very low incidence of common scab, and a specific gravity matching the trial average of 1.081. Internal quality was good, where there was no hollow heart recorded and 22% vascular discoloration across trials. The tubers were oval to pear-shaped with a vine maturity slightly later than Snowden.

MSW474-1; this is a Michigan State University clone that was trialed in the Potato Outreach Program for the first time in 2015. Although it was only trialed in two locations its performance was excellent, exhibiting above average yields (522 cwt/A), specific gravity (1.086), and resistance to potato common scab. For the 2015-2016 MRC Box Bin Storage trial it has chipped well out of storage through the most recent sample date of January 4th, 2016.

AF4648-2; this clone was developed by the University of Maine and was evaluated for the first time in 2015 by the Potato Outreach Program. It was evaluated broadly throughout the state in ten different trials. Marketable yields were below the trial average at 448 cwt/A, with specific gravity near the trial average at 1.080. Tuber shape was oval with nice bright skin. This line had excellent resistance to potato common scab, averaging an overall rating of 0.2 across the ten trials. Chip quality has been variable out of storage and will be addressed in the storage report.

W5955-1; this selection has been developed at the University of Wisconsin and 2015 represents the third year of evaluation in the Potato Outreach Program. This variety appears to chip process well from out-of-the-field and from early to mid-season storage. Average marketable yields of the clone were lower than average in 2015, producing 440 cwt/A with specific gravity slightly above average at 1.083. Overall internal quality was good on this line in 2015, with low levels of hollow heart and vascular discoloration. This line exhibited excellent resistance to potato common scab in 2015 and a mid-season maturity. Chip quality out of the field was good in 2015 and storage quality has been good so far in 2015-2016 through January.

MSR127-2; this is a Michigan State University clone with a heavy netted skin, uniform tuber type and excellent resistance to potato common scab. It has been evaluated for multiple years in the Potato Outreach Program, although seed availability in 2015 limited it's evaluation to one trial (MRC Box Bin). In that trial, marketable yields were below the trial average (362 cwt/A) with higher than average specific gravity (1.093) and superior common scab resistance (0.0) compared with the trial average (1.4). Chip quality appears to be good from early storage, and storage quality has held up well in 2015-2016 MRC box bin trials.

B. USPB / SFA Chip Trial Results

The Michigan location of the USPB / SFA chip trial was on Sandyland Farms, LLC in Montcalm County in 2015. Table 3 shows the yield, size distribution and specific gravity of the entries when compared with Atlantic, Lamoka and Snowden (in bold font). Table 4 shows the at-harvest raw tuber quality results. Table 5 shows the out-of-the-field chip quality evaluations from samples processed and scored by Herr Foods, Inc., Nottingham, PA. Table 6 provides the blackspot bruise susceptibility of each entry. Table 7 provides a pre-harvest panel for each of the 10 varieties in the trial.

USPB / SFA Chip Trial Highlights

A Cornell University clone, NY152 topped the yield table in 2015, followed by the check variety Snowden and AF4648-2, all of which yielded above the trial average of 424 cwt/A (Table 3). AF4648-2 and Atlantic had the largest percentage of recorded oversize tubers (25%)(Table 3). Specific gravities for the trial overall were low, with a trial averae of 1.076, with Atlantic (1.081) the highest followed by a three-way tie (1.079) with Snowden, A00188-3C and W6822-3 and then AF4648-2 (1.078). Internal quality across the trial was generally acceptable, but the evidence of in-season environmental stress was observed in some lines (Table 4). Hollow heart was severe in AC03433-1W (40%) and Atlantic (30%) and to a lesser extent in Snowden, AC01151-5W and W6822-3 (all at 3%). Lamoka and CO03243-3W had the highest percentage of vascular discoloration at 27% followed by Snowden (23%). Lamoka exhibited a substantially higher level of internal brown spotting at 23% compared with the trial average of 4%. Table 5 shows the post-harvest chip quality based on samples collected on October 21st, 2015 and processed at Herr Foods, Inc. on November 3rd, 2015. Chip color was generally acceptable across the trial, with NY152 having the highest Agtron score of the trial at 65.2 followed by Lamoka at 64.9. The varieties, listed in ranked order based on quality observations from Herr Foods, Inc. are as follows: A00188-3C, W6822-3, Snowden, AC034331W, CO03243-3W, Lamoka, NY152, AF4648-2, AC01151-5W and lastly Atlantic. W6822-3, Snowden, Atlantic, NY152 and Lamoka showed the greatest susceptibility to blackspot bruising (Table 6).

C. Fresh Market and Variety Trial Results

A description of the freshpack varieties, their pedigree and scab ratings are listed in Table 8. Table 9 shows the overall yield averages from the thirteen russet-type trials located in the following counties: Antrim, Delta, Kalkaska, Monroe, Montcalm, Presque Isle, Van Buren, Cass LaGrange (IN) and St. Joseph. Non-russet-type freshpack trial averages are listed in Table 10 including primarily red-skinned, yellow and round-white types. Large block plantings were conducted at Walther Farms (Caribou Russet, Reveille Russet, W9433-1Rus), Kitchens Farms (Caribou Russet, Reveille Russet, W8152-1Rus), R&E Farms (Caribou Russet, Reveille Russet, W9433-1Rus), Elmaple Farms (Caribou Russet, Reveille Russet) Lippens Potato Farm (Caribou Russet) and L. Yoder Farms (Caribou Russet, Reveille Russet).

Fresh Market Variety Highlights

2015 fresh market variety trial data was compiled into separate summary sheets (Table 9 and 10) based on tuber type (russets and non-russets). A description of the relevant fresh market varieties is given below.

Red Skin

Dakota Ruby; this North Dakota State University variety has a buff dark red skin appearance with a very uniform round tuber shape. In the 2015 freshpack variety trials, this clone had a 353 cwt/A US#1 yield, slightly above the 331 cwt/A average of the check variety Red Norland (Table 10). Internal quality was excellent in this variety with no observed hollow heart, internal brown spot, or brown center, and 5% vascular discoloration. Although common scab pressure was substantial in these trials, this variety exhibited good resistance to it, maintaining an overall average scab rating of 0.5. The maturity of the vines mimicked Red Norland in that they matured relatively early.

Yellow Flesh

Soraya; this variety is licensed by Norika America and it is the first year that it has been evaluated by the Potato Outreach Program. It was trialed in six on-farm trials where it yielded near the top for yellow fleshed lines at 464 cwt/A, although specific gravity was lower than average at 1.059. It exhibited a good size profile with oblong tuber type and deep yellow flesh. In southern trials, a greater percentage of pick outs were observed with 23% in Monroe County (due to knobby appearance), indicating potential susceptibility to heat stress. Along with excellent internal quality, this line had excellent tolerance to common scab. Vines matured mid-season.

MSV093-1Y; this Michigan State University variety has uniform round tuber type with a nice yellow flesh. In 2015, MSV093-1Y yielded 503 cwt/A US#1 across six locations, well above the yellow check line (Molli) average (381 cwt/A US#1) with a medium vine maturity. Internal defects were low in this line with 15% vascular discoloration reported. It also exhibited some tolerance to potato common scab, with an average rating of 0.9. Specific gravity was near the trial average at 1.071, and it exhibited a good size profile with 84% of the harvested tubers falling within the A size class.

Round White

MSU161-1; this Michigan State University variety yielded well in 2015 across four locations at 481 cwt/A US#1, above the round white check variety Reba which yielded 420 cwt/A US#1. Specific gravity was above the freshpack trial average at 1.075 and internal quality was excellent with only 5% vascular discoloration. MSU161-1 was among the round white lines exhibiting greater resistance to potato common scab with an average rating of 1.0. It has a round, uniform tuber type with netted skin with medium vine maturity.

Russet-type

Reveille Russet (ATX91137-1Rus); this variety was crossed in Aberdeen, ID and selected by the Texas A&M breeding program in 1993. In 2014 it was named Reveille Russet. In 2015 it was trialed in twelve locations across the state. It was among the highest yielding lines in 2015 with 535 cwt/A US#1, above the trial average of 434 cwt/A US#1. There was very little common scab observed in this line in 2015 with a rating of 0.3 and it matured overall slightly later than Russet Norkotah. 84% of the total yield was classified as US#1 giving it a nice size profile. The tuber's appearance was oblong to blocky with a nice russeted skin. The variety seems to be well adapted to all of the regions where it was evaluated as it performed well broadly across the state with good internal quality across the trials.

Caribou Russet (AF3362-1Rus); this University of Maine selection had a 525 cwt./A US#1 yield, placing it near the top for US#1 yields in 2015 (across twelve locations). It had an average specific gravity of 1.073 and no incidence of hollow heart reported (Table 9). The tuber appearance was long and blocky with a nice netted russet skin. Vine maturity was medium. This variety appears very promising for the early russet market. Caribou Russet performed well across all geographic latitudes and it also has common scab tolerance and appears to be more resistant to herbicide injury than Silverton.

W9433-1Rus; this University of Wisconsin selection had a 513 cwt/A US#1 yield with an average specific gravity of 1.073. It had a relatively large size profile with 31% of tubers classified as oversized although only 1% hollow heart was reported. Tuber appearance was light russeted skin with oblong to blocky shape. Vine maturity was medium and it showed some tolerance to potato common scab. It appeared to yield well under un-irrigated conditions as the top yielding russet line in the Presque Isle County trial.

Mountain Gem Russet (A03158-2TERus); this variety was crossed and selected in Aberdeen, Idaho and yielded above average in 2015 at 494 cwt/A US#1 (across 10 locations). It had an average specific gravity of 1.076 and exhibited some tolerance to potato common scab. While overall trial averages indicate that some hollow heart was detected (12%), it tended to be more of an issue in southern trial locations. Tuber appearance was blocky to long in shape with a nice dark russeted skin type. It had a medium vine maturity.

Table 1

2015 MSU Processing Potato Variety Trials

Entry	Pedigree	2014 Scab Rating*	Characteristics
Atlantic	Wauseon X B5141-6 (Lenape)	2.6	High yield, early maturing, high incidence of internal defects, high specific gravity
FL1879	Snowden X FL1207	2.5	High yield, late maturity, large tuber type, late season storage, medium specific gravity
Lamoka (NY139)	NY120 X NY115	1.5	High yield, mid-late season maturity, medium specific gravity, oval to oblong tuber type, low internal defects, long term chip quality
Manistee (MSL292-A)	Snowden X MSH098-2	2.5	Average yield, scab resistance similar to Snowden, medium specific gravity, long storage potential, uniform, flat round tuber type, heavy netted skin
MegaChip (W1201)	WISCHIP X FYF85	1.0	High specific gravity, round oval tubers, medium-large size, common scab resistant, deep apical eye
Pike (NYE55-35)	Allegany X Atlantic	1.3	Average yield, early to mid-season maturity, small tuber size profile, early storage, some internal defects, medium specific gravity
Pinnacle (W5015-12)	Brodick X W1355-1	2.6	High tuber set and yield, medium-late vine maturity, uniform size tubers, tubers tend toward flat shape, very flat in some environments
Snowden (W855)	B5141-6 X Wischip	2.6	High yield, late maturity, mid-season storage, reconditions well in storage, medium to high specific gravity
A00188-3C	A91790-13 X Dakota Pearl	1.5	Medium yield, scaly buff skin, high specific gravity, mid-season chip quality, common scab resistant
A01143-3C	COA95070-8 X Chipeta	1.8	Average yielding, scaly buff chipper, smaller tuber size, late maturity, high incidence of sheep-nose
AC01151-5W	COA96142-7 X NDA2031-2	1.5	Low yielding, high specific gravity, medium maturity, medium vine size, round tuber with white skin and white flesh
AC03433-1W	A94322-8C X COA96141-4	-	High yield potential with good size profile, medium maturity, resistance to internal defects and black spot bruise
AF4648-2	NY132 X Liberator	-	High yield potential, common scab resistant, high specific gravity, low internal defects

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data and descriptions provided by Potato Outreach Program with novel line information derived from MSU Potato Breeding and Genetics Program and other potato breeding programs.

Entry	Pedigree	2014 Scab Rating*	Characteristics
AF4975-3	Atlantic X W1355-1	-	High yield potential, high specific gravity, good chip color
CO03243-3W	BC894-2W X A91790-13W	1.5	Large vine size with medium maturity, large yield potential, medium specific gravity
MSR127-2	MSJ167-1 X MSG227-2	1.4	Scab resistant, high specific gravity, good chip quality from storage, above average yield potential, medium-late maturity
MST441-1	Kalkaska X OP	-	Average yield potential, common scab resistant, medium specific gravity
MSU383-A	MSP292-7 X MSG227-2	-	Medium/high yield potential, common scab resistant, medium specific gravity
MSV033-1	Beacon Chipper X MSJ147-1	-	High yield potential, common scab susceptible, high specific gravity
MSX540-4	MSR061-1 X NY139	-	Medium/high yield potential, common scab, late blight and PVY resistant, high specific gravity
MSW474-1	MSN190-2 X MSP516-A	-	Average yield potential, common scab resistant, moderately susceptible to late blight, high specific gravity
NY148	B38-14 X Marcy	1.6	High yield potential, high specific gravity, moderate common scab resistance, late maturing
NY152	NYH15-5 X Marcy	1.5	High yield potential, medium to high specific gravity, moderate resistance to common scab
NY154	B3814 X Marcy	1.6	High yield potential, high specific gravity, moderate common scab resistance, late maturing
NY157	White Pearl X Marcy	-	High yield potential, low internal defects, medium specific gravity, moderate common scab resistance

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data and descriptions provided by Potato Outreach Program with novel line information derived from MSU Potato Breeding and Genetics Program and other potato breeding programs.

Entry	Pedigree	2014 Scab Rating*	Characteristics
NYK28-18	Snowden X E48-2	-	Moderately high yield potential, high specific gravity, common scab resistant
W5955-1	Pike X C31-5-120	1.6	Average yield, high specific gravity, size profile similar to Atlantic, long storage potential, pear-shaped
W6822-3	White Pearl X Dakota Pearl	1.8	Average yield, medium maturity, high specific gravity, susceptible to internal defects, moderate common scab resistance

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. Common scab data and descriptions provided by Potato Outreach Program with novel line information derived from MSU Potato Breeding and Genetics Program and other potato breeding programs.

Table 2

2015 Statewide Chip Processing Potato Variety Trials
Overall Average- Ten Locations

LINE	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	OTF CHIP SCORE[3]	RAW TUBER QUALITY[2] (%) HH	VD	IBS	BC	COMMON SCAB RATING[4]	VINE VIGOR[5]	VINE MATURITY[6]	COMMENTS
MSV033-1[j]	765	815	94	4	86	8	2	1.081	1.0	3	58	3	0	0.0	3.5	3.4	uniform round tuber type, heat sprouts, sticky stolons
MSV313-2[gj]	631	651	97	2	53	44	1	1.083	1.0	0	18	0	0	0.5	3.8	2.8	large round tuber type, heavy netted skin, gc
NY152[i]	596	676	88	10	81	7	2	1.074	1.0	0	13	3	0	1.2	2.5	3.5	sl compressed tuber type
NY154[abcdefghj]	592	629	93	6	86	7	1	1.083	1.1	3	31	2	0	0.8	3.1	3.2	netted skin type, flat to oval tuber type, alligator hide
NY157[abcdefgj]	552	595	92	6	85	7	2	1.081	1.0	0	23	1	3	0.4	3.1	2.9	alligator hide, oval to pear shaped tuber type
A01143-3C[aefgh]	535	610	87	9	83	4	4	1.081	1.2	0	23	5	0	0.6	3.5	3.5	knobby tuber shape, sheepnosing in pickouts, heat sprouts, sl alligator hide
FL1879[aefj]	**533**	**560**	**93**	**6**	**68**	**25**	**1**	**1.079**	**1.1**	**5**	**22**	**13**	**3**	**0.6**	**2.8**	**2.3**	**severe pink eye, alligator hide, flattened tuber shape**
MSW474-1[gj]	522	642	80	20	78	2	0	1.086	1.0	0	3	0	0	0.3	4.0	2.9	compressed tuber type, heavy netted skin, sl sheep nose
Snowden[abefghij]	**514**	**559**	**91**	**7**	**81**	**10**	**2**	**1.083**	**1.0**	**2**	**40**	**2**	**0**	**2.1**	**3.3**	**2.0**	**compressed tuber type, pink eye, netted skin type, gc**
MSX540-4[gj]	507	572	88	11	87	1	1	1.096	1.3	0	24	3	0	1.0	4.0	2.5	sticky stolons, round pointed tuber type
W6822-3[ij]	502	562	88	9	76	12	3	1.085	1.0	2	14	23	0	0.6	3.3	2.2	points in tubers, moderate pinkeye
Pike[aefj]	**474**	**502**	**91**	**9**	**86**	**5**	**0**	**1.085**	**1.0**	**0**	**25**	**28**	**0**	**0.0**	**3.0**	**2.6**	**sl alligator hide, round to pear shaped tuber type**
AF4975-3[aefgj]	466	517	89	8	76	13	3	1.082	1.5	2	19	20	7	0.4	3.6	2.4	heat sprouts, knobby tuber shape, raised lenticels
CO03243-3W[abcdefghij]	461	497	92	6	80	12	2	1.076	1.2	1	18	0	0	1.8	2.9	3.2	uniform round tuber type, thin skin, sl rot
Manistee[abcdefgj]	455	483	93	6	81	12	1	1.081	1.0	4	27	1	0	1.8	2.6	2.2	compressed tuber type, netted skin type, sl alligator hide
Lamoka[abcdefgij]	**449**	**477**	**94**	**4**	**80**	**14**	**2**	**1.082**	**1.0**	**0**	**38**	**6**	**0**	**0.6**	**3.6**	**2.7**	**oval to pear shaped tuber type, alligator hide**
AF4648-2[abcdefghij]	448	494	90	8	79	11	2	1.080	1.2	1	6	1	0	0.2	2.7	2.8	oval shaped tuber type, bright tuber appearance, sl alligator hide
W5955-1[abcdefghj]	440	490	89	8	76	13	3	1.083	1.0	5	19	7	1	0.3	3.3	2.9	alligator hide, netted skin type, uniform round shaped tubers
NY148[h]	426	475	90	7	85	5	3	1.082	1.0	0	0	0	0	0.5	2.0	4.0	
Atlantic[i]	**418**	**452**	**93**	**4**	**68**	**25**	**3**	**1.081**	**1.0**	**30**	**3**	**0**	**0**	**0.7**	**3.0**	**2.0**	**netted skin type**
AC01151-5W[i]	400	542	74	24	71	3	2	1.072	1.0	3	10	3	0	2.7	2.5	4.0	gc
A00188-3C[i]	384	487	79	13	76	3	8	1.079	1.0	0	7	0	0	0.0	4.0	3.5	pointed tubers in pickouts
MSR127-2[g]	362	428	85	15	85	0	0	1.093	1.0	0	20	0	0	0.0	3.5	2.5	small uniform tuber size
AC03433-1W[i]	320	375	85	7	62	23	8	1.068	1.0	40	20	0	0	1.7	1.5	3.5	
MEAN	**490**	**545**	**89**	**9**	**78**	**11**	**2**	**1.081**	**1.1**	**4**	**20**	**5**	**1**	**0.8**	**3.1**	**2.9**	tr = trace, sl = slight, N/A = not available gc=growth crack

2015 Chip Variety Trial Sites

[a]County Line Farms; Allegan Co.
[b]Crooks Farms; Set #1; Montcalm Co.
[c] Crooks Farms; Set#2; Montcalm Co.
[d] Crooks Farms; Set#3; Montcalm Co.
[e] Lennard Ag. Company; St. Joseph Co.
[f]Main Farms; Montcalm Co.
[g] MSU Box Bin Trial; Montcalm Co.
[h] Sandyland Farms; Set #1; Montcalm Co.
[i] Sandyland Farms; SFA Trial (replicated); Montcalm Co.
[j] Walther Farms (replicated); St. Joseph Co.

[1]SIZE
Bs: < 4.0 oz.
As: 4.0 - 10.0 oz.
OV: > 10 oz.
PO: Pickouts

[3]CHIP COLOR SCORE - Snack Food Association Scale
(Out of the field)
Ratings: 1 - 5
1: Excellent
5: Poor

[2]TUBER QUALITY (percentage of tubers)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[5]VINE VIGOR RATING
Ratings: 1 - 5
1: Slow Emergence
5: Early Emergence (vigorous vine, some flowering)

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

[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

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
NY152	596	676	88	10	81	7	2	1.074
Snowden	**579**	**634**	**91**	**6**	**79**	**12**	**3**	**1.079**
AF4648-2	457	493	93	4	68	25	3	1.078
Atlantic	**418**	**452**	**93**	**4**	**68**	**25**	**3**	**1.081**
AC01151-5W	400	542	74	24	71	3	2	1.072
CO03243-3W	384	446	86	12	77	9	2	1.070
A00188-3C	384	487	79	13	76	3	8	1.079
W6822-3	356	435	82	12	76	6	6	1.079
Lamoka	**344**	**379**	**91**	**6**	**75**	**16**	**3**	**1.077**
AC03433-1W	320	375	85	7	62	23	8	1.068
MEAN	**424**	**492**	**86**	**10**	**73**	**13**	**4**	**1.076**

*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
NY152	0	13	3	0
Snowden	**3**	**23**	**3**	**0**
AF4648-2	0	3	0	0
Atlantic	**30**	**3**	**0**	**0**
AC01151-5W	3	10	3	0
CO03243-3W	0	27	0	0
A00188-3C	0	7	0	0
W6822-3	3	13	10	0
Lamoka	**0**	**27**	**23**	**0**
AC03433-1W	40	20	0	0

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

Table 5. 2015 Post-Harvest Chip Quality[1]						
	Agtron	SFA[2]	Specific	Percent Chip Defects[3]		
Entry	Color	Color	Gravity	Internal	External	Total
NY152	65.2	3.0	1.077	16.5	11.1	27.6
Snowden	**62.8**	**3.0**	**1.075**	**31.1**	**16.4**	**47.5**
AF4648-2	62.0	3.0	1.083	30.3	22.5	52.8
Atlantic	**58.2**	**4.0**	**1.072**	**29.3**	**40.3**	**69.6**
AC01151-5W	53.1	3.0	1.068	9.3	4.0	13.3
CO03243-3W	62.1	2.0	1.074	22.5	30.9	53.4
A00188-3C	62.2	2.0	1.075	9.7	16.4	26.1
W6822-3	61.3	2.0	1.076	14.2	16.4	30.6
Lamoka	**64.9**	**3.0**	**1.075**	**19.8**	**12.9**	**32.7**
AC03433-1W	56.2	3.0	1.067	14.5	23.9	38.4

[1] Samples collected October 21st and processed by Herr Foods, Inc., Nottingham, PA on November 3rd, 2015.

Chip defects are included in Agtron and SFA samples.

[2] SFA 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.

Table 6. Black Spot Bruise Test																		
	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
NY152	14	9	1				24	58	0.5	10	9	3	2			24	42	0.9
Snowden	**19**	**5**					**24**	**79**	**0.2**	**9**	**9**	**6**	**1**			**25**	**36**	**1.0**
AF4648-2	20	1					21	95	0.0	19	5					24	79	0.2
Atlantic	**20**	**3**	**1**				**24**	**83**	**0.2**	**10**	**10**	**3**			**1**	**24**	**42**	**0.9**
AC01151-5W	20	4					24	83	0.2	16	7	1				24	67	0.4
CO03243-3W	22	2					24	92	0.1	14	10					24	58	0.4
A00188-3C	21	2	1				24	88	0.2	20	4					24	83	0.2
W6822-3	19	6					25	76	0.2	1	5	9	2	2	5	24	4	2.6
Lamoka	**21**	**3**					**24**	**88**	**0.1**	**10**	**9**	**3**	**1**			**23**	**43**	**0.8**
AC03433-1W	20	4					24	83	0.2	18	6					24	75	0.3

[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 at least 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 8/12/15								
								Average[5]
	Specific	Glucose[1]	Sucrose[2]	Canopy		Number of		Tuber
Entry	Gravity	%	Rating	Rating[3]	Uniform.[4]	Hills	Stems	Weight
NY152	1.077	0.004	0.271	100	100	3	9	2.84
Snowden	1.073	0.004	0.621	100	100	4	20	3.31
AF4648-2	1.076	0.011	0.740	100	100	3	17	2.79
Atlantic	**1.078**	**0.005**	**0.927**	**100**	**100**	**4**	**10**	**3.94**
AC01151-5W	1.073	0.011	0.626	100	100	3	14	1.84
CO03243-3W	1.076	0.004	0.372	100	100	4	13	3.38
A00188-3C	1.072	0.007	0.912	100	100	4	25	3.20
W6822-3	1.079	0.004	0.733	100	100	4	13	4.04
Lamoka	**1.075**	**0.006**	**2.025**	**100**	**100**	**4**	**15**	**4.95**
AC03433-1W	1.070	0.007	0.718	100	100	4	12	3.74

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.

Table 7B. Pre-Harvest Panel, 8/31/15								
								Average[5]
	Specific	Glucose[1]	Sucrose[2]	Canopy		Number of		Tuber
Entry	Gravity	%	Rating	Rating[3]	Uniform.[4]	Hills	Stems	Weight
NY152	1.074	0.002	0.305	100	100	4	12	3.98
Snowden	1.076	0.002	0.411	100	100	3	14	5.17
AF4648-2	1.070	0.008	0.546	100	100	3	11	4.28
Atlantic	**1.078**	**0.004**	**0.454**	**75**	**100**	**4**	**12**	**6.85**
AC01151-5W	1.067	0.010	0.574	100	100	3	10	2.59
CO03243-3W	1.078	0.003	0.550	100	100	3	14	3.33
A00188-3C	1.075	0.004	1.150	100	100	4	25	2.97
W6822-3	1.079	0.003	1.011	75	100	4	9	3.54
Lamoka	**1.081**	**0.003**	**0.761**	**75**	**100**	**3**	**15**	**4.06**
AC03433-1W	1.087	0.007	0.649	100	75	5	14	3.87

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.

Table 8

2015 MSU Tablestock Potato Variety Trials

Russet type

Entry	Pedigree	2014 Scab Rating*	Characteristics
Caribou Russet (AF3362-1Rus)	Reeves Kingpin X Silverton Russet	1.0	A long russet with good yield, processing potential and generally good appearance, common scab tolerance, early bulking potential, medium russet skin, tolerant to Sencor & Linuron
Goldrush Russet (ND1538-1Rus)	ND450-3Rus X Lemhi Russet	0.8	Medium maturity, oblong-blocky to long tubers, bright white flesh, common scab resistance, average yield potential
Mountain Gem Russet (A03158-2TE)	A98292-2 X A98104-4	-	High yield potential, common scab and tuber late blight resistance, medium-late maturity
Payette Russet (A02507-2LB)	EGA09702-2 X Gemstar	-	High yield potential, high specific gravity, late blight and PVY resistance, late maturing
Russet Norkotah (ND534-4Rus)	ND9526-4Rus X ND9687-5Rus	1.8	Average yield, mid-season maturity, long to oblong tubers, heavy russet skin, low specific gravity
Reveille (ATX91137-1Rus)	Bannock Russet X A83343-12	1.1	Common scab tolerant, some incidence of growth defects, high yield potential
Silverton Russet (AC83064-6)	A76147-2 X A 7875-5	1.6	High yield, oblong to long blocky tuber type, medium netted russet skin, masks PVY, medium specific gravity, possible Sencor & Linuron susceptibility
Targhee Russet (A01010-1)	A92303-7 X A96004-8	-	High yield potential, hollow heart, black spot bruise, and soft rot resistance
A06084-1TE	A98345-1 X A97267-1	-	High yield potential, heavy russet skin

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

A08014-11TE	Blazer Russet X A98196-5	-	Early maturing, oblong shape, medium yield potential
A09001-12TE	A03293-2 X A98345-1	-	Good yield potential, early maturity
A06021-1TRus	A99031-1TE X A96013-2	1.0	Medium yield potential, prominent lenticels, common scab tolerance
AC05039-2Rus	A99032-2TE X COA00287	-	-
AF4124-7Rus	A8469-5 X SC9512-4	1.8	Below average yield potential, good internal quality
AF4953-6Rus	W3160-51LB X W1836-3Rus	-	Late maturity, moderate resistant to common scab, long-oblong shape
AF4615-5Rus	A94066-42LB X COA00329-3	-	Medium-late maturity, moderate susceptibility to common scab, moderate resistance to late blight, long-oblong shape
AF5164-19Rus	Reeves Kingpin X AF4185-1	-	Medium-late maturity, verticillium wilt resistant, golden nematode resistant, long-oblong shape
AF5312-1Rus	A86102-6 X CO82142-4	-	Medium maturity, resistant to common scab, moderately resistant to black spot bruise, long-oblong shape
AF5314-2Rus	Bannock Russet X W1151Rus	-	Medium maturity, resistant to common scab and black spot bruise, long-oblong shape
CO05068-1Rus	-	-	-

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

CO05175-1Rus	-	-	-
CO07015-4Rus	-	-	-
CO07049-1Rus	-	-	-
ND8068-5Rus	ND2667-9Russ X ND4233-1Russ	-	Very early vine maturity, susceptible to common scab, good storage, attractive tubers with gold russet skin, resistant to sugar end defect
W8152-1Rus	A93004-3Rus X CO94035-15Rus	1.6	High yield potential, blocky shape, high specific gravity, long storage potential
W9433-1Rus	Calwhite X A96023-6	1.3	Light russet skin type, less internal defects than Russet Norkotah, tolerance to verticillium wilt and early blight, medium-late maturity, oblong to long blocky tuber type
W9519-3Rus	W1836-3rus X W1151rus	-	Medium maturity
W9742-3Rus	A99134-1 X AOND95249	-	Medium/late maturity
W10043-1Rus	Bannock Russet X Millennium Russet	-	Medium/late maturity
W10074-8Rus	Premier Russet X Freedom Russet	-	Late maturity

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

2015 MSU Tablestock Potato Variety Trials

Yellow Flesh Type

Entry	Pedigree	2014 Scab Rating*	Characteristics
Lehigh	Keuka Gold X Pike	-	High yield potential, round to oblong tuber shape, blackspot bruise resistance, common scab tolerance
Merlot	French Fingerling X Red Gold	0.5	High yield, small to medium oval tubers, medium to late maturity, red skin yellow flesh
Molli	I-79.318 X I-76.20/5	-	Early maturing, dark yellow flesh, round to oval shape
Oneida Gold (W6703-1Y)	Satina X W2275-2Y	1.2	Good yield, medium maturity, slightly better shape than W6703-5Y, common scab tolerant, medium yellow flesh, buff to slightly netted skin type
Soraya	-	-	High yield, late maturity, large oval-oblong tubers with yellow skin and yellow flesh
A02267-1Y	Inca Gold X ND5256-7R	-	Bright yellow skin, light yellow flesh
A05182-7Y	ATND93331-2Pinto X A99433-5Y	-	Champagne color, good size profile, smooth skin
CO05037-3W/Y	-	-	-
CO07370-1W/Y	-	-	-
MST252-1Y	MSL024-AY X MSL211-3	-	Moderate yield potential, high tolerance to common scab

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

MSV093-1Y	McBride X MSP408-14Y	-	High yield potential, moderate tolerance to common scab, yellow flesh
W9576-11Y	Dakota Pearl X Gala	-	Medium maturity
W9576-13Y	Dakota Pearl X Gala	-	Medium maturity
W9577-6Y	Dakota Pearl X Alegria	-	Late maturity
VC1009-1W/Y	Agria X MN12823	0.5	High yield, medium maturity, medium specific gravity

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

2015 MSU Tablestock Potato Variety Trials

Red Skin Type

Entry	Pedigree	2014 Scab Rating*	Characteristics
Dakota Ruby	ND7188-4R X ND5256-7R	-	Uniform round, smooth tubers with white flesh, vigorous vine
Red Norland	ND 626 X Red Kote	1.4	Early maturity, medium yield, low specific gravity, smooth round to oblong tubers, medium red skin color
CO07102-1R	-	-	-
ND6002-1R	NorDonna x Bison	-	Uniform tubers, bright red skin, good yield potential, medium vine maturity and specific gravity
ND7132-1R	ND5002-3R X ND5438-1R	-	Medium maturity and yield potential, bright red skin with white flesh, oval to oblong shape

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

2015 MSU Tablestock Potato Variety Trials

Round white & Novelty type

Entry	Pedigree	2014 Scab Rating*	Characteristics
Onaway	USDA X96-56 X Katahdin	2.0	High yield, early maturity, round tuber type, low specific gravity, smooth skin, white flesh, medium deep eyes, few internal defects
Reba (NY 87)	Monona X Allegany	2.3	High yield, bright tuber appearance, low incidence of internal defects, mid to late season maturity, medium-low specific gravity
Michigan Purple	W870 X Maris Piper	-	Strong purple skin, white flesh. High yield potential with mid-early vine maturity. Susceptible to common scab
MSQ131-A	MSF373-8 X Missaukee	1.9	High yielding, large tuber size, round to oval tuber type
MSU161-1	MSM182-1 X MSL211-3	-	High yield potential, round white, moderate resistance to late blight
MSS487-2	Stirling X Missaukee	-	High yield potential, round white, resistant to late blight
MSS576-5SPL	MSI005-20Y X MSL211-3	-	High yield potential, white flesh, pink-splashed skin, resistant to late blight, low black spot bruise incidence
MST386-1P	Michigan Purple X Liberator	-	High yield potential, bright purple skin with white flesh, high tolerance to common scab

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

Table 9

2015 Statewide Russet Freshpack Potato Variety Trials
Overall Averages- Thirteen Locations

	CWT/A		PERCENT OF TOTAL[1]						RAW TUBER QUALITY[2](%)				COMMON SCAB	VINE	VINE	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	RATING[3]	VIGOR[4]	MATURITY[5]	COMMENTS[6]
W10074-8Rus[jlm]	614	681	90	9	71	19	2	1.088	33	0	0	0	0.5	4.0	3.2	tuber break down noted, sticky stolons, dark russet skin type, heavy lenticels
W9742-3Rus[ejm]	572	667	83	4	30	53	13	1.092	6	16	8	0	1.0	4.0	2.3	pear shaped tubers and knobs in pickouts
Reveille Russet[abcdefghijkm] (ATX91137-1Rus)	535	628	84	12	61	23	4	1.066	0	17	4	0	0.3	2.3	2.7	nice uniform tuber type, tubular shape, tr heat sprouts, dark russet skin type, nice general appearance
Caribou Russet[abcdefghijklm] (AF3362-1Rus)	525	595	87	10	64	23	3	1.073	0	30	13	0	0.3	3.6	2.5	**sl alligator hide, nice large uniform blocky tubers, misshapened pickouts, heavy netted skin**
W9433-1Rus[abcdefghijklm]	513	594	87	6	56	31	7	1.073	1	14	21	0	0.7	3.2	3.1	sl alligator hide, very large tuber size profile, misshapen and knobs in pickouts, light russet skin type, heavy lenticels,
A06021-1TRus[beijl]	499	587	85	11	65	20	4	1.077	15	24	20	0	0.1	2.8	2.1	**alligator hide, misshapened pickouts, nice blocky tuber type, light to medium russet skin type**
W9519-3Rus[em]	496	571	88	8	68	20	4	1.065	6	11	3	0	0.6	4.0	2.3	
Mountain Gem Russet[abcdeghijk] (A03158-2TE)	494	597	82	12	60	22	6	1.076	12	10	0	0	0.4	3.2	2.8	alligator hide, large tuber size profile, blocky to long uniform tuber type, many eyes on tubers, eyes can be deep, nice dark russet skin type
Silverton Russet[abcdefghijkm]	**463**	**562**	**81**	**14**	**64**	**17**	**5**	**1.067**	**6**	**18**	**7**	**0**	**0.4**	**3.6**	**2.9**	**alligator hide, misshapen and gc in pickouts, oval to oblong tuber type, medium heavy netted russet skin type, heat sprouts**
GoldRush Russet[bdk]	**446**	**570**	**79**	**14**	**68**	**11**	**7**	**1.069**	**13**	**3**	**0**	**0**	**0.0**	**2.7**	**2.2**	**nice general appearance, dark heavy russet skin type**
Payette Russet[bijl] (A02507-2LBRus)	440	551	80	11	63	17	9	1.085	3	8	3	0	0.2	2.3	3.1	oval blocky tuber type, medium russet skin, misshapened pickouts
AF4953-6Rus[bcdeijl]	433	567	78	10	62	16	12	1.078	11	6	8	0	0.8	3.1	3.1	**misshapened knobby pickouts, oval to oblong non-uniform tuber type, light to medium russet skin**
AF4124-7Rus[bcdgij]	399	489	82	12	65	17	6	1.080	0	19	2	0	0.7	3.0	2.0	**tr alligator hide and pinkeye, nice appearance, good tuber type, light to medium russet skin, sl powdery scab**
CO05175-1Rus[bcdefghik]	396	536	72	16	58	14	13	1.077	16	8	0	1	0.6	3.1	3.1	alligator hide, blocky oblong tuber type, heavy lenticels, heat sprouts, light to medium russet skin
CO05068-1Rus[bcdfghikm]	394	511	76	20	69	7	4	1.086	16	7	12	1	0.5	2.9	3.2	sl alligator hide, gc and misshapened pickouts, oval to oblong tuber type, light to medium russet skin, heat sprouts
A09001-12TERus[bijl]	392	464	85	9	65	20	6	1.088	28	5	0	0	1.3	3.1	2.4	**sl pinkeye, knobby and misshapened pickouts, round to oval tuber type, medium russet skin, heavy eyebrowing**
W10043-1Rus[lm]	378	416	91	4	58	33	5	1.080	15	20	0	0	0.5	2.5	2.5	misshapened and gc in pickouts, heavy netted skin
Russet Norkotah[abcdefghijklm]	**375**	**472**	**77**	**19**	**68**	**9**	**3**	**1.068**	**7**	**12**	**1**	**0**	**1.0**	**3.3**	**1.6**	**sl alligator hide, small uniform tuber type, nice dark russet skin**
A06084-1TERus[behij]	368	481	69	26	57	12	5	1.077	5	11	6	0	0.1	3.5	2.3	**nice general appearance, small tubular tuber type, light to medium russet skin**
A08014-11TERus[bil]	366	480	76	18	61	15	6	1.074	17	7	0	0	0.2	2.8	2.3	**misshapened knobby pickouts, sticky stolons, medium to dark russet skin type**
Targhee Russet[bcim] (A01010-1)	365	462	79	15	75	4	6	1.076	0	11	0	0	0.7	3.5	2.6	sl alligator hide, tubular non-uniform tuber type, heavy russet skin
ND8068-5Rus[abcdghjkm]	278	361	74	23	71	4	3	1.079	7	13	3	0	1.5	3.9	1.6	severe alligator hide, russet burbank-like skin, severe pitted scab, common scab susceptible, light russet skin,
ACO05039-2Rus[bcdeghi]	240	381	63	35	58	5	3	1.077	0	13	0	0	0.2	3.5	1.4	**alligator hide, small tuber type, medium to heavy russet skin**
CO07015-4Rus[acjl]	233	361	63	35	61	2	3	1.072	3	8	3	0	0.2	3.1	1.3	nice oval blocky tuber type, heavy russet skin
MEAN	**434**	**531**	**80**	**14**	**62**	**18**	**6**	**1**	**9**	**12**	**5**	**0**	**1**	**3**	**2**	tr = trace, sl = slight, N/A = not available

gc=growth crack

2015 Russet Variety Trial Sites

[a] Horkey Brothers. Monroe Co.
[b] Elmaple Farm; Kalkaska Co.
[c] Crawford Farms; Montcalm Co.
[d] Kitchen Farms; Antrim Co.
[e] Walther Farms (Norkotah); Van Buren Co. (Replicated)
[f] Walther Farms (Silverton); St. Joseph Co. (Replicated)
[g] VanDamme Farms; Delta Co.
[h] Erke Farms, Presque Isle Co.
[i] Walther Farms (pinkeye); St. Joseph Co.
[j] NFPT (selected lines replicated); Walther Farms; St. Joseph Co.
[k] Lennard Ag. Co.; LaGrange Co. IN
[l] P.O.P MRC Russet Trial, Montcalm Co.
[m] PBG MRC Russet Trial, Montcalm Co.(replicated)

[1]SIZE
Bs: < 4.0 oz.
As: 4.0 - 10.0 oz.
OV: > 10 oz.
PO: Pickouts

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

[3] 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

[4]VINE VIGOR RATING
Ratings: 1 - 5
1: Slow Emergence
5: Early Emergence
(vigorous vine, some flowering)

[5]VINE MATURITY RATING
Ratings: 1 - 5
1: Early (vines completely dead)
5: Late (vigorous vine, some flowering)

Table 10

2015 Statewide Freshpack Potato Variety Trials
Overall Average- Six Locations

TYPE	LINE	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	RAW TUBER QUALITY[2] (%) HH	VD	IBS	BC	COMMON SCAB RATING[3]	VINE VIGOR[4]	VINE MATURITY[5]	COMMENTS
RED / PURPLE SKIN	MST386-1P[aef]	560	592	95	1	69	26	4	1.080	0	23	0	0	1.8	3.8	3.2	large uniform round tuber type, nice purple skin and white flesh
	ND7132-1R[acef]	432	485	89	8	77	12	3	1.066	0	28	3	0	1.6	3.5	2.5	uniform oval tuber type, nice red skin color, netted skin
	CO07102-1R[ab]	391	459	85	12	84	1	3	1.068	0	5	0	0	3.8	2.0	0.5	nice smooth skin type, good reddish purple color
	Merlot[abcdef]	368	505	69	28	69	0	3	1.078	0	17	0	0	1.0	2.6	3.1	oval to oblong shaped tuber type, light red netted skin
	ND6002-1R[acef]	363	414	86	12	78	8	2	1.066	0	10	0	0	1.8	3.5	2.0	alligator hide, small uniform tuber type, nice red skin color
	Dakota Ruby[abcf]	353	428	79	20	79	0	1	1.074	0	5	0	0	0.5	2.7	1.8	uniform round tubers, nice buff red skin
	Dark Red Norland[abcef]	**331**	**384**	**82**	**16**	**81**	**1**	**2**	**1.065**	**0**	**14**	**2**	**0**	**1.5**	**3.7**	**1.4**	**alligator hide smooth red skin, nice white flesh**
ROUND WHITE	Whitney[e]	651	725	90	8	69	21	2	1.053	10	20	0	50	2.0	2.5	2.0	bright white tuber appearance, smooth skin type
	MSU161-1[acef]	481	542	87	11	81	6	2	1.075	0	5	0	0	1.0	3.6	2.9	alligator hide uniform round tuber type, netted skin
	MSS487-2[abdef]	454	522	87	13	83	4	0	1.072	0	0	0	0	1.3	3.1	2.9	uniform round tuber type, heavy netted skin
	MSQ131-A[de]	442	497	89	10	81	8	1	1.068	1	3	0	0	1.6	3.1	2.9	uniform round tuber type, bright white skin
	MSS576-5SPL[acef]	442	481	90	9	79	11	1	1.071	0	13	0	0	1.8	4.1	2.6	bright white tuber appearance, pink splash around eyes
	Reba[acdef]	**420**	**470**	**88**	**11**	**79**	**9**	**1**	**1.072**	**0**	**2**	**0**	**4**	**1.0**	**3.6**	**2.4**	**tr alligator hide, large oval tuber type, deep apical eyes**
	Onaway[d]	292	401	73	18	70	3	9	1.059	0	20	0	0	0.5	3.5	1.5	poor tuber shape, poor overall appearance
YELLOW SKIN	VC1009-1W/Y[abcdef]	507	634	78	21	75	3	1	1.079	2	23	0	0	1.1	3.3	3.9	uniform yellow flesh color, flattened tuber shape, sticky stolons
	MSV093-1Y[abcdef]	503	554	90	9	84	6	1	1.071	0	15	0	0	0.9	3.5	3.0	alligator hide nice uniform round tuber type, nice yellow flesh
	Soraya[abcdef]	464	547	83	12	75	8	5	1.059	0	5	0	2	0.3	3.3	2.5	alligator hide, nice deep yellow flesh, oblong tuber type, points in pickouts
	W9576-11Y[bd]	452	588	75	24	74	1	1	1.059	0	25	0	0	0.8	3.0	1.9	tr alligator hide, buff skin type, nice yellow flesh color,
	A05182-7Y[e]	425	707	60	39	60	0	1	1.069	0	30	0	0	3.5	3.0	3.0	light yellow flesh, oval tuber type, powery scab lesions present
	W9576-13Y[bd]	410	518	80	18	78	2	2	1.074	0	15	0	5	0.5	3.3	2.0	smooth waxy skin, nice yellow flesh color
	W9577-6Y[bd]	391	467	83	16	82	1	1	1.070	0	30	5	0	0.0	3.3	2.3	oval tuber type, buff skin type
	Molli[abcdef]	**381**	**473**	**77**	**20**	**75**	**2**	**3**	**1.069**	**0**	**12**	**2**	**0**	**1.3**	**4.1**	**1.7**	**alligator hide oval tuber type, light waxy yellow skin**
	MST252-1Y[de]	350	432	82	14	74	8	4	1.070	0	15	0	0	0.5	2.3	2.3	netted skin type, gc in pickouts, cream colored flesh
	A02267-1Y[abcdef]	342	436	78	21	76	2	1	1.064	0	12	0	0	1.1	3.3	2.7	pink blotching around eyes, yellow flesh
	Lehigh[d]	329	361	91	5	78	13	4	1.073	0	0	0	0	0.0	2.0	1.5	netted skin type, gc in pickouts, yellow flesh, oval tuber type
	Oneida Gold[abcdef]	281	370	75	24	74	1	1	1.075	0	15	0	0	0.4	3.2	2.3	alligator hide, small flat round tuber type, buff skin type
	CO07370-1W/Y[be]	268	370	73	23	73	0	4	1.067	0	40	0	0	3.5	2.8	3.0	tr heat sprouts, nice yellow flesh, buff skin
	CO05037-3W/Y[abcdef]	159	353	45	54	45	0	1	1.069	0	12	0	0	0.8	3.6	1.3	alligator hide pink blotching around eyes, round tuber type
	MEAN	**301**	**399**	**74**	**23**	**71**	**4**	**3**	**1.070**	**0**	**15**	**0**	**0**	**1.1**	**3.0**	**2.1**	tr = trace, sl = slight, N/A = not available gc=growth crack

2015 Tablestock Variety Trial Sites

[a] Crawford Farms; Montcalm Co.
[b] Elmaple Farm; Kalkaska Co.
[c] Erke Farms, Presque Isle Co.
[d] Horkey Brothers Farm, Monroe Co.
[e] Kitchen Farms; Antrim Co.
[f] VanDamme Farms; Delta Co.

[1]SIZE
Bs: < 4.0 oz.
As: 4.0 - 10.0 oz.
OV: > 10 oz.
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[2]TUBER QUALITY
(percentage of tubers)
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[4]VINE VIGOR RATING
Ratings: 1 - 5
1: Slow Emergence
5: Early Emergence
(vigorous vine, some flowering)

[5]VINE MATURITY RATING
Ratings: 1 - 5
1: Early (vines completely dead)
5: Late (vigorous vine, some flowering)

[3]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

Understanding the chemical ecology of *Solanum* sp. for Colorado potato beetle management

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Solanaceous plants, such as the potato, have considerable variation in plant quality; they contain glycoalkaoids, a group of steroidal compounds that can be toxic to some insects. There is considerable intra-family variation among solanaceous plants for glycoalkaloids and the response of the specialist herbivore, Colorado potato beetle, *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae) to these metabolites varies greatly (Hsiao and Frankel 1968; Flanders et al. 1992; Hollister et al. 2001). Glycoalkaloids in *Solanum chacoense* have been associated with resistance to *L. decemlineata* and efforts have focused on using these secondary metabolites for pest management (Sinden et al. 1986; Lawson et al. 1993). The qualitative aspect of plant volatile blends is also important for *L. decemlineata* host location: adding odors from non-host solanaceous species, such as *Solanum habrochaites* (wild tomato) into the odor blend stopped *L. decemlineata* from responding to potato odor (Thiery and Visser 1986).

Here we evaluate interactions between *L. decemlineata* preference and performance. We measured responses of *L. decemlineata* when exposed to single accessions of three wild potato species: *S. chacoense, S. immite, S. pinnatisectum* and the cultivated potato *S. tuberosum* cv. Atlantic. We determined performance by measuring larval survival, feeding, and development and, we evaluated the adaptiveness of female preference by measuring oviposition of *L. decemlineata* when simultaneously exposed to the four plant species in choice experiments. Finally, the allelochemical (glycoalkaloid) and volatile organic compound contents in the four plant species were analyzed to determine how variation in resource quality relates to oviposition preference and larval performance.

Materials and methods

Insect and plant material

Leptinotarsa decemlineata larvae and adults used in all the experiments were obtained from a laboratory colony maintained at the Vegetable Entomology Laboratory at Michigan State University (East Lansing, MI). The colony was kept in continuous culture on *Solanum tuberosum* cv. Atlantic in a rearing room at 25°C and 16:8 (L:D) photoperiod.

The wild host species we tested were *S. chacoense*, Bitter (PI 123123, selection 3), *S. immite*, Dunal (PI 365330, selection 3), and *S. pinnatisectum*, Dunal (PI 184774, selection 88), obtained from the United States Potato Genebank (NRSP-6, Sturgeon Bay, WI). These species originate from different countries, occur at different altitudes and have different levels of insect and disease resistance (Table S1). *Solanum tubersoum* cv. Atlantic, the cultivated potato was used in all experiments, obtained from plants grown at the Montcalm Potato Research Farm (Stanton, MI).

All plants were vegetatively propagated and grown in an environmental chamber at 25ºC, 75% RH, 14:10 (L:D), planted in 12 cm diameter plastic pots in a perlite soil mix (Suremix Perlite, Michigan Grower Products Inc., Galesburg, MI). Plants were fertilized weekly with a 5g/l 14-10-14 N-P-K (Scott's, Miracle-Grow Products, Inc. Marysville, OH) solution.

Larval foliage consumption

Foliage consumption by larvae was compared in a no choice experiment. The youngest fully expanded leaf was collected from different 4-5-week-old plants for each no choice trial. To prevent desiccation, each leaf petiole was placed in a 1.7 ml water-filled plastic microcentrifuge vial with a perforated cap. Individual leaves were placed in plastic Petri dishes (90 x 15 mm) on moist filter paper (Whatman #1, VWR, Radnor, PA). Leaf area (cm^2) was obtained using a Li-Cor Portable Leaf Area Meter (LI-3000C, Lincoln, NE). Newly ecdysed second instar *L. decemlineata* were starved for 4 hours preceding the assay and one larva was placed in each Petri dish. Ten Petri dishes per plant species were prepared and held at 25°C, 70-75% RH, 16:8 (L:D) for 48 h. The water in the microcentrifuge vials was checked twice daily and refilled when necessary. At the end of the 48-h-period larvae were removed, leaves were rinsed using tap water to eliminate excreta, wiped dry and scanned again to record the final leaf area. This experiment was repeated ten times on two different dates (05-Aug-2014 and 22-Aug-2014) using new groups of larvae and plants each time (N=20 per plant species).

Larval foliage consumption was calculated by subtracting the final leaf area from the initial leaf area. Data were evaluated using analysis of variance (ANOVA) and post-hoc means comparisons were done by Tukey's Honest Significant Different (HSD). This test and all subsequent statistical tests, unless noted otherwise, were performed using R (R version 3.2.2, R Core Team, 2015).

Larval survival

Egg masses were collected from the *L. decemlineata* colony and allowed to hatch at room temperature in Petri dishes. Five neonates (0-24-h-old) from different egg masses were placed on the upper third of every potato plant using a paintbrush. The 4-5-week-old plants were covered with mesh (white polyester, 680µm mesh aperture, Megaview, Taichung, Taiwan) and the material was secured with a string around the top of the pot to prevent larvae from escaping. In order to keep the mesh away from the plants, two metal wire hoops were bent over each pot with their ends inserted into the soil.

Infested plants were arranged in a randomized complete block design with five replications per plant species and held at 25°C, 70-75% RH, 16:8 (L:D) for 8 days. The numbers and developmental stages of living and dead larvae were recorded at the end of 8 days. The experiment was replicated twice (10-Oct-2014 and 11-Nov-2014) for a total of 10 replications per plant species. The number of larvae surviving after 8 days was analyzed with a two-way ANOVA (plant species and block as factors) followed by Tukey's HSD procedure to determine differences among means (α=0.05).

Oviposition preference

The oviposition behavior of mated *L. decemlineata* females on the four plant species was compared in choice tests. One 5-week-old plant of each species was organized randomly in the four corners of a 0.6 x 0.6 x 0.6 m square collapsible metal cage (BioQuip Products Inc., Rancho Dominguez, CA). Plants were chosen so that the four plants in a cage were matched for size. Ten cages were organized in a completely randomized design and kept on lab benches at 22-25°C, 70-75% RH and 16:8 (L:D). At the start of the experiment, one mated female (approximately 8-10 days post-emergence) was released in the center of each cage. Plants were inspected for new egg masses daily for five days, without removing the egg masses from the plant. At the end of the 5 days, the total number of egg masses and number of eggs per egg mass were counted. Egg masses laid anywhere other than plant tissue were omitted from the analysis. The entire experiment was replicated twice, once in 2014 and once in 2015, for a total of 20 replications per plant species.

Differences in the total number of egg masses and total number of eggs among potato species were compared using a Kruskal-Wallis test followed by Dunn's test for post-hoc means comparison (α=0.05). The average number of eggs per egg mass was compared with an ANOVA followed by Tukey's HSD procedure to determine differences among means. Cumulative number of egg masses were compared with a χ^2 test by day across species.

Plant tissue analysis

Glycoalkaloid analysis was done on 4-week-old undamaged plants. Ten plants were used per species and one leaflet from the top third part of each plant was collected for extraction. The tissue (100 mg) was pulverized in liquid nitrogen, and 1 ml of extraction solvent (water, methanol and acetic acid, 49:49:2 v/v/v) was added. The samples were then heated at 60°C in a water bath for 30 min, followed by centrifugation at 15,000 RPM for 20 min and then the supernatant was transferred to a 2 ml glass vial. Samples were analyzed with a Waters G2-XS QToF liquid chromatograph - mass spectrometer (MS) interfaced to a Waters Acquity Ultra Performance Liquid Chromatography system using a method described previously (Schilmiller et al. 2015). A non-targeted analysis of peaks from the lowest collision energy function was performed using Waters Markerlynx XS (Version 3.0.1, Waters Corp.). Masses between m/z 50 and 1500 were included using a mass window of 0.05 and a marker intensity threshold of 5000 counts. Filtering was performed to remove masses that had a fractional mass above 0.7. Peak areas of alkaloids were averaged across ten replicates for each species. Peak areas of all detected glycoalkaloids were analyzed using nonmetric multidimensional scaling and an analysis of similarity (ANOSIM, α=0.05) to determine overall glycoalkaloid profile differences among species. Peak areas of chaconine, solanine and tomatine were compared among the four plants with ANOVA followed by Tukey's HSD (α=0.05).

Headspace analysis

Volatile organic compound collection from the four *Solanum* species (n = 6: *S. chacoense, S. immite*; n = 7: *S. pinnatisectum*, *S. tuberosum*) was conducted in the same growth chamber where plants were grown (25ºC, 75% RH, 14:10 L:D). Undamaged 4-5-week-old plants were individually placed into closed glass chambers (18 cm diameter, 38 cm height). The soil and pot were covered with aluminum foil to minimize odor contamination of the headspace. A vacuum pump pulled air from the chambers through a Super Q trap (50/80 mesh; Alltech, Deerfield, IL; 30 mg in a 150 mm by 50 mm glass tube) for 6 h at a rate of 1 L min^{-1}. Air was allowed to enter the chamber through a charcoal filter. Volatiles were extracted from the Super Q trap using 150 µl of methylene chloride. The volatile extracts were analyzed on an Agilent 7890A gas chromatograph (GC) equipped with a HP-5MS Agilent J&W column (30 m length, 250 µm diameter and

0.25 µm film thickness, He as the carrier gas at constant 1 ml min^{-1} flow) coupled with an Agilent 5975C inert XL MS. Compounds were separated by injecting 1 µl of sample into the GC/MS. The GC oven temperature program consisted of 35°C for 1 min followed by 10°C min^{-1} to 260°C then hold at 260°C for 6.5 min. After an initial solvent delay of 4 min, masses between m/z 40-550 atomic mass units were scanned.

Volatile organic compounds separated by GC/MS were processed with the Automated Mass Spectral Deconvolution and Identification System (AMDIS, Version 2.70, National Institute of Standards and Technology (NIST, Version 11, Gaithersburg, MD). A library of 37 known compounds was compiled with AMDIS using the NIST database as a reference. The AMDIS report was processed with the 'Metab' R package (Aggio et al. 2011). Data was normalized to the internal standard, by fresh plant biomass and h of collection to calculate volatile emission per sample (ng / g / h). Headspace composition was then compared among the four plant species using nonmetric multidimensional scaling and ANOSIM. The quantities of limonene, copaene, nonanal, methyl salicylate, and caryophyllene were compared in the four plant species using ANOVA followed by Tukey's HSD (α=0.05). These five compounds were identified using comparison of their retention times and spectra to standards.

Results

Larval foliage consumption

Leaf area consumed by second instars during 48 h was significantly different among the plant species ($F = 28.98$, d.f. = 3, 74, $P < 0.01$), ranging from 1.16 to 8.61 cm^2 (Fig. 1). Leaf area consumed was the lowest on *S. immite* among the four species, followed by *S. pinnatisectum*. Both of these species had significantly less feeding than either *S. tuberosum* or *S. chacoense* (all $t > 1.69$, d.f. = 74, $P < 0.05$). *Solanum tuberosum* and *S. chacoense* had similar amounts of leaf areas consumed ($t = 0.68$, d.f. = 74, $P = 0.53$). On average, larval feeding on *S. immite* was 84.53% less than on *S. tuberosum* and 86.53 % less than on *S. chacoense.* After 48 h, all larvae that fed on *S. chacoense* and *S. tuberosum* were third instar, whereas all larvae feeding on *S. immite* and *S. pinnatisectum* remained in the second instar. No larval mortality was observed during the 48-h-period.

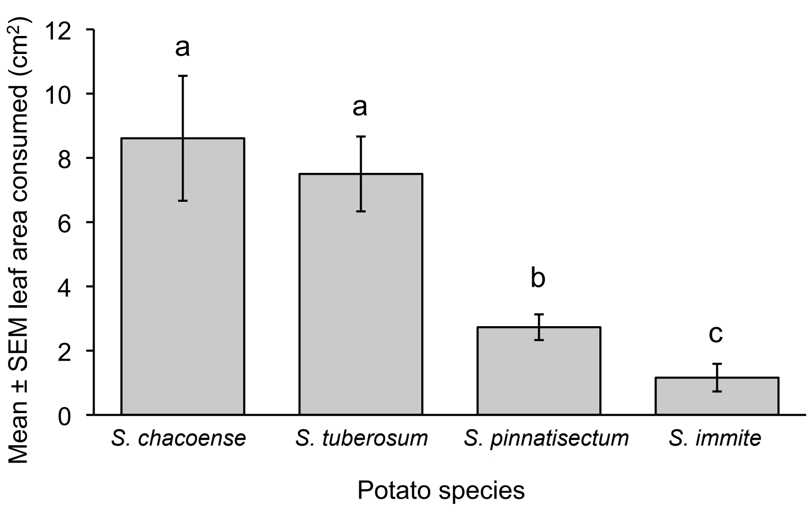

Figure 1. *Mean (± SEM) leaf surface area (cm^2) of four Solanum species consumed by second instar L. decemlineata during 48 h of feeding. Different letters above bars denote significant differences among means (Tukey's HSD, P < 0.05).*

Larval survival

Larvae confined on the four potato species for 8 days had significantly different survival (F = 29.43, d.f. = 3, 25, P < 0.01; Fig. 2). None of the larvae on *S. immite* survived, while on average 60% survived on *S. tuberosum* (t = 7.48, d.f. = 25, P < 0.01). An average of one larva out of five was found alive on *S. pinnatisectum* after 8 days. There were no differences in the number of larvae that survived on *S. tuberosum* and *S. chacoense* (average of 3 larvae in both species, t = 0.21, d.f. = 25, P = 0.83). After 8 days, all larvae that survived on *S. pinnatisectum* were still second instars but larvae on *S. chacoense* and *S. tuberosum* were all fourth instars.

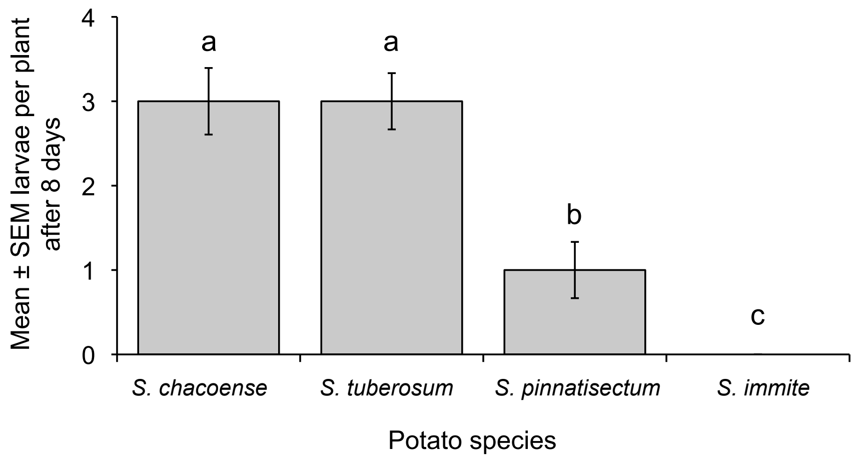

Figure 2. *Mean (± SEM) survivorship of L. decemlineata larvae on four Solanum species after 8 days; 5 neonates were placed on each plant at the beginning of the trial. Different letters above bars denote significant differences among means (Tukey's HSD, P < 0.05).*

Oviposition preference

The number of eggs per mass was significantly different among the four plant species (χ^2 =9.34, d.f. = 3, P = 0.03; Fig. 3a). *Solanum immite* received the most egg masses, about 40-50% more than *S. chacoense* or *S. pinnatisectum* (χ^2 > 2.52, d.f. = 3, P < 0.01). *Solanum tuberosum* received 37% fewer egg masses than *S. immite* (χ^2 = 2.39, d.f. = 3, P < 0.01). In terms of the total number of eggs, *S. immite* received about 70% more eggs than *S. chacoense* or *S. pinnatisectum* (χ^2 > 2.84, d.f. = 3, P < 0.01, Fig. 3b). *Solanum tuberosum* had 2.24 times fewer eggs than *S. immite* (χ^2 = 2.61, d.f. = 3, P < 0.01). The average number of eggs per egg mass was similar on *S. chacoense* and *S. tuberosum* at 7 eggs/mass (t = 0.01, d.f. = 19, P = 1.00), but egg masses on *S. immite* had 32 eggs/mass, significantly more than on any of the other three species (all t > 3.12, d.f. = 19, P < 0.05; Fig. 3c). In the first two days of the assay, 65-90% of the total egg masses were laid on *S. immite*, *S. chacoense* and *S. pinnatisectum*, while 46% were laid on *S. tuberosum* (Fig. 3d). Significant differences among the cumulative numbers of eggs appeared on the second day of the experiment and egg numbers remained the highest on *S. immite* until the end of the experiment (χ^2 > 7.09, d.f. = 3, P < 0.01; Fig. 3d).

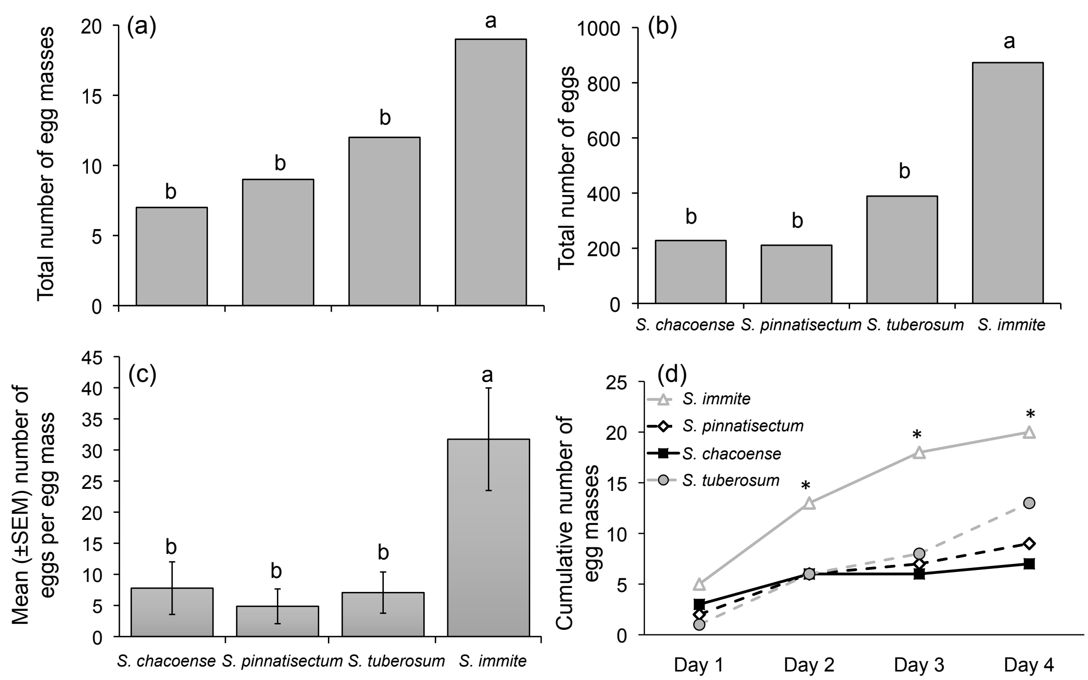

Figure 3. *Oviposition preference of L. decemlineata females in a four-choice test, (a) total number of L. decemlineata egg masses, (b) total number of eggs laid, (c) mean (± SEM) number of eggs per egg mass and, (d) cumulative number of egg masses over 4 days on four Solanum species. Different letters above bars and asterisks denote significant differences among means (P < 0.05).*

Plant tissue analysis

The glycoalkaloid profiles significantly differed across plant species (ANOSIM: $R^2 = 0.94$, $P < 0.01$; Fig. 4a). Chaconine and solanine were detected in *S. chacoense*, *S. immite* and *S. tuberosum*, but not in *S. pinnatisectum* (Fig. 4b). On the other hand, tomatine was only detected in *S. pinnatisectum*. The amount of chaconine and solanine was similar in *S. immite* and *S. tuberosum* (all t >13.75, d.f. = 36, P < 0.01) but significantly less in *S. chacoense* than in the other two species (all t >13.75, d.f. = 36, P < 0.01).

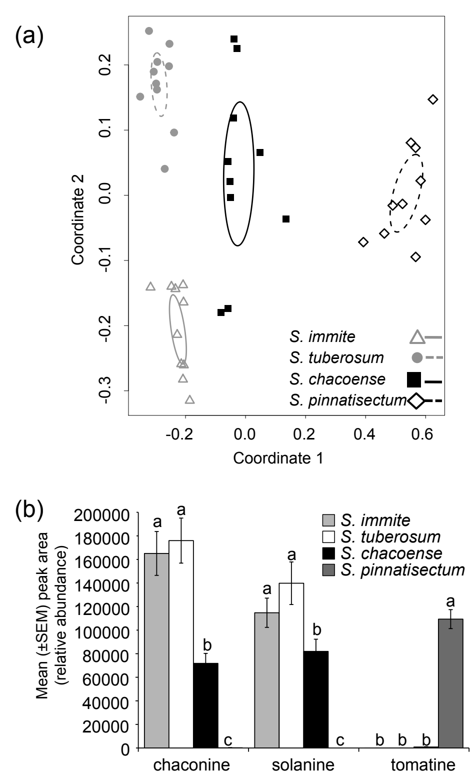

Figure 4. *Nonmetric multidimensional scaling with leaf total glycoalkaloid content of four Solanum species (a). Mean (± SEM) peak area of three different leaf glycoalkaloids (chaconine, solanine, tomatine) in the four Solanum species (b). Different letters above bars denote significant differences among means (Tukey's HSD, P < 0.05).*

Headspace analysis

A comparison of 37 compounds revealed significant differences among the four species' headspace composition (ANOSIM: $R^2 = 0.29$, $P < 0.01$; Fig. 5a). The quantities of limonene, copaene, methyl salicylate, and caryophyllene were significantly different among the four species (all $F > 3.26$, d.f. = 3, 22, $P < 0.05$; Fig. 5b). There was significantly more limonene in *S. immite* than in *S. tuberosum* ($t = 2.96$, d.f. = 22, $P = 0.03$), but there was significantly more copaene in *S. tuberosum* than in *S. immite* ($t = 3.48$, d.f. = 22, $P = 0.01$). The amount of methyl salicylate and caryophyllene was significantly higher in *S. chacoense* than in any of the other three species (all $t > 4.70$, d.f. = 22, $P < 0.01$). The quantity of nonanal was not significantly different among the four species ($F = 2.59$, d.f. = 3, 22, $P = 0.08$; Fig. 5b).

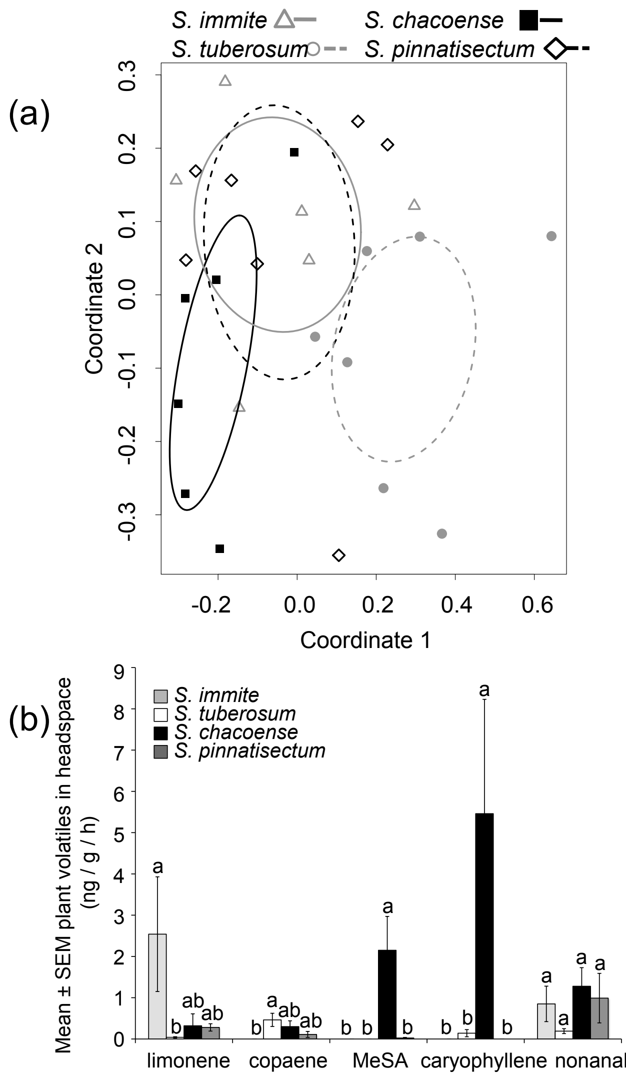

Figure 5. *Nonmetric multidimensional scaling comparison of the total volatile profile of four Solanum species (a). Mean (± SEM) ng / g / h emission for five specific volatile compounds by Solanum species, MeSA - methyl salycilate (b). Different letters above bars denote significant differences among means (Tukey's HSD, P < 0.05).*

Summary

Since *L. decemlineata* specializes on plants in the genus *Solanum*, we hypothesized that oviposition behavior will be closely aligned with larval performance; instead, we found evidence for the 'bet-hedging' strategy. While larvae performed best on *S. tuberosum* and *S. chacoense*, females preferred to lay eggs on *S. immite*, a plant that caused the highest larval mortality. Thus we provide evidence for a decoupling of female preference and larval performance when females are offered a choice.

Since secondary plant metabolites play an important role in insect host specificity, we hypothesized that the metabolite profiles for suitable oviposition and larval hosts will be similar. Contrary to our expectation, we found that the overall glycoalkaloid profiles were not related to oviposition or larval performance. For example, the number of egg masses laid on *S. chacoense*, *S. pinnatisectum* and *S. tuberosum* were similar but their glycoalkaloid profiles were qualitatively different from each other. However, larval feeding and development in our experiments were highest on plants that contained solanine and chaconine, the two secondary plant compounds that make up the majority of *S. tuberosum*'s glycoalkaoids.

We recovered some resolution of preference and performance with our observations of volatile organic compounds in the headspace. Overall headspace profiles of *S. pinnatisectum* and *S. immite* were similar, and these were the two species least preferred for larval feeding. When examining some individual headspace volatile organic compounds, *S. immite* was different in that it emitted limonene in larger quantities than the other three species. Limonene is a well-known insect repellent with insecticidal properties (Ibrahim et al. 2001).

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Aphid trapping in a Michigan seed potato field

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Aphids can carry virus particles and spread them between plants. PVY (Potato virus Y) can be spread by many species of aphids (small, soft-bodied insects that feed on plant sap). Within minutes of starting to feed on a PVY-infected plant, the PVY particles get stuck in the aphid's stylet (its piercing-sucking mouthpart). If the aphid then moves to a healthy plant and soon starts to feed, the virus particles are transmitted to the healthy plant. This process, termed "non-persistent" transmission, is similar to contaminating a glass of pure water with a straw you previously used to drink lemonade—a small amount of lemonade will taint the pure water.

PVY has limited management options in the absence of host plant resistance. The most important strategy to minimize on-farm spread of PVY is to minimize the initial inoculum in the field, i.e. plant virus-free certified seed. Minimizing the spread of virus into or within a field by controlling aphid vectors is need; specifically more information about the proper timing of control efforts. If the identity, origins, and timing of movement of important PVY vectors could be predicted, then growers would have the option to focus preventative oil sprays at high risk periods and, whenever possible, to avoid planting potatoes in high-risk areas. This can be especially important for high value, early generation seed crops.

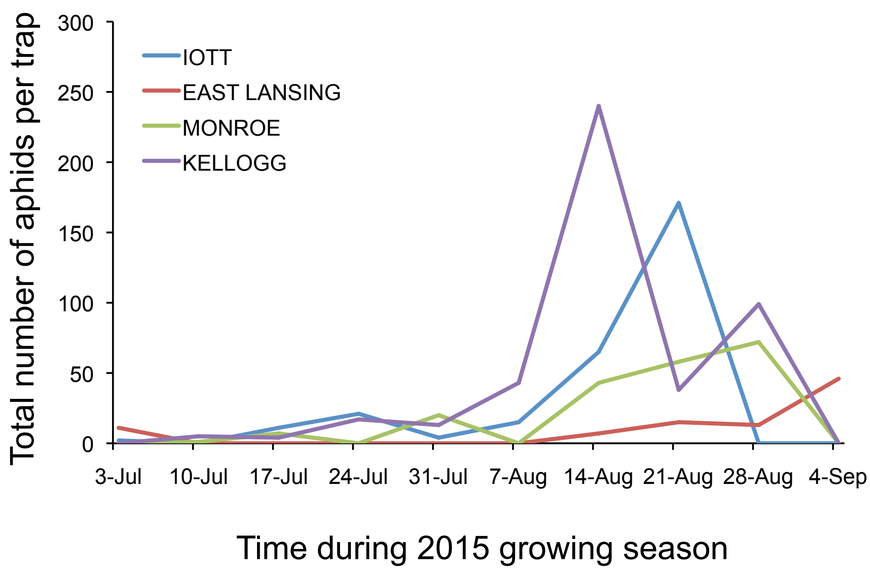

Figure 1. *Total number of aphids captured in suction traps at four different locations in Michigan in 2015. The blue line represents the seed potato farm.*

In 2015, we set up a suction trap at one collaborating seed potato farm in Michigan and monitored/emptied it weekly. Samples were sent for identification to the University of Illinois. The abundance of aphids in the trap peaked in mid-August in 2015 (blue line in Fig. 1). The most abundant aphid species during the season in the trap was oat bird-cherry aphid (158), followed by the soybean aphid (31), the spotted alfalfa aphid (17), and English grain aphid (13). The trap at the potato seed farm captured 289 aphids during the growing season.

Potato Pathology Update for Crop Year 2015

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Introduction

Potato (*Solanum tuberosum* L.) is among the world's most important food crops and is the highest-volume vegetable grown in the U.S. Moreover potato comprises the largest harvested acreage of vegetables. Potato production in Michigan (MI) is ranked eighth (~$208 million) in the US. It is also one of the most intensively managed crops. Potato production systems have long been plagued by a multitude of recurrent and persistent soil-borne, seed, foliar and storage diseases. Potato production in Michigan is no exception (Table 1). During the 2015 growing season Michigan potato production faced management challenges with recurrent, sporadic and emerging diseases that included stem canker and black scurf, late blight and aerial stem rot respectively.

Rhizoctonia stem canker and black scurf of potato

Rhizoctonia diseases of potato are caused by the fungus *Rhizoctonia solani* Kühn (teleomorph *Thanatephorus cucumeris* (A. B. Frank) Donk) and can be found on all underground parts of the plant at different times during the growing season. In the US, *Rhizoctonia solani* has been associated with disease on legumes (peas, beans), cereals, sugarbeet and potato. *Rhizoctonia solani* has many synonyms and is divided into subgroups called anastomosis groups (AG's), in which isolates are categorized according to the ability of their hyphae to anastomose (fuse) with one another. *Rhizoctonia* AG-4 has typically been associated with legumes. *Rhizoctonia* AG-8 is typically associated with cereals (wheat & barley). *Rhizoctonia* AG2-2 111b and IV and AG-4 with sugarbeet stem canker and damping off. *Rhizoctonia* AG-3 is associated with potato stem canker and black scurf. In Michigan, *R. solani* causes black scurf on tubers (Figure 1), and stem and stolon canker on underground stems and stolons (Figure 2), and occurs wherever potatoes are grown. However, *R. solani* causes economically significant damage only in cool wet soils. In the more southern temperate areas of Michigan, losses from *Rhizoctonia* are sporadic and only occur when the weather is cold and wet in the weeks following planting. In northern areas, where growers often must plant in cold soils, *Rhizoctonia* is a more consistent problem. Poor stands, stunted plants, reduced tuber number and size, and misshapen tubers are characteristic of diseases caused by *R. solani*. Chemical seed treatment management is accomplished through the use of products specifically developed for control of seed-borne potato diseases and offer broad-spectrum control for Rhizoctonia, silver scurf, Fusarium dry rot and to some extent Black dot (*Colletotrichum coccodes*). These include Tops MZ, Maxim MZ (and other Maxim formulations + Mancozeb) and MZ. Application of fungicide in-furrow at planting has resulted in significant improvement in control of Rhizoctonia disease of potatoes. Products such as Moncut and Quadris applied in-furrow at planting have given consistent and excellent control of Rhizoctonia diseases of potatoes in trials at MSU. However, both seed treatments and in-furrow applications on some occasions have resulted in poor control of Rhizoctonia. This sporadic failure may be due to extensive periods of wet and cold soil shortly after planting or planting in fields with plentiful inoculum. Quadris applied in-furrow has been reported to reduce the symptoms of Black Dot on lower stems and tubers.

Late blight of potato

Late blight, caused by the water mold (oomycete) *Phytophthora infestans*, has the potential to be a very destructive disease of potato in Michigan. Over the past growing seasons late blight has no longer been a sporadic disease and as such has been reported throughout the United States from multiple production areas (Figure 3). Potato late blight was found in in Montcalm and St. Joseph

County in southern Michigan in 2015. Some crops in southern Michigan were in early decline and ready to be desiccated or already being harvested. The amount of disease was generally light in southern counties. Areas in fields that were vulnerable were field margins, especially those close to tree lines, raised cable lines and where water accumulated, such as around pivot tracks and tractor wheel lines. The genotype of the *Phytophthora infestans* isolate responsible for all late blight confirmations in potatoes have been the US-23 genotype. Conditions remained conducive for late blight in potato crops and the risk of tuber blight is high, especially in fields in areas that experienced heavy rain during August. Late blight protection programs should be based on a residual protectant fungicide such as chlorothalonil or mancozeb. Under high disease pressure situations, the programs incorporating Revus products, Forum, Curzate 60DF, Ranman, Tanos, Gavel, Ariston, Zing! or Previcur Flex should be used. Ridomil-based products have proved very effective in recent years where the genotype of *P. infestans* has changed to one that is metalaxyl-sensitive as with US-23, which has predominated in Michigan since 2013. In Michigan, Headline and Quadris have been effective in late blight management, but these products should be used in strict adherence with anti-resistance development strategies, i.e., always mix with a protectant fungicide. These products must be used in combination with protectant materials such as EBDC or chlorothalonil-based products. Destruction of areas within crops with late blight should follow the rules that 30 rows either side of the newest lesions at the border of the late blight locus and 100 feet along the row (either side) are killed with Reglone or with Gramoxone.

Aerial blackleg of potato
Dickeya spp. and *Pectobacterium* spp. are commercially important seed-borne soft rot bacteria that cause aerial blackleg of potato. Aerial and lower stem blackleg in potatoes has emerged as an important disease of potato and have increased in prevalence in certain European countries and Israel. Direct crop loses primarily occurs is cases of downgrading or rejection of seed by certification programs. The disease has not been a major issue in the US until a recent outbreak this past growing season. A wet June resulted in a high incidence of aerial stem rot in parts of Michigan. Effective management starts with proper identification and diagnosis and growers should only plant certified seed. Seed is only certified if it is within the incidence tolerance of tuber presence with soft-rot symptoms (0.05 percent), but the seed is unlikely to be completely free of *Dickeya* spp. and *Pectobacterium* spp. contamination. *Dickeya* spp. and *Pectobacterium* spp. does not survive well outside of the potato, therefore rotational programs of two or more years may help control this disease. Seed cutting can also spread inoculum, therefore sanitation and disinfesting potato-cutting equipment and careful seed handling post-cutting reduces the risk of this disease. Prevention of seed piece decay with fungicidal seed treatments can indirectly prevent seed contamination, especially during the cutting operation. Seeds should be planted during conditions that favor fast emergence, and planting into cool and wet soils should be avoided.

Summary
The first step in effective disease management of potato is accurate identification and diagnosis. It is important to adhere to manufacturer's label recommendations when implementing disease management programs. We will continue to evaluate the effectiveness of promising biologically based and conventional treatments on common scab management, tuber yield and quality, under multiple field conditions and locations over the coming growing seasons.

More information available at: http://www.potatodiseases.org/

Acknowledgements
This project was partially supported by the Michigan Potato Industry Commission, and the Michigan State University Project GREEEN.

Table 1. Major seed-borne, foliar and storage diseases in Michigan potato production systems.

Type	Common name	Pathogens	Type of organism	Symptoms
Seed-borne (soil)				
	Late blight	*Phytophthora infestans*	Oomycete	Irregularly shaped, slightly depressed brown to purplish areas on skin
	Fusarium dry rot	*Fusarium sambucinum*	Fungus	Delayed or non-emergence
	Stem canker and black scurf	*Rhizoctonia solani*		Black scurf on tubers
	Black dot	*Colletotrichum coccodes*	Fungus	Black dots form on tubers
	Bacterial soft rot	*Pectobacteria* spp. *Dickeya* spp. 2015	Bacteria	Decaying seed piece
	Common scab	*Streptomyces scabies*	Bacteria	Cork-like or russeted lesions
	Corky ringspot/TRV	*Tobacco rattle virus*	Virus	Small prominent brown flecks
	PVY and variants	*Potato virus Y*	Virus	Sometimes brown rings
Field (foliar)				
	Late blight	*P. infestans*	Oomycete	Dark, circular to irregularly shaped lesions
	Early blight	*Alternaria solani*	Fungus	Dark concentric rings
	Brown leaf spot	*Alternaria alternata*	Fungus	Small, round, dark brown spots
	White mold	*Sclerotinia sclerotiorum*	Fungus	Lesions with white cottony growth
	Gray mold	*Botrytis* cinerea	Fungus	Tan lesions
	Black leg	*Pectobacterium* and *Dickeya* spp.	Bacteria	Brown to black water-soaked lesions extending from the base of the stem
	Early die	*Verticillium dahliae* /*Pratylenchus penetrans*	Fungus/nematode	Vascular discoloration and premature senescence
	Corky ringspot/TRV	*Tobacco rattle virus*	Virus	Ring spot or stem mottle
Storage (tuber)				
	Late blight	*P. infestans*	Oomycete	Entire tuber becomes blighted and discolored

Fusarium dry rot	*F. sambucinum* and others	Fungus	Dark depressions on tuber surface
Pink rot	*P. erythroseptica*	Oomycete	Tuber decay that begins at or near the stem or stolon end
Pythium Leak	*Pythium ultimum*	Oomycete	Darkening of tissue and presence of liquid exudates
Soft rot	*Pectobacterium* and *Dickeya* spp.	Bacteria	Cream colored to tan, soft and granular
Silver scurf	*Helminthosporium solani*	Fungus	Tan or grey, circular lesions on periderm
Black dot	*C. coccodes*	Fungus	Small abundant black dots (sclerotia)

Figure 1. Brown, sunken lesions on underground stems and stolons caused by *Rhizoctonia solani*

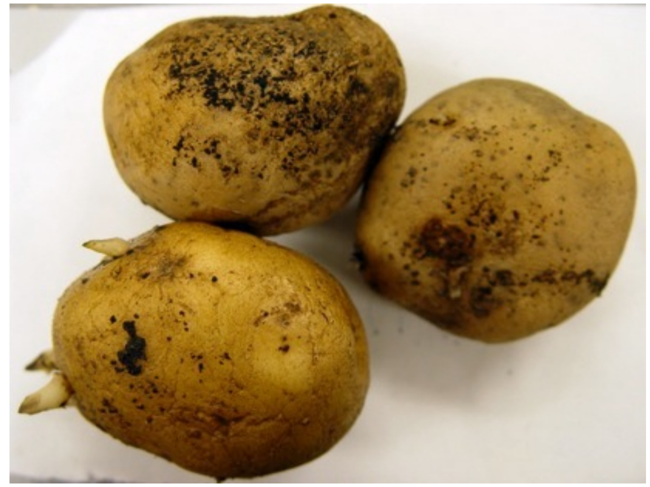

Figure 2. *Rhizoctonia solani* sclerotia on the surface of tubers

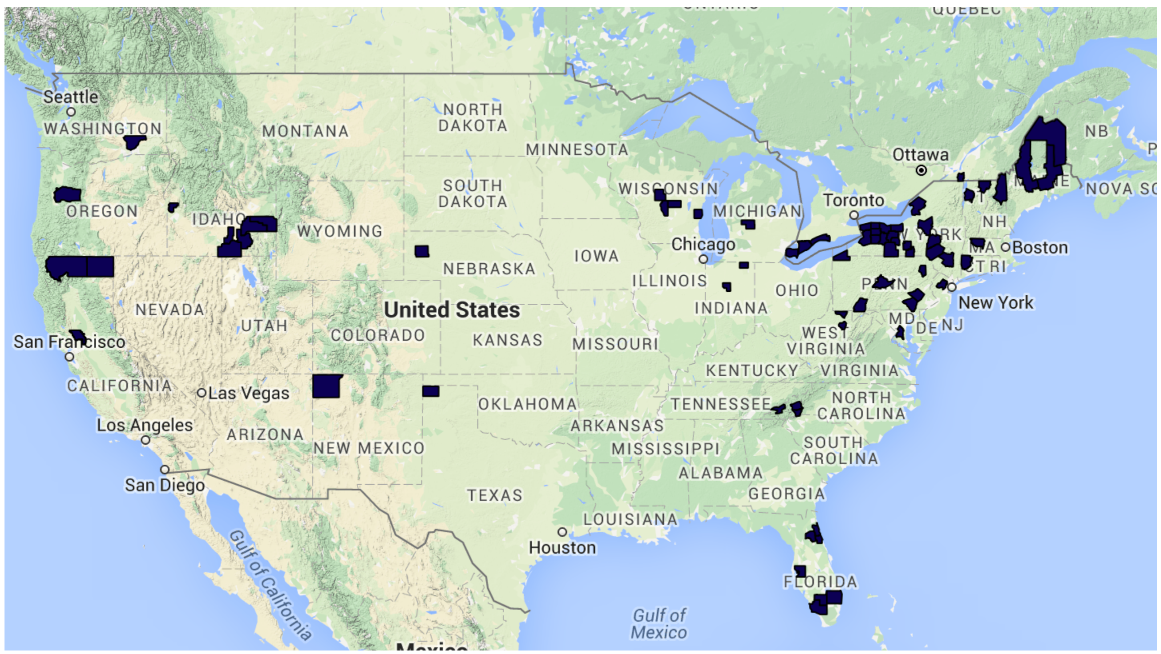

Figure 3. Late blight across the US (2015), source http://usablight.org

Figure 4. Aerial stem rot symptoms on a potato plant in the field caused by *Pectobacterium* spp.

Figure 5. Aerial stem rot symptoms on a potato plant in the field caused by *Pectobacterium* spp.

Figure 6. Blackleg symptoms on a potato seed piece caused by *Pectobacterium* spp.

Figure 7. Tuber soft rot symptoms on a potato seed piece caused by *Pectobacterium* spp.

Funding: Industry and MPIC

Evaluation of fungicide programs for potato late blight control: 2015.

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Potatoes ('Atlantic', cut seed, treated with Maxim FS at 0.16 fl oz/cwt) were planted at Michigan State University Horticultural Experimental Station, Clarksville, MI (Capac loam soil); 42.8733, -85.2604 deg; elevation 895 ft. on 25 May into two-row by 25-ft plots (ca. 10-in between plants to give a target population of 50 plants at 34-in row spacing) replicated four times in a randomized complete block design. Plots were irrigated as needed with sprinklers and were hilled immediately before sprays began. All rows were inoculated (3.4 fl oz/25-ft row) with a zoospore suspension of *Phytophthora infestans* [US-23 biotype (sensitive to mefenoxam, A1 mating type)] on 29 Jul at 10^4 spores/fl oz. Plots were irrigated as needed with sprinklers and were hilled immediately before sprays began. All fungicides in this trial were applied on a 7-day interval from 8 Jul to 3 Sep (9 applications) with an ATV rear-mounted R&D spray boom calibrated to deliver 25 gal (80 p.s.i.) using three XR11003VS nozzles per row. Weeds were controlled by hilling and with Dual 8E (2 pt on 5 Jun), Poast (1.5 pt on 17 Jul). Insects were controlled with Admire 2F (20 fl oz at planting), Sevin 80S (1.25 lb on 17 and 31 Jul), Thiodan 3EC (2.33 pt on14 Aug) and Pounce 3.2EC (8 oz on 17 Jul). Plots were rated visually for percentage foliar area affected by late blight on 14, 21, 27 Aug and 3 Sep, [16, 23, 29, and 36 days after the inoculation (DAI)] when there was about 100% foliar infection in the untreated plots. The relative area under the late blight disease progress curve was calculated for each treatment from the date of inoculation to 3 Aug, a period of 36 days. Vines were killed with Reglone 2EC (1 pt on 14 Sep). Plots (2 x 25-ft row) were harvested on 8 Oct and tubers from individual treatments were weighed and graded. A sample of 50 tubers was collected from each plot at harvest and the incidence of late blight affected tubers was evaluated. Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to 31 Oct. Average daily air temperature (ºF) from Jun to Oct was 59.3, 63.8, 68.3, 67.3, 64.7 and 49.9 and the number of days with maximum temperature >90ºF was 0 (May to Oct). Average daily relative humidity (%) over the same period was 69.4, 73.1, 70.5, 74.1, 71.8 and 73.6. Average daily soil temperature at 4" depth (ºF) over the same period was 60.0, 68.2, 73.6, 71.6, 68.9 and 55.9. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 35.6, 36.6, 32.7, 35.7, 37.1, and 35.8. Precipitation was 4.01, 3.02, 0.29, 3.09, 3.52, and 3.07 in. Plots were irrigated to supplement precipitation to about 0.1 in./4 day period with overhead sprinkle irrigation. The total number of late blight disease severity values (DSV) over the disease development period from 29 Jul (inoculation date) to 3 Sep was 48 using 90%RH (ambient air) as a basis for DSV accumulation.

Late blight developed steadily after inoculation due to extended leaf wetness periods and moderate air temperature during Aug and untreated controls reached on average 100% foliar infection by 3 Sep. Up to 21 Aug, most fungicide programs had significantly less foliar late blight than the untreated control (42.5%) although some programs had already started to show that they were ineffective (data not shown). By 27 Aug, programs with less than 76.3% foliar late blight had significantly better foliar late blight control than the untreated control (95.0 %). By 3 Sep as the epidemic intensified, only programs with less than 56.1% foliar late blight had significantly better foliar late blight control than the untreated control (100 %). Fungicide programs with RAUDPC values less than 50.6 were significantly lower in comparison to the untreated control (62.8), which was one of the highest RAUDPC values ever recorded at CRC. At harvest, the percent incidence of infected tubers from untreated plots was 3.8% and no treatments were significantly different in comparison to the untreated control. Treatments with greater than US1 yield of 169 and total yield of 225 cwt, respectively were significantly different from the untreated control (US1 = 115 and total yield = 165 cwt). Phytotoxicity was not noted in any of the treatments.

Funding: Industry and MPIC

Treatment and rate	Foliar potato late blight (%) 27 Aug 29 DAI[a]		Foliar potato late blight (%) 3 Sep 36DAI		RAUDPC[b] 36 DAI		Yield (cwt) US1		Yield (cwt) Total		Tuber blight (%)[c] 135 DAP[d]
Inoculated Check…………………………..	95.0	a[f]	100	a	62.8	a	115	e	165	e	3.8
Bravo WS 6SC 1.5 pt (A-I[e])……………….	12.3	c	70.7	abc	18.4	b-e	243	abc	302	abc	2.8
Bravo WS 6SC 1.5 pt (ACFH)…………….	22.5	bc	92.2	ab	26.9	b	199	cd	254	cd	1.6
Zing! 4.9SC 32 fl oz + Kinetic 90SL 0.25 % v/v (A-I)…………….	10.3	cd	53.2	bc	16.1	b-e	228	a-d	284	a-d	4.6
Zing! 4.9SC 34 fl oz + Kinetic 90SL 0.25 % v/v (A-I)…………….	6.7	cd	35.1	c	9.0	e	286	a	343	a	6.5
Zing! 4.9SC 32 fl oz (ABFI); Revus Top 4.16SC 5.5 fl oz; Curzate 60DF 3.3 oz (DFH); Manzate Pro-Stick 75WG 2 lb (DE); Previcur Flex 6SC 1.2 pt (E); Super Tin 4L 4FL 3 fl oz (EGI); Bravo WS 6SC 1.5 pt (F); Gavel 75DF 2 lb (H) + Kinetic 90SL 0.25 % v/v (A-I)…………..	20.5	c	67.6	abc	21.2	b-e	274	ab	331	ab	4.1
CX-10250 100D 1.13 oz (A-I)…………….	76.3	ab	100	a	50.6	a	199	cd	261	cd	5.6
CX-10250 100D 1.13 oz (ACFH); Bravo WS 6SC 1.5 pt (BEGI)……………...	23.4	bc	97.5	a	25.2	bcd	205	cd	258	cd	4.2
Elixir 75DF 1.8 lb (A-I)……………………	17.7	c	74.3	ab	26.4	bc	226	a-d	275	a-d	1.8
Elixir 75DF 2 lb (A-I)……………………...	15.3	c	64.2	abc	19.0	b-e	192	cd	243	cd	2.7
Bravo WS 6SC 1.5 pt (A-I)…………..........	8.9	cd	52.6	bc	16.2	b-e	213	bcd	265	bcd	5.4
Elixir 75DF 1.8 lb (ABCD); Bravo WS 6SC 6SC 1.5 pt (EFGHI)………	6.1	cd	56.1	abc	13.8	cde	185	cd	240	cd	5.2
Elixir 75DF 2 lb (ABCD); Bravo WS 6SC 1.5 pt (EFGHI)……………	2.8	d	60.3	abc	12.4	de	169	de	225	de	5.5
OxiPhos 41.1L 4.0 qt (A-I)………………...	91.0	a	100	a	60.4	a	200	cd	256	cd	1.9
OxiPhos 41.1L 2.5 qt (A-I) + OxiDate 2.0 27L 0.25 % v/v (A-I)…………	85.8	a	100	a	56.4	a	166	de	223	de	1.5
p-value if NSD											0.127

[a] Days after inoculation of *Phytophthora infestans* (US-23, A1 mating type, mefenoxam sensitive) on 29 Jul.
[b] RAUDPC, relative area under the disease progress curve calculated from day of appearance of initial symptoms (14 Aug) to 3 Sep (20 days) and 36 days after inoculation.
[c] Incidence of tuber late blight at harvest.
[d] Days after planting.
[e] Application dates: A= 8 Jul; B= 15 Jul; C= 22 Jul; D= 30 Jul; E= 6 Aug F= 13 Aug; G= 20 Aug; H= 27 Aug; I= 3 Sep.
[f] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD).

Funding: MPIC and Industry

Seed treatments and seed plus in furrow treatments for control of seed-borne *Rhizoctonia solani*, 2015.

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Potatoes with *Rhizoctonia solani* (black scurf), 2- 5% tuber surface area infected, were selected for the trials. Potato seed (Russet Norkotah) was prepared for planting by cutting and treating with fungicidal seed treatments two days prior to planting. Seed were planted at the Michigan State University Horticultural Experimental Station, Clarksville, MI (Capac loam soil); 42.8733, -85.2604 deg; elevation 895 ft. on 25 May into two-row by 25-ft plots (ca. 10-in between plants at 34-in row spacing) replicated four times in a randomized complete block design. A 5-ft not-planted alley separated the two-row beds. Dust formulations were measured and added to cut seed pieces in a miniature cement mixer (seed-treater) and mixed for 2 min to ensure even spread of the fungicide. Potato seed liquid treatments were applied in water suspension at a rate of 0.2 pt onto the exposed seed tuber surfaces in the seed treater. In-furrow at-planting applications were delivered in 8 pt water/A in a 7 in. band using a single XR11003VS nozzle at 30 psi. Fertilizer was drilled into plots before planting, formulated according to results of soil tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP (days after planting). Previcur N 6SC was applied at 0.7 pt/A on a seven-day interval, total of four applications, starting one day after inoculation of adjacent plots with *Phytophthora infestans* to prevent spread of potato late blight. Weeds were controlled by hilling and with Dual 8E at 2 pt/A 10 DAP and Poast 1.5EC at 1.5 pt/A 58 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Sevin 80S at 1.25 lb/A 30 and 50 DAP, Thiodan 3 EC at 2.33 pt/A 60 and 80 DAP and Pounce 3.2EC at 8 oz/A 50 DAP. Vines were killed with Reglone 2EC (1 pt/A on 5 Sep). Plant stand was rated 16, 23 and 35 days after planting (DAP) and relative rate of emergence was calculated as the Relative Area Under the Emergence Progress Curve [RAUEPC from 0 – 35 DAP, maximum value = 100]. Plots were harvested on 20 Oct and individual treatments were weighed and graded. Four plants per plot were harvested 73 days after planting (6 Aug) and the percentage of stems and stolons with greater than 5% of the total surface area affected were counted. Samples of 20 tubers per plot were stored for 1 day after harvest and assessed for black scurf (*R. solani*) incidence (%) and severity. Severity of black scurf was measured as an index calculated by counting the number of tubers (n = 20) falling into each class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >15% surface area of tuber covered with sclerotia. The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with sclerotia. Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to 31 Oct. Average daily air temperature (ºF) from Jun to Oct was 59.3, 63.8, 68.3, 67.3, 64.7 and 49.9 and the number of days with maximum temperature >90ºF was 0 (May to Oct). Average daily relative humidity (%) over the same period was 69.4, 73.1, 70.5, 74.1, 71.8 and 73.6. Average daily soil temperature at 4" depth (ºF) over the same period was 60.0, 68.2, 73.6, 71.6, 68.9 and 55.9. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 35.6, 36.6, 32.7, 35.7, 37.1, and 35.8. Precipitation was 4.01, 3.02, 0.29, 3.09, 3.52, and 3.07 in. Plots were irrigated to supplement precipitation to about 0.1 in./4 day period with overhead sprinkle irrigation.

Rhizoctonia was very severe in this trial due to conducive weather conditions throughout the early part of the growing season and also due to the impact of infected seed and contaminated soil (rotations were following corn and potatoes for the past 6 years). Treatments with plant stand greater than 62.1% had significantly greater final plant stand in comparison to the not treated control (46.9%). Several treatments had almost full emergence and treatments were greater than 82.6% final plant stand were significantly different from treatments with lower final plant stand. Treatments with RAUEPC greater than 60.6 had significantly greater RAUEPC values in comparison to the not treated control (RAUEPC = 49.0). Several treatments had high RAUEPC values and treatments with greater than RAUEPC = 60.6 were significantly different from treatments with lower RAUEPC values. No treatments significantly affected yield, which ranged from 179 (not treated control) to 257 cwt/A and 218 (not treated control) to 282 cwt/A (US1 and total yield, respectively). No treatments had mean final stem number significantly different from the not-treated control (2.1 stems/plant) and ranged from 1.7 to 4.0 stems per plant. No treatments had significantly less stem canker (incidence of stems with >5% of the total surface area affected) than the not-treated control (100%) and ranged from 90.6 to 100%. No treatments had significantly different mean number of stolons per plant from the not-treated control (9.3 stolons/plant) and ranged from 9.6 to 18.4. No treatments had significantly mean different percentage incidence of stolons with stem canker (greater than 5% of the total surface area affected) in comparison to the not-treated control (60.1%) and ranged from 46.6 to 85.6. Treatments with less than 50.7% incidence of tuber black scurf had significantly less black scurf than the not-treated control (50.7%). Although some treatments had significantly higher incidence of tuber black scurf in comparison the not-treated control the severity of black scurf on these tubers was much less severe. Treatments with less than 25.7 tuber black scurf severity index had significantly lower black scurf severity in comparison to the not-treated control (25.7). Seed treatments were not phytotoxic.

Funding: MPIC and Industry

Treatment and rate potato seed (A[a]); In-furrow rate/1000 row feet (B)	Emergence (%) 23 DAP[b]		RAUEPC[c] Max = 100 (0 – 23 DAP		Yield (cwt/A) US-1	Yield (cwt/A) Total
Untreated…………………………	46.9	i[d]	49.0	gh	179	218
Quadris 2.08SC 0.8 fl oz (B)…….	62.1	ghi	54.6	fgh	189	232
Emesto Silver 1FS 0.31 fl oz + Nubark mancozeb 6DS 16 oz (A)..	89.7	a-d	85.2	ab	224	269
Emesto Silver 1FS 0.31 fl oz + Reason 4.2SC 0.15 fl oz (A)………	81.3	c-f	72.9	cde	199	238
Emesto Silver 1FS 0.31 fl oz + Reason 4.2SC 0.15 fl oz + Nubark mancozeb 6DS 16 oz (A)….	85.7	a-e	75.4	bcd	224	264
Emesto Silver 1FS 0.31 fl oz + Nubark mancozeb 6DS 16 oz (A); Serenade Soil 1.34F 12.5 fl oz (B)…	81.7	b-f	77.7	a-d	204	255
Emesto Silver 1FS 0.31 fl oz + Nubark mancozeb 6DS 16 oz (A); Quadris 2.08SC 0.6 fl oz (B)………	85.8	a-e	75.7	bcd	213	258
WE1042-2 6DS 1 lb (A)…………..	91.5	a-d	87.6	a	257	282
WE1043-1 6DS 1 lb (A)………….	94.1	ab	86.0	ab	204	240
Maxim 4FS 0.08 fl oz (A)…………	85.6	a-e	78.5	a-d	222	258
Maxim 4FS 0.08 fl oz + WE1502-1 L 2.55 fl oz (A)………..	57.5	ghi	52.7	fgh	232	258
Maxim 4FS 0.08 fl oz + WE1042-2 6DS 1 lb (A)…………..	96.1	a	86.5	ab	237	265
Emesto Silver 1FS 0.4 fl oz + WE1042-2 6DS 1 lb (A)…………...	93.7	abc	83.0	abc	211	246
Actinovate AG 0.01DS 0.15 oz + Maxim 4FS 0.08 fl oz + WE1042-2 6DS 1 lb (A)……………	80.1	def	75.8	bcd	205	242
Moncut 70 DF 70DF 1.04 oz (B)…..	60.7	ghi	53.0	fgh	203	250
Moncut 70 DF 70DF 1.56 oz (B)…..	60.2	ghi	59.3	efg	223	261
Moncut 70 DF 70DF 1.04 oz + Serenade Soil 1.34F 4.7 fl oz (B)…..	51.8	hi	46.7	gh	203	245
Quadris 2.08SC 0.65 fl oz (B)……...	67.8	fgh	60.6	efg	194	243
Vertisan 1.67EC 1.56 fl oz (B)……..	55.9	ghi	43.2	h	194	237
Priaxor 4.17SC 0.65 fl oz (B)………	81.3	c-f	69.7	de	186	228
Convoy 40 SC 40SC 1.62 fl oz (B)...	50.5	hi	47.2	gh	242	264
Prostar 70 WG 70WG 1.04 oz (B)…	54.0	ghi	48.0	gh	216	246
Convoy 40 SC 40SC 0.38 fl oz + Nubark mancozeb 6DS 0.75 lb (A)..	88.0	a-e	76.3	a-d	188	229
Emesto Silver 1FS 0.31 fl oz + Firbark 0D 0.5 lb (A)	82.6	b-f	71.0	cde	197	240
Moncoat MZ 7.5DP 0.75 lb (A)…...	72.7	efg	67.1	def	226	261
Treatment Prob (F)					0.62	0.42

[a] Application dates: A= 27 May (liquid formulations for seed piece application at 0.2 pt); B= 28 May (in-furrow).
[b] DAP = Days After Planting.
[c] RAUEPC = Relative area under the emergence progress curve measured from planting to 31 days after planting.
[d] Values followed by the same letter are not significantly different at *p* = 0.05 (Fishers LSD) and Probability F value shown if no significant difference among treatments.

Funding: MPIC and Industry

Treatment and rate potato seed (A[a]); In-furrow rate/1000 row feet (B)	Stems Number per plant (34 DAP[b])	Stems Percent Incidence Infection[e]	Stolons Number per plant (34 DAP)	Stolons Percent Incidence Infection[f]	Tubers Incidence Tuber black scurf (%)	Tubers Severity[g] (0 – 100 Index)
Untreated…………………………...	2.1	100.0	9.3	60.1	50.7 c	25.7 a
Quadris 2.08SC 0.8 fl oz (B)……….	1.8	90.6	11.9	46.6	24.9 d	9.6 b
Emesto Silver 1FS 0.31 fl oz + Nubark mancozeb 6DS 16 oz (A)….	2.1	100.0	12.0	64.0	11.5 fg	2.8 e
Emesto Silver 1FS 0.31 fl oz + Reason 4.2SC 0.15 fl oz (A)………..	4.0	100.0	16.2	68.0	18.7 def	5.0 b-e
Emesto Silver 1FS 0.31 fl oz + Reason 4.2SC 0.15 fl oz + Nubark mancozeb 6DS 16 oz (A)….	3.3	100.0	18.4	74.7	17.0 def	4.9 b-e
Emesto Silver 1FS 0.31 fl oz + Nubark mancozeb 6DS 16 oz (A); Serenade Soil 1.34F 12.5 fl oz (B)…	2.7	100.0	12.1	85.6	19.8 def	5.7 b-e
Emesto Silver 1FS 0.31 fl oz + Nubark mancozeb 6DS 16 oz (A); Quadris 2.08SC 0.6 fl oz (B)……….	1.8	100.0	9.6	65.8	16.8 def	4.9 b-e
WE1042-2 6DS 1 lb (A)……………	2.7	93.8	13.0	60.6	13.6 efg	3.9 cde
WE1043-1 6DS 1 lb (A)…………..	3.1	93.8	11.0	63.9	19.7 def	6.3 b-e
Maxim 4FS 0.08 fl oz (A)………….	2.1	100.0	10.6	83.8	24.4 d	9.7 b
Maxim 4FS 0.08 fl oz + WE1502-1 L 2.55 fl oz (A)………...	2.2	96.4	10.4	70.4	22.2 de	7.8 bcd
Maxim 4FS 0.08 fl oz + WE1042-2 6DS 1 lb (A)…………...	3.0	100.0	13.7	64.0	17.2 def	5.0 b-e
Emesto Silver 1FS 0.4 fl oz + WE1042-2 6DS 1 lb (A)………….....	3.8	100.0	17.3	76.6	16.0 def	4.8 b-e
Actinovate AG 0.01DS 0.15 oz + Maxim 4FS 0.08 fl oz + WE1042-2 6DS 1 lb (A)……………	2.8	100.0	11.1	75.8	6.8 g	2.7 e
Moncut 70 DF 70DF 1.04 oz (B)…..	1.9	95.8	12.8	55.8	61.6 bc	3.2 e
Moncut 70 DF 70DF 1.56 oz (B)…..	2.2	100.0	13.9	58.8	78.4 ab	8.0 bc
Moncut 70 DF 70DF 1.04 oz + Serenade Soil 1.34F 4.7 fl oz (B)…..	1.7	100.0	12.9	49.6	84.7 a	3.9 cde
Quadris 2.08SC 0.65 fl oz (B)……...	2.6	96.9	13.1	58.0	78.7 ab	6.5 b-e
Vertisan 1.67EC 1.56 fl oz (B)……..	1.8	100.0	11.8	73.4	88.6 a	3.3 de
Priaxor 4.17SC 0.65 fl oz (B)………	2.3	100.0	10.6	65.0	74.8 ab	9.5 b
Convoy 40 SC 40SC 1.62 fl oz (B)...	2.3	100.0	11.1	54.3	83.7 a	4.2 cde
Prostar 70 WG 70WG 1.04 oz (B)…	1.9	100.0	10.0	69.7	82.0 ab	4.3 cde
Convoy 40 SC 40SC 0.38 fl oz + Nubark mancozeb 6DS 0.75 lb (A)..	2.4	100.0	13.3	63.7	79.5 ab	6.8 b-e
Emesto Silver 1FS 0.31 fl oz + Firbark 0D 0.5 lb (A)	2.1	100.0	10.7	65.2	83.5 a	3.9 cde
Moncoat MZ 7.5DP 0.75 lb (A)…...	1.9	100.0	13.1	58.8	75.0 ab	8.2 bc
Treatment Prob (F)	0.16	0.68	0.21	0.64		

[a] DAP = Days After Planting.
[c] Application dates: A= 24 May (liquid formulations for seed piece application at 0.2 pt); B= 27 May (in-furrow); C= 6 Jun (foliar); D= 7 Jul (foliar).
[c] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD).
[e] Stems with greater than 5% of area with stem canker due to *Rhizoctonia solani.*
[f] Stolons with greater than 5% of area with stolon canker due to *Rhizoctonia solani*.
[g] Severity of black scurf was measured as an index calculated by counting the number of tubers (n = 20) falling into each class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >15% surface area of tuber covered with sclerotia. The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with sclerotia.

Funding: MPIC and Industry

Evaluation of fungicide programs for potato early blight, brown leaf spot control, Botrytis tan spot and white mold, 2015.

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Potatoes ('Russet Norkotah', cut seed, treated with Maxim FS at 0.16 fl oz/cwt) were planted at in a grower field, near Constantine, MI (Capac loam soil); 41.8277, -85.6616 deg; elevation 833 ft. on 15 Apr into two-row by 20-ft plots (ca. 10-in between plants to give a target population of 50 plants at 34-in row spacing) replicated four times in a randomized complete block design. Plots were irrigated as needed with sprinklers and were hilled immediately before sprays began. All fungicides in this trial were applied on a 7-day interval from 2 Jun to 30 Jul (9 applications) with an ATV rear-mounted R&D spray boom calibrated to deliver 25 gal (80 psi) using three XR11003VS nozzles per row. Potato late blight was prevented from movement into the plots with bi-weekly applications of Previcur N 6SC at 1.2 pt from early canopy closure on 15 Jun to 5 Aug. Weeds were controlled by hilling and with Dual 8E (2 pt on 3 May), Poast 1.5EC (1.5 pt on 13 Jun). Insects were controlled with Admire 2F (20 fl oz at planting), Pounce 3.2EC (8 oz on 22 May), Sevin 80S (1.25 lb on 13 and 29 Jun), and Thiodan 3EC (2.33 pt on13 Jun). Plots were rated visually for combined percentage foliar area affected by early blight and brown leaf spot and Botrytis tan spot on 21, 28 Jul and 5 Aug [6 days after final application (DAFA). The evaluations for early blight and brown leaf spot were combined into a single assessment and also the ratings for all three pathogens were combined for an overall defoliation rating. White mold and bacterial vine rot were measured as percent severity. Vines were killed with Reglone 2EC (1 pt on 1 Sep). Plots were harvested on 18 Sep and tubers from individual treatments were weighed and graded. Meteorological variables were measured with a Campbell weather station located at the farm from 1 Apr to 30 Aug. Average daily air temperature (ºF) from 1 Apr was 46.5, 62.5, 66.6, 68.3 and 68.1 and the number of days with maximum temperature >90ºF was 0 (Apr, May, Jun, Jul, Aug, respectively). Average daily relative humidity (%) over the same period was 69.8, 73.7, 78.4, 78.4, and 76.4. Average daily soil temperature at 4" depth (ºF) over the same period was 45.1, 58.9, 69.3, 73.4, and 71.3. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 25.7, 26.0, 27.0, 26.8, and 21.8. Precipitation was 3.24, 5.52, 6.07, 4.75, and 2.59 in. Plots were irrigated to supplement precipitation to about 0.1 in./4 day period with overhead irrigation. Early blight severity values accumulated from emergence on 1 may to 29 Sep (evaluation date) were 1050 P-days.

Weather conditions were cool throughout the spring and summer and not conducive for the development of early blight and brown leaf spot, Botrytis tan spot or white mold and symptoms were not severe for any of the diseases. Early blight, brown leaf spot and Botrytis tan spot developed slowly but steadily during Aug and untreated controls reached about 24.9% foliar infection by 5 Aug after which the vines started to senesce making disease assessment difficult as several diseases were interacting. All treatments had significantly less combined early blight, brown leaf spot and Botrytis tan spot than the untreated control. White mold developed slowly during Aug and untreated controls reached 14.8% foliar area affected on 5 Aug, six days after the final fungicide application was applied. All fungicide programs had significantly lower white mold in comparison to the untreated control. No fungicide programs had significantly less bacterial stem rot in comparison to the untreated control although the levels in the control were low. Treatments with greater than US-1 yield of 349 cwt/A and total yield of 419 cwt/A were significantly different from the untreated control. Phytotoxicity was not noted in any of the treatments.

Treatment and rate In-furrow rate/1000 row feet (A)	Early Blight		Brown Leaf Spot		Alternaria combined[b]		Botrytis tan spot		Alternaria + Botrytis[c]		Alternaria + Botrytis Combined RAUDPC[d]	
	Final foliar severity 112 DAP[a] (%)											
Bravo WS 6SC 1.5 pt (B-H[e])……………	4.9	b[f]	6.1	ab	11.3	bc	7.1	b	18.2	bc	8.1	bc
Bravo WS 6SC 1.5 pt[g] (BC) Bravo WS 6SC 1.5 pt + Scala 5SC 7 fl oz (D) Bravo WS 6SC 1.5 pt + Luna Tranquility 4.16SC 11.2 fl oz (EFH) Bravo WS 6SC 1.5 pt + Reason 44.4SC 5.5 fl oz (G)………………	2.8	c	4.1	bc	7.4	cd	6.0	b	13.6	cd	5.8	cd
Serenade Soil 1.34F 17.6 fl oz (A) Bravo WS 6SC 1.5 pt + Scala 5SC 7 fl oz (D) Bravo WS 6SC 1.5 pt + Luna Tranquility 4.16SC 11.2 fl oz (EFH) Bravo WS 6SC 1.5 pt + Reason 44.4SC 5.5 fl oz (G)……………	2.8	c	3.4	cd	6.5	d	5.0	b	11.5	d	3.7	e
Bravo WS 6SC 1.5 pt* (BCDFH) Bravo WS 6SC 1.5 pt Luna Tranquility 4.16SC 11.2 fl oz (EG)	0.0	d	1.8	d	1.8	e	5.0	b	6.8	e	3.9	de
OxiDate 2.0 27L 1 % v/v + AquaSil 100L 0.07 % v/v (B-H)………….	7.1	b	7.3	a	14.6	b	7.1	b	21.3	b	10.0	b
OxiDate 2.0 27L 1 % v/v + Kinetic 90SL 8 fl oz + Bravo WS 6SC 1.5 pt + Luna Tranquility 4.16SC 11.2 fl oz (B-H).	0.4	d	2.0	cd	2.4	e	2.6	c	5.0	e	1.9	f
Untreated Check…………………………	15.7	a	8.6	a	24.9	a	11.9	a	36.8	a	16.2	a

[a] DAP= days after planting
[b] Combination of foliar infection due to a combination of early blight [EB (*Alternaria solani*)] *and* Brown leaf spot [BLS (*A. alternata*)] on 5 Aug, 16 days after appearance of initial symptoms of *Alternaria* spp.
[c] Combination of foliar infection due to a combination of early blight [EB (*Alternaria solani*)], Brown leaf spot [BLS (*A. alternata*)] and Botrytis tan spot (*Botrytis cinerea*) on 5 Aug.
[d] RAUDPC, relative area under the disease progress curve calculated from day of appearance of initial symptoms of the combination of EB, BLS and Botrytis tan spot from 21 Jul to 5 Aug (16 days).
[e] Application dates: A= 15 Apr; B= 2 Jun; C= 9 Jun; D= 16 Jun; E= 23 Jul; F= 1 Jul; G= 8 Jul; H= 15 Jul; I= 23 Jul; J= 30 Jul
[f] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD)
[g] All treatments included at Kinetic 90SL 8 fl oz

Funding: MPIC and Industry

Treatment and rate In-furrow rate/1000 row feet (A)	White mold severity (%) 85 104 DAP[a]		Bacterial Vine Rot severity (%) 8/5 104 DAP		Yield (cwt) US-1		 Total	
Bravo WS 6SC 1.5 pt (B-H)……………….	4.9	c[c]	1.2	a	456	ab	523	a
Bravo WS 6SC 1.5 pt* (BC) Bravo WS 6SC 1.5 pt + Scala 5SC 7 fl oz (D) Bravo WS 6SC 1.5 pt + Luna Tranquility 4.16SC 11.2 fl oz (EFH) Bravo WS 6SC 1.5 pt + Reason 44.4SC 5.5 fl oz (G)………………..	4.6	c	1.4	a	402	c	467	b
Serenade Soil 1.34F 17.6 fl oz (A) Bravo WS 6SC 1.5 pt + Scala 5SC 7 fl oz (D) Bravo WS 6SC 1.5 pt + Luna Tranquility 4.16SC 11.2 fl oz (EFH) Bravo WS 6SC 1.5 pt + Reason 44.4SC 5.5 fl oz (G)……………….	6.6	bc	1.6	a	412	c	463	b
Bravo WS 6SC 1.5 pt* (BCDFH) Bravo WS 6SC 1.5 pt Luna Tranquility 4.16SC 11.2 fl oz (EG)….	5.5	c	1.6	a	411	c	481	ab
OxiDate 2.0 27L 1 % v/v + AquaSil 100L 0.07 % v/v (B-H)…………...	10.1	ab	1.2	a	421	bc	485	ab
OxiDate 2.0 27L 1 % v/v + Kinetic 90SL 8 fl oz + Bravo WS 6SC 1.5 pt + Luna Tranquility 4.16SC 11.2 fl oz (B-H)...	3.5	c	2.5	a	465	a	523	a
Untreated Check……………………………	14.8	a	2.5	a	349	d	415	c

[a] DAP= days after planting
[b] Application dates: A= 16 Jul; B= 23 Jul; C= 30 Jul; D= 6 Aug; E= 13 Aug; F= 21 Aug; G= 27 Aug; H= 3 Sep
[c] Values followed by the same letter are not significantly different at p = 0.05 (Fishers LSD)

Funding: MPIC and Industry

In-furrow and foliar fluopyram treatments for control of Verticillium wilt of potatoes, 2015.

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In-furrow and foliar combinations of the chemical fluopyram were applied at the Michigan State University Clarksville Research Center (CRC), Clarksville, MI (Capac loam soil); 42.8733, -85.2604 degrees. Potato seed ("FL2137") was prepared for planting by cutting two days prior to planting. Seed pieces were planted on 27 May into two-row by 25-ft plots (~10-in between plants to give a target population of 60 plants/plot at 34-in row spacing) replicated four times in a randomized complete block design. A 5-ft not-planted alley separated the two-row beds. Fluopyram 4.16SC (11.2 fl oz/A) was applied throughout the season at three different timings. The first timing was at planting, in-furrow (Timing A). A separate foliar application of fluopyram was applied 21 DAP (days after planting) at the same rate as the in-furrow treatment (Timing B). A final foliar treatment, was applied 42 DAP at the same rate (Timing C). Irrigation was applied to each plot immediately after the applications of Timing treatment B and Timing treatment C to allow the chemical to get into the root system. Vydate 3.77SC was applied with each treatment in-furrow (at planting; 34 oz/A), and to foliage at 21 DAP (17 oz/A) and 42 DAP (17 oz/A). In-furrow, at-planting applications of fluopyram and Vydate were delivered in 8 pt water/A in a 7 in. band using a single XR11003VS nozzle at 30 psi. Foliar applications of fluopyram and Vydate were applied with an R&D spray boom delivering 25 gal/A (80 psi) and using three XR11003VS nozzles per row. Fertilizer was drilled into plots before planting, formulated according to results of soil tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP. Bravo WS 6SC 1.5 pt/A was applied on a seven-day interval, total of eight applications, for foliar disease control. Weeds were controlled by cultivation and with Dual 8E at 2 pt/A 10 DAP, Basagran at 2 pt/A 20 and 40 DAP and Poast at 1.5 pt/A 58 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Sevin 80S at 1.25 lb/A 31 and 55 DAP, Thiodan 3 EC at 2.33 pt/A 65 and 87 DAP and Pounce 3.2EC at 8 oz/A 48 DAP. Vines were killed with Reglone 2EC (1 pt/A on 1 Oct). Plots (1 x 25-ft row) were harvested on 20 Oct (121 DAP) and individual treatments were weighed and graded.

Sampling

Soil was sampled on 17 Jun (21 DAP) and 8 Jul (42 DAP) and sent to the MSU Plant Diagnostic Clinic to determine populations of *Verticillium dahliae* colony forming units (CFUs) in each plot. Similarly, soil was sampled on 27 May (AP), 17 Jun (21 DAP) and 8 Jul (42 DAP) and sent to the MSU Plant Diagnostic Clinic to determine populations of *Pratylenchus penetrans* (Root-Lesion Nematode (RLN)) in each plot. Potato early die (PED) visual assessment was done on 7 Aug (72 DAP) and 24 Aug (89 DAP) using the following scale: 0=No potato early die seen; 1=Small amounts of yellow and flagging of petioles; 2=Moderate amounts of yellowing and flagging of petioles, some of the the flagged petioles becoming necrotic; 3=Symptomatic plants are start to have stems stand straight up while the rest of the plant is laying down, the upright stems are yellow and petioles are wilted and necrotic; 4=Majority of the plot has upright necrotic stems; 5=Entire plot is necrotic, upright stems are brown and petioles are wilted and necrotic, tuber may have brown speckling throughout the stem-end. Randomly selected samples of 10 tubers per plot were washed and assessed for stem end vascular beading incidence (%) on 19 Nov 2015, 30 days after harvest (151 DAP).

Meteorological Data

Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to 31 Oct. Average daily air temperature (^{o}F) from May to Oct was 59.3, 63.8, 68.3, 67.3, 64.7 and 49.9 and the number of days with maximum temperature >90^{o}F was 0 (May to Oct). Average daily relative humidity (%) over the same period was 69.4, 73.1, 70.5, 74.1, 71.8 and 73.6. Average daily soil temperature at 4” depth (^{o}F) over the same period was 60.0, 68.2, 73.6, 71.6, 68.9 and 55.9. Precipitation was 4.01, 3.02, 0.29, 3.09, 3.52, and 3.07 in. Plots were irrigated to supplement precipitation to about 0.1 in./4 day period with overhead sprinkle irrigation.

Results (Table 1.)

All treatments aside from Timing C alone had a higher percent of emergence when compared to the not-treated control indicating that early season treatment with fluopyram has an effect on emergence. No treatment differed significantly from the not-treated control in regards to *Verticillium dahliae* CFUs at either sample date. Root-lesion nematode (RLN) numbers from treated plots were not significantly different from the not-treated control on 27 May or 17 Jun but all treatments had significantly lower RLN populations compared to the not-treated control on 8 Jul. These RLN population numbers could indicate that plots treated with fluopyram at various times have greater late-season nematode control compared to not-treated control plots. Though late season nematode populations were significantly decreased in all treated plots compared to the not-treated control, no significant differences were observed in potato early die ratings between treatments and the not-treated control on 7 Aug or 24 Aug. No significant differences were seen between treatments and the not treated control in regards to total yield. Timing C alone had a significantly higher percent of tuber vascular discoloration compared to the not-treated control. Soil treatments were not phytotoxic in terms of plant stand, rate of emergence, or marketable yield.

Conclusions

Environmental conditions were conducive to Verticillium wilt throughout the state, but heavy rainfall throughout the month of June had a negative impact on plot development. *Verticillium dahliae* and RLN populations were very low throughout the growing season at this sight which contributed to the lack of PED seen in the plot. Though PED was not present in the majority of the plots in this trial, it is important to note the apparent effect of fluopyram on late-season RLN populations. The manufacturers of fluopyram have reason to believe that this chemistry has a significant nematicidal property. Since potato early die is manifested via the conjunction of root-lesion nematodes and *V. dahliae*, further work needs to be conducted to better determine the meaning of the results found through this trial.

Funding: MPIC and Industry

Table 1. Effects of in-furrow, at planting, and foliar fluopyram treatments on emergence percent, *Verticillium dahliae* colony forming units (CFU) in soil, *Pratylenchus penetrans* numbers in soil, potato early die ratings, yield in hundred-weight per acre, and vascular discoloration of tubers.

Timing of Fluopyram Application[a]	Emergence %	Average CFU/10 g of Soil 17 Jun[b,c]	Average CFU/10 g of Soil 8 Jul	RLN[d]/100cc Soil 27 May	RLN/100cc Soil 17 Jun	RLN/100cc Soil 8 Jul	PED[e] Rating 7 Aug	PED Rating 24 Aug	Total Yield in CWT/A	% VD[f] in Tubers
Not-treated Control	87.5 bc[g]	3.3	4.1	2.0	0.5	3.8 a	0.8	2.5	171.0	40.0 b
Timing A	97.9 a	4.8	2.4	2.0	0.0	0.0 c	0.8	1.8	160.5	30.0 b
Timing B	95.4 a	1.8	1.2	2.0	0.7	0.0 c	1.3	1.8	106.4	50.0 b
Timing C	85.4 c	3.8	3.2	2.0	0.0	1.1 b	0.8	1.8	150.1	70.5 a
Timing A & B	92.1 abc	4.0	3.7	2.0	0.3	0.0 c	1.3	2.0	159.6	30.8 b
Timing A & C	97.1 a	2.0	1.6	2.0	0.5	0.5 bc	1.3	2.0	132.5	40.8 b
Timing B & C	94.2 ab	3.3	2.1	2.0	1.5	0.0 c	1.3	2.0	145.7	50.0 b
Timing A, B & C	93.3 ab	4.8	3.5	2.0	0.3	0.1 bc	1.3	1.8	171.6	40.8 b

[a] In-furrow at planting (Timing A), 21 DAP foliar application (Timing B), 42 DAP foliar application (Timing C)
[b] Soil sampled from each plot and plated on *Verticillium dahliae* selective media and incubated for 21 days. Work done at MSU Diagnostic Clinic.
[c] CFU=colony forming units seen on selective *Verticillium dahliae* media
[d] RLN=Root-Lesion Nematode. Work done at MSU Diagnostic Clinic.
[e] PED=Potato Early Die rating using the following scale: 0=No potato early die seen; 1=Small amounts of yellow and flagging of petioles; 2=Moderate amounts of yellowing and flagging of petioles, some of the the flagged petioles becoming necrotic; 3=Symptomatic plants are start to have stems stand straight up while the rest of the plant is laying down, the upright stems are yellow and petioles are wilted and necrotic; 4=Majority of the plot has upright necrotic stems; 5=Entire plot is necrotic, upright stems are brown and petioles are wilted and necrotic, tuber may have brown speckling throughout the stem-end.
[f] VD=Vascular discoloration of the stem end; percentage calculated from 40 tubers
[g] Means followed by same letter do not significantly differ (α=0.10, LSD)

Funding: MPIC and Industry

In-furrow and foliar treatment programs for control of Verticillium wilt of potatoes, 2015.

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In-furrow and foliar combinations of the chemical fluopyram were applied at the Michigan State University Montcalm Research Center (MRC), Entrican, MI (sandy soil); 43.3526, -85.1761 deg; elevation 951 ft. Potato seed (“FL2137”) was prepared for planting by cutting two days prior to planting. Seed pieces were planted on 14 May into two-row by 25-ft plots (~10-in between plants to give a target population of 60 plants/plot at 34-in row spacing) replicated four times in a randomized complete block design. A 5-ft not-planted alley separated the two-row beds. A not-treated control was compared with 7 different treatment programs to compare their efficacy in controlling potato early die (PED). Timings in the trial were in-furrow at planting (Timing A), at 2” emergence (Timing B), and 7 days after 2” emergence (Timing C).The 7 treatments were: Luna Tranquility 4.16SC (11.2 oz/A) at Timing B alone; Luna Tranquility 4.16SC (11.2 oz/A) at Timing C alone; Luna Tranquility 4.16SC (11.2 oz/A) at Timing B and C; Luna Privilege 4.16SC (0.442 oz/1000 row-ft) at timing A followed by Luna Tranquility 4.16SC (11.2 oz/A) at Timings B and C; Seranade ASO 1.34%F (4.16 oz/1000 row-ft) at timing A followed by Luna Tranquility 4.16SC (11.2 oz/A) at Timings B and C; Vydate 3.77SC (2.21 oz/1000 row-ft) at Timing A followed by Luna Tranquility 4.16SC (11.2 oz/A) at Timings B and C; Vydate 3.77SC (17 oz/A) at Timings B and C. Irrigation was applied to each plot immediately after the applications of Timing treatment B and Timing treatment C to allow the chemical to get into the root system. At-planting applications (Timing A) were delivered in 8 pt water/A in a 7 in. band using a single XR11003VS nozzle at 30 psi. Foliar applications of (Timings B and C) were applied with an R&D spray boom delivering 25 gal/A (80 psi) and using three XR11003VS nozzles per row. Fertilizer was drilled into plots before planting, formulated according to results of soil tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP. Bravo WS 6SC 1.5 pt/A was applied on a seven-day interval, total of eight applications, for foliar disease control. Weeds were controlled by cultivation and with Dual 8E at 2 pt/A 10 DAP, Basagran at 2 pt/A 20 and 40 DAP and Poast at 1.5 pt/A 58 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Sevin 80S at 1.25 lb/A 31 and 55 DAP, Thiodan 3 EC at 2.33 pt/A 65 and 87 DAP and Pounce 3.2EC at 8 oz/A 48 DAP. Vines were killed with Reglone 2EC (1 pt/A on 1 Sep). Plots (1 x 25-ft row) were harvested on 21 Sep (130 DAP) and individual treatments were weighed and graded.

Sampling

Soil was sampled on 8 Jun (25 DAP) and 2 Jul (49 DAP) and sent to the MSU Plant Diagnostic Clinic to determine populations of *Verticillium dahliae* colony forming units (CFUs) in each plot. Similarly, soil was sampled on 14 May (AP), 8 Jun (25 DAP) and 2 Jul (49 DAP) and sent to the MSU Plant Diagnostic Clinic to determine populations of *Pratylenchus penetrans* (Root-Lesion Nematode (RLN)) in each plot. Unfortunately, RLN were not detected in the plot at any of the sampling times. Potato early die (PED) visual assessment was done on 6 Aug (84 DAP) and 20 Aug (98 DAP) using the following scale: 0=No potato early die seen; 1=Small amounts of yellow and flagging of petioles; 2=Moderate amounts of yellowing and flagging of petioles, some of the the flagged petioles becoming necrotic; 3=Symptomatic plants are start to have stems stand straight up while the rest of the plant is laying down, the upright stems are yellow and petioles are wilted and necrotic; 4=Majority of the plot has upright necrotic stems; 5=Entire plot is necrotic, upright stems are brown and petioles are wilted and necrotic, tuber may have brown speckling throughout the stem-end. Tubers out of the field were taken to the MSU Chip Lab and fried to determine an SFA Chip Score (Snack Food Association Scale (Out of the field); Ratings: 1-5; 1: Excellent, 5: Poor). Randomly selected samples of 10 tubers per plot were washed and assessed for stem end vascular beading incidence (%) on 20 Oct, 30 days after harvest (150 DAP).

Meteorological Data

Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to 30 Sep. Average daily air temperature (^{o}F) from May to Sep was 59.1, 64.7, 68.1, 67.4, and 65.4 and the number of days with maximum temperature >90^{o}F was 0, 0, 0, 0, and 1. Average daily relative humidity (%) over the same period was 71.6, 73.7, 73.0, 77.0, and 76.6. Average daily soil temperature at 4" depth (^{o}F) over the same period was 60.1, 69.3, 73.8, 70.7, and 66.6. Precipitation was 2.96, 4.79, 1.72, 2.42, and 3.90 in. Plots were irrigated to supplement precipitation to about 0.1 in./4 day period with overhead sprinkle irrigation.

Results (Table 1.)

No treatment differed significantly from the not-treated control in emergence. No treatment differed significantly from the not-treated control in regards to *Verticillium dahliae* CFUs at either sample date. Root-lesion nematode (RLN) populations were not found in the plots at the times sampled. Luna Tranquility at Timing B and Vydate at Timings B and C had significantly lower PED Ratings compared to the not-treated control on 6 Aug. Luna Tranquility at Timing B, Luna Tranquility at Timings B and C, Luna Privilege at Timing A followed by Luna Tranquility at Timings B and C, and Vydate at Timings B and C had significantly lower PED ratings compared to the not-treated control on 20 Aug. Luna Tranquility at Timing C, Seranade ASO at Timing A followed by Luna Tranquility at Timings B and C, and Vydate at Timings B and C had significantly lower US #1 yield compared to the not-treated control. No treatment had significantly different B size yields compared to the not-treated control. Luna Tranquility at Timing C alone had significantly lower percentage of tubers with vascular discoloration compared with the not-treated control. Luna Privilege at Timing A followed by Luna Tranquility at Timings B and C and Serenade ASO at Timing A followed by Luna Tranquility at Timings B and C had significantly higher SFA Chip Scores compared to the not-treated control.

Conclusions

Environmental conditions were conducive to Verticillium wilt throughout the state, but heavy rainfall throughout the month of June had a negative impact on plot development. *Verticillium dahliae* populations were low to moderate throughout the growing season at this sight but differences between plots in PED ratings indicate that levels were sufficient to cause disease. Lack of RLN populations is most likely attributed to sampling technique. Luna Tranquility as a foliar treatment at Timing B does seem to have an impact on PED. The manufacturers of Luna Tranquility have reason to believe that one of the chemistries in the product has a significant nematicidal property. Since potato early die is manifested via the conjunction of root-lesion nematodes and *V. dahliae*, further work needs to be conducted to better determine the meaning of the results found through this trial.

Table 1. Effects of in-furrow, at planting, and foliar treatments on emergence percent, *Verticillium dahliae* colony forming units (CFU) in soil, potato early die ratings, marketable yield in hundred-weight per acre, vascular discoloration of tubers, and SFA chip score.

Treatment	Application Timing[a]	Emergence %	Average CFU/10g of Soil[bc] 8 Jun	Average CFU/10g of Soil 2 Jul	PED[d] Rating 6 Aug	PED Rating 20 Aug	US #1 Yield in CWT/A	B Size Yield in CWT/A	% VD[e] in Tubers	SFA Chip Score[f]
Not-treated Control		99.6	24.0 ab[g]	24.3 ab	2.8 ab	4.0 a	311.2 ab	32.9 ab	63.0 abc	1.88 c
Luna Tranquility	B	94.0	18.8 ab	26.5 ab	2.0 c	3.3 bc	318.2 ab	40.6 a	70.0 a	1.88 c
Luna Tranquility	C	98.7	15.5 b	20.5 b	3.0 a	3.5 ab	256.7 d	40.3 a	33.0 d	2.38 abc
Luna Tranquility	B & C	98.5	15.3 b	30.3 ab	2.5 abc	3.3 bc	317.3 ab	24.3 b	65.0 ab	2.00 bc
Luna Privilege Luna Tranquility	A B & C	98.6	20.3 ab	40.0 a	2.5 abc	3.3 bc	297.3 abc	39.7 a	43.0 bcd	2.75 a
Serenade ASO Luna Tranquility	A B & C	96.9	19.5 ab	36.3 ab	2.5 abc	3.8 ab	287.5 bcd	35.1 a	40.0 cd	2.63 ab
Vydate Luna Tranquility	A B & C	95.2	31.8 a	26.3 ab	3.0 a	3.5 ab	257.7 cd	37.8 a	43.0 bcd	2.00 bc
Vydate	B & C	98.6	22.8 ab	25.0 ab	2.3 bc	2.8 c	328.4 a	41.2 a	55.0 abcd	2.00 bc

[a] In-furrow at planting (Timing A), 2” Emergence (Timing B), 7 Days after 2” Emergence (Timing C)
[b] Soil sampled from each plot and plated on *Verticillium dahliae* selective media and incubated for 21 days. Work done at MSU Diagnostic Clinic.
[c] CFU=colony forming units seen on selective *Verticillium dahliae* media
[d]PED=Potato Early Die rating using the following scale: 0=No potato early die seen; 1=Small amounts of yellow and flagging of petioles; 2=Moderate amounts of yellowing and flagging of petioles, some of the the flagged petioles becoming necrotic; 3=Symptomatic plants are start to have stems stand straight up while the rest of the plant is laying down, the upright stems are yellow and petioles are wilted and necrotic; 4=Majority of the plot has upright necrotic stems; 5=Entire plot is necrotic, upright stems are brown and petioles are wilted and necrotic, tuber may have brown speckling throughout the stem-end
[e]VD=Vascular discoloration of the stem end; percentage calculated from 40 tubers
[f]SFA Chip Score: Snack Food Association Scale (Out of the field); Ratings: 1-5; 1: Excellent, 5: Poor
[g] Means followed by same letter do not significantly differ (α=0.10, LSD)

Seed treatments for control of seed-borne *Phytophthora infestans* (US-23 genotype) in a range of cultivars and advanced breeding lines, 2015.

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Field trial: Five commercial potato cultivars (Atlantic, Snowden, Russet Norkotah, Missaukee and Jacqueline Lee), and nine advanced breeding lines (ABL) from the Michigan State University Potato Breeding and Genetics Program were tested in field and growth chamber trials. In the field potato tubers were cut, into two or three sections longitudinally (depending on the size of tuber) ensuring the presence of viable sprouts on each seed-piece. The cut seed pieces were immersed in a mixture of mycelium and zoospores of *Phytophthora infestans* [US-23 biotype (sensitive to mefenoxam, A1 mating type)] for 30 min then dried for 1 h prior to treating with fungicides. Three fungicides Nubark Mancozeb, Reason and Emesto Silver were used in this experiment. Treatments applied to seed pieces were (i) non-inoculated, (ii) inoculated, (iii) inoculated with fungicides. Treated seed pieces were planted the following day at the Michigan State University Horticultural Experimental Station, Clarksville, MI (Capac loam soil); 42.8733, -85.2604 deg; elevation 895 ft. on 28 May into two-row by 10-ft plots (ca. 10-in between plants to give a target population of 10 plants at 34-in row spacing) replicated four times in a randomized complete block design. Plots were irrigated as needed with sprinklers and were hilled immediately before sprays began. Weeds were controlled by hilling and with Dual 8E (2 pt on 5 Jun), Poast (1.5 pt on 17 Jul). Insects were controlled with Admire 2F (20 fl oz at planting), Sevin 80S (1.25 lb on 17 and 31 Jul), Thiodan 3EC (2.33 pt on14 Aug) and Pounce 3.2EC (8 oz on 17 Jul). The number of emerged plants was recorded over a 42-day period after planting, final plant stand (%) and the relative area under the emergence progress curve (RAUEPC) was calculated. The RAUEPC was calculated by dividing the AUEPC by the maximum AUEPC (100 X duration of emergence period) from planting to full emergence. Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to 31 Oct. Average daily air temperature (^{o}F) from Jun to Oct was 59.3, 63.8, 68.3, 67.3, 64.7 and 49.9 and the number of days with maximum temperature >90^{o}F was 0 (May to Oct). Average daily relative humidity (%) over the same period was 69.4, 73.1, 70.5, 74.1, 71.8 and 73.6. Average daily soil temperature at 4" depth (^{o}F) over the same period was 60.0, 68.2, 73.6, 71.6, 68.9 and 55.9. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 35.6, 36.6, 32.7, 35.7, 37.1, and 35.8. Precipitation was 4.01, 3.02, 0.29, 3.09, 3.52, and 3.07 in.

Results: Data was analyzed using ANOVA separated using mean separation with Tukey's HSD test. Late blight developed in seed pieces and affected plant stands in all treatments. No treatments achieved 100% emergence including the non-inoculated non-treated control. The non-inoculated non-treated control had greater plant stand (78.8%) in comparison to all other treatments. Tubers inoculated with Nubark Mancozeb (NM) (68.1%), Reason+NM (67.9%) and Emesto Silver+NM (65.8%) had significantly greater plant stand compare to the inoculated control. The inoculated control treatment was significantly reduced stand compared to all four treatments (24.0%) (Table 1). The RAEUPC values were comparable to final plant stand. The non-inoculated non-treated control had a greater RAUEPC value (42.5) in comparison to all other treatments. The Nubark Mancozeb treatment had an RAUEPC value of 36.8 and was not statistically significant from non-inoculated non-treated control. Reason+NM and Emesto Silver+NM had RAUEPC values of 35.3 and 34.6, respectively and were significantly lower from non-inoculated and non-treated control. The inoculated control had an RAUEPC value of 12.0 and was significantly lower to all other treatments (Table 1).

Growth chamber trial: The same cultivars and ABL were used for a growth chamber trial. Tuber inoculations with *Phytophthora infestans* [US-23 biotype (sensitive to mefenoxam, A1 mating type)] were done using colonized agar plugs inserted into tubers, and a non-colonized agar as a control. A total of 20 potato tubers from each cultivar/ABL were placed in 5lb mesh bags and replicated four times consisting 5 tubers in each replication. Tubers were incubated in plastic boxes lined with wet paper towel at 15°C in an environmental control chamber for 30 days. After 30 days, disease incidence was evaluated using digital scanner and image analysis software. The severity of tuber blight development represented by tissue darkening and relative average reflection intensity (RARI) was calculated. RARI (%) = (1-mean ARI treatment/mean ARI control) x 100; % RARI has a minimum value of zero (no darkening) and maximum value of 100 (tuber surface completely darkened).

Results: Data was analyzed using ANOVA and treatments separated using mean separation with Tukey's HSD test. The results indicated that severity of tuber blight between cultivars and breeding lines were significant. The overall results showed that the most susceptible cultivar was Russet Norkotah. Among breeding lines and commercial cultivars eight of them had significantly lower tuber blight severity compared to Russet Norkotah (Table 2).

Table 1. Effect of seed treatments for control of seed-borne *Phytophthora infestans* (US-23) in different potato cultivars and advanced breeding lines (ABL), 2015 plant stand (%), relative area under emergence progress curve values (RAUEPC 0-100).

Variety/ABL	Final Plant Stand (%)	Final Plant Stand (Treatments) (%)	
MSV235-2PY	76.0 a[a]	Non-inoculated check	78.8 a
MSS576-5SPL	75.5 ab	Nubark Mancozeb (NM)	68.1 ab
MSS206-2	74.0 ab	Reason/NM	67.9 ab
Missaukee	73.0 ab	Emesto Silver/NM	65.8 b
MSS176-1	70.5 abc	Inoculated check	24.0 c
MSL211-3	70.0 abc		
Snowden	65.5 abc		
MSS428-2	64.5 abc		
MSQ131-A	56.0 abcd		
MSS487-2	53.0 bcd		
Jacqueline lee	49.0 cd		
Russet Norkotah	39.0 de		
Atlantic	26.0 e		

Variety/ABL	RAUEPC (%)[b]	RAUEPC (Treatments) (%)	
MSV235-2PY	42.6 a[a]	Non-inoculated check	42.5 a
MSS576-5SPL	37.9 ab	Nubark Mancozeb (NM)	36.8 ab
MSS206-2	40.6 ab	Reason/NM	35.3 b
Missaukee	38.6 ab	Emesto Silver/NM	34.6 b
MSS176-1	38.8 ab	Inoculated check	12.0 c
MSL211-3	35.7 abcd		
Snowden	38.5 ab		
MSS428-2	36.4 abc		
MSQ131-A	27.9 bcde		
MSS487-2	25.0 cdef		
Jacqueline lee	22.9 def		
19.2	19.2 ef		
Atlantic	15.0 e		

[a] Values followed by the same letter are not significantly different at $p = 0.05$ (Least Square Means Tukey HSD).

[b] Relative area under the emergence progress curve measured from planting to 42 days after planting.

Table 2. Effect of tuber tissue late blight as mean Relative Area Reflection Intensity (RARI%) in different potato cultivars and advanced breeding lines (ABL) after inoculation with US-23 genotypes of *Phytophthora infestans*.

Variety/ABL	Mean RARI (%)[a]	
Russet Norkotah	25.98	a[b]
MSS576-5SPL	22.45	ab
MST145-2	16.95	abc
MSL211-3	16.70	abc
Missaukee	15.29	bcd
MSS487-2	14.01	bcd
MSQ131-A	11.97	cd
Snowden	11.95	cd
Atlantic	11.68	cd
Jacqueline Lee	11.03	cd
MSV235-2PY	10.03	cd
MSS428-2	9.02	cd
MSS176-1	6.94	d
MSS206-2	5.35	d

[a] Normalized tuber tissue darkening score expressed as RARI (%) = (1-mean ARI treatment/mean ARI control) x 100; % RARI has a minimum value of zero (no darkening) and maximum value of 100 (tuber surface completely darkened).
[b] Values followed by the same letter are not significantly different at $p = 0.05$ (Least Square Means Tukey HSD).

Crop rotations for enhancing soil health, plant health, and disease management in potato production

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A long-term potato crop management experimental research trial was established at MSU's Montcalm Research Center (Figures 1 and 2). A randomized complete split-block design with four replications (4-row 50 ft plots) was used and treatment plots consist of the following crop rotations: 1) Potato (2013-16); 2) Corn (2013), Potato (2014), Corn (2015) and Potato (2016); 3) Corn (2013-14) and Potato (2015) and Corn (2016); and 4) Corn (2013-2015) and Potato (2016). The split-block included organic and inorganic fertilizer treatments (Table 1). All management practices (irrigation, fertilization, insects, weeds, nematodes, and disease control) were according to conventional grower practices. Agronomic metrics of crop health such as plant stand, final yield quantity, quality and tuber health were measured. Potato crops were harvested and individual treatments were weighed and graded. Tubers were assessed for scab. Potato petiole where sampled twice during the growing season. Bulk and rhizosphere soil was sampled pre-planting and two times during the growing season from the potato and corn plots for each treatment, and transported immediately to the laboratory on ice.

Experimental field trials

The study was conducted on a sandy loam soil at the Michigan State University Montcalm Potato Research Farm, Entrican at 10-inch spacing and 34-inch rows (Figures 1 and 2). The experiment was arranged as a randomized complete block design with four replications. Individual plots were 12 ft. wide by 50 ft. in length and planted with the potato (*Solanum tuberosum*) and corn (*Zea mays*) cultivar "Snowden" and variety "DKC 48-12" respectively. The organic amendments were a stand-alone nutrient source to provide up to 250 lbs N (Table 1). The inorganic fertility program used a combination of urea, ammonium sulfate and ammonium sulfate-nitrate to provide up to 250 lbs N at 3 application timings of pre-plant incorporated, emergence, and hilling. Plot harvest was from 50 feet from one plot row. The inorganic fertilizer treatments receive starter fertilizer banded on both sides of the seed piece and two inches away from seed pieces. Foliar applications of Bravo WS 6SC 1.5 pt/A was applied on a seven-day interval, total of eight applications, for foliar disease control with a R&D spray boom delivering 25 gal/A (80 psi) and using three XR11003VS nozzles per row. Weeds were controlled by cultivation and with Dual 8E at 2 pt/A 10 DAP, Basagran at 2 pt/A 20 and 40 days after planting (DAP) and Poast at 1.5 pt/A 58 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Sevin 80S at 1.25 lb/A 31 and 55 DAP, Thiodan 3 EC at 2.33 pt/A 65 and 87 DAP and Pounce 3.2EC at 8 oz/A 48 DAP. Vines were killed with Reglone 2EC (1 pt/A on 6 Sep). Plots (1 x 50-ft row) were harvested on 15 Sept and individual treatments were weighed and graded. Soil samples were taken prior to planting, Jul 1 (15 days after emergence [DAE]), and 20 Aug (83 DAE). Potato petiole samples were taken on Jul 17 (30 DAE) and Aug 13 (60 DAE). Potato tubers were harvested, graded, culled and internal defects were noted. Tuber numbers for each group and weights (CWT) were recorded. Severity of common scab was measured as surface area affected (1=1 lesion to 1%; 2= 1.1-10%; 3=10.1-20%; 4= 20.1-30%; 5= > 50% surface area). Data was analyzed using ANOVA and treatments separated using mean separation with Fisher's Protected LSD. Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to the end of Sept. Average daily air temperature (^{o}F) from 10 June was 66.0, 66.1, 65.2, and 65.4 and the number of days with maximum temperature >90^{o}F was 0, 0, 0, 0 and 0 (May, Jun, Jul, Aug, Sep, respectively). Average daily relative humidity (%) over the same period was 71.6, 73.7, 70.5, 74.9 and 76.6%. Average daily soil temperature at 4" depth (^{o}F) over the same period was 63.2, 72.1, 69.7, 70.5, and 62.6. Precipitation (in.) over the same period was 0.98, 4.79, 1.72, 2.42, and 3.90. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

Based on petiole sampling at 30 DAE Mn and Zn ppm was significantly higher in the back-to-back potato inorganic fertility program (Table 1). Similarly at 60 DAE, Ca ppm was significantly higher the back-to-back potato inorganic treatment compared to the potato following corn organic treatment (Table 1). Based on petiole sampling at 60 DAE ppm B and Zn was significantly higher in potato following corn in inorganic fertility programs compared to the organic back-to-back organic and inorganic potato following corn fertility treatments, and percent S in the organic potato following corn fertility treatment was significantly lower compared to the back-to-back potato organic fertility treatment (Table 1). Moreover at 60 DAE Zn ppm was significantly higher in both organic fertility treatments compared to both inorganic fertility treatments (Table 1). Finally scab severity was significantly lower in the organic potato following corn fertility treatment compared to the inorganic back-to-back potato fertility treatment (Table 1). Scab severity was significantly lower in organic corn potato rotation lots (Table 1).

Laboratory experiments

Soil was sampled from the plots for each treatment described above three times during the season (pre-planting, emergence and prior to vine kill), and transported immediately to the laboratory on ice. 0.5 grams of soil from each sample will be used for DNA extraction, using the Mo Bio 101 DNA extraction kit (Mo Bio Laboratories Inc., Carlsbad, CA). Three soil samples per plot, consisting of three soil cores (240 DNAs in total) were used for DNA sequence analyses. Subsequent to DNA extraction quantity and quality was assessed using a NanoDrop ND-2000c spectrophotometer (NanoDrop Wilmington, DE). Soil genomic DNA was used for PCR amplification of the 16S variable regions and samples were sequenced by the Illumina paired-end technique using the previously described protocol (3) with slight modifications for total bacterial community analysis. PCR products were separated on 1% (w/v) agarose gel in 0.5×TBE stained with GelRed Nucleic Acid Stain (Phenix Research Products, Chandler, NC) by electrophoresis and visualized by UV exposure using the Gel Doc 2000 apparatus (Bio-Rad, Hercules, CA) (Figures 3-5). Total environmental genomic DNA from the soil sample was used as a template for polymerase chain reaction (PCR) amplification of the bacterial 16S rRNA gene. Preparation of amplicons and library construction was performed according to the previously described standard operating procedure (SOP) protocol (4). Amplicon libraries were submitted to the Michigan State University Research and Technology Support Facility (RTSF) for next-generation sequencing on the MiSeq Illumina platform (San Diego, CA). The resulting sequence data were analyzed using the previously described SOP analysis pipeline (4) with the mother v.1.33.0 software package (5). An additional phylotype assignment was determined by analysis of processed sequence data using the Ribosomal Database Project (RDP) 16S rRNA gene training set (version 9) (1, 2). Bacterial diversity was significantly higher early in the season in bulk soil from corn potato rotation with an inorganic fertility program and rhizosphere soil from the corn potato rotation with an organic fertility program (Table 1). Bacterial diversity was significantly lower late in the season in rhizosphere soil from both organic and inorganic back-to-back potato fertility programs, and corn potato rotation inorganic fertility programs (Table 1).

Literature cited

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Figure 1. Aerial image of rotational potato crop management experimental research trial at MSU Montcalm Potato Research Center

Figure 2. Long-term rotational potato crop management experimental research trial at MSU Montcalm Potato Research Center

Table 1. Summary of results from long-term rotational potato crop management experimental research trial at Michigan State University Montcalm Potato Research Center

		30 DAE[b, c]								
Treatment[a]	Rate	SPAD[d]	NO_3N %	P %	K %	Ca %	Mg %	S %	Zn ppm	Mn ppm
Potatoes, PPPP Inorganic MAP 11-52-0 K2O 0-0-62 AS 21-0-0-24 Urea 46-0-0	 120 lb ai/A 150 lb ai/A 66 lb ai/A 134 lb ai/A	39.38 a	1.04 a	0.39 a	10.80 a	0.75	0.26 a	0.25 a	35.50 a	171.50 a
Potatoes, PPPP Organic Herbrucks AS 21-0-0-24 Urea 46-0-0	 2 ton/A 40 lb ai/A 80 lb ai/A	41.40 a	1.60 a	0.36 a	10.33 b	0.89	0.39 a	0.28 a	31.25 b	81.25 c
Potatoes, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	.	.	.
Potatoes, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	.	.	.	.	.	.	.	.	.
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	41.45 a	1.27 a	0.38 a	9.52 d	0.88	0.36 a	0.24 a	32.00 b	110.75 b
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	42.63 a	1.54 a	0.39 a	9.92 c	0.92	0.42 a	0.26 a	32.00 b	76.00 c
Corn, CCCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	.	.	.
Corn, CCCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-	-

[a]Rotation treatments included: 1) Potato (2013-16); 2) Corn (2013), Potato (2014), Corn (2015) and Potato (2016); 3) Corn (2013-14) and Potato (2015) and Corn (2016); and 4) Corn (2013-2015) and Potato (2016).
[b]DAE=days after emergance.
[c]Means followed by same letter do not significantly differ (*P*=0.10, LSD).
[d]SPAD=soil plant analysis development measured by chlorophyll meter indicating leaf color.

Table 1. Continued

		30 DAE[b, c]							Diversity (Inverse Simpson)[d]			
Treatment[a]	Rate	Cu ppm	B ppm	Al ppm	Fe ppm	Na %	Total Yield CWT	Specific Gravity	Bulk Soil (early)	Rhizosphere Soil (early)	Bulk Soil (late)	Rhizosphere Soil (late)
Potatoes, PPPP Inorganic MAP 11-52-0 K2O 0-0-62 AS 21-0-0-24 Urea 46-0-0	 120 lb ai/A 150 lb ai/A 66 lb ai/A 134 lb ai/A	6.97 a	28.75 a	29.25 a	94.50 a	0.01 a	422.1 a	1.07 a	273.1 abcd	284.8 abcd	241.5 cde	188.2 ef
Potatoes, PPPP Organic Herbrucks AS 21-0-0-24 Urea 46-0-0	 2 ton/A 40 lb ai/A 80 lb ai/A	7.49 a	28.50 a	21.00 a	89.50 a	0.01 a	441.0 a	1.08 a	309.5 abc	285.7 abcd	253.9 cde	197.9 ef
Potatoes, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	.	.	.	.	.
Potatoes, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	.	.	.	.	.	.	.				
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	7.94 a	28.25 a	33.00 a	89.50 a	0.01 a	345.7 a	1.07 a	342.3 a	269.5 bcd	223.2 def	187.4 ef
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	8.64 a	28.00 a	31.75 a	93.25 a	0.01 a	462.2 a	1.08 a	328.8 ab	334.1ab	167.9 f	250.7 cde
Corn, CCCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	.	.	.	.	.
Corn, CCCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	.	.	.	.	.	.	.	.	.	.	.

[a]Rotation treatments included: 1) Potato (2013-16); 2) Corn (2013), Potato (2014), Corn (2015) and Potato (2016); 3) Corn (2013-14) and Potato (2015) and Corn (2016); and 4) Corn (2013-2015) and Potato (2016).

[b]DAE=days after Emergence.

[c]Means followed by same letter do not significantly differ (*P*=0.10, LSD)

[d]Mean comparison among treatments and sampling time, means followed by the same letter do not significantly differ (*P*=0.05 Tukey's HSD)

Table 1. Continued

Treatment[a]	Rate	60 DAE[b,c]							
		SPAD[d]	NO_3N %	P %	K %	Ca %	Mg %	S %	Zn ppm
Potatoes, PPPP Inorganic MAP 11-52-0 K2O 0-0-62 AS 21-0-0-24 Urea 46-0-0	 120 lb ai/A 150 lb ai/A 66 lb ai/A 134 lb ai/A	38.35 a	0.80 a	0.21 a	8.09 a	1.31 a	0.85 a	0.28 a	36.00 a
Potatoes, PPPP Organic Herbrucks AS 21-0-0-24 Urea 46-0-0	 2 ton/A 40 lb ai/A 80 lb ai/A	38.85 a	0.99 a	0.23 a	7.05 a	1.45 a	0.99 a	0.32 a	27.75 c
Corn, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	-	-	-
Corn, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	.	.	.	.	.	-	-	-
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	37.70 a	0.66 a	0.27 a	6.63 a	1.34 a	0.88 a	0.29	31.75 b
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	36.30 b	0.61 a	0.26 a	6.31 a	1.40 a	0.70 a	0.32	29.00 bc
Corn, CCCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	.	.
Corn, CCCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-

[a]Rotation treatments included in trial were: 1) Potato (2013-16); 2) Corn (2013), Potato (2014), Corn (2015) and Potato (2016); 3) Corn (2013-14) and Potato (2015) and Corn (2016); and 4) Corn (2013-2015) and Potato (2016).
[b]DAE=days after emergence.
[c]Means followed by same letter do not significantly differ (*P*=0.10, LSD)
[d]SPAD=soil plant analysis development measured by chlorophyll meter indicating leaf color

Table 1. Continued

		60 DAE[b, c]						122 DAP[d]			
Treatment[a]	Rate	Mn ppm	Fe ppm	Cu ppm	B ppm	Al ppm	Na %	Scab Incidence	Scab Severity[e]	% Emergence	Yield (BU/A)
Potatoes, PPPP Inorganic MAP 11-52-0 K2O 0-0-62 AS 21-0-0-24 Urea 46-0-0	 120 lb ai/A 150 lb ai/A 66 lb ai/A 134 lb ai/A	516.25 a	110.75 a	7.25 a	32.00 a	15.75 a	0.02 a	73.7 a	47.2 ab	80.3 a	.
Potatoes, PPPP Organic Herbrucks AS 21-0-0-24 Urea 46-0-0	 2 ton/A 40 lb ai/A 80 lb ai/A	226.50 c	112.00 a	6.00 a	31.25 ab	17.25 a	0.02 a	92.5 a	59.6 a	80.0 a	
Corn, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	-	-	-	230.7 a.
Corn, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	.	.	.	.	.	.	-	-	-	212.0 a
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	305.00 b	105.75 a	8.25 a	29.75 b	11.00 a	0.02 a	82.5 a	41.8 b	85.3 a	.
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	150.00 d	112.25 a	7.50 a	32.50 a	29.00 a	0.02 a	83.8 a	39.6 b	83.8 a	
Corn, CCCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	.	.	.	.	.	.	.	.	.	245.7 a
Corn, CCCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-	-	228.4 a

[a]Rotation treatments included in trial were: 1) Potato (2013-16); 2) Corn (2013), Potato (2014), Corn (2015) and Potato (2016); 3) Corn (2013-14) and Potato (2015) and Corn (2016); and 4) Corn (2013-2015) and Potato (2016).
[b]DAE=days after emergence.
[c]Means followed by same letter do not significantly differ (*P*=0.10, LSD)
[d]DAP=days after planting
[e]Severity of common scab was measured as surface area affected (1=1 lesion to 1%; 2= 1.1-10%; 3=10.1-20%; 4= 20.1-30%; 5= > 50% surface area)

Effect of soil fumigants on potato soilborne disease management: 2015

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A potato crop soil fumigation disease management experimental research trial was established at MSU's Montcalm Research Center (Figure 1). A randomized complete block design with six replications (4-row 50 ft plots) was used and treatment plots consisted of the following: 1) Untreated Check; 2) Vapam 45 gal/a; 3) Dominus 20 gal/a; 4) PicPlus 98 lb/a; 5) PicPlus 116 lb/a; and 6) PicPlus 140 lb/a (Table 1). All management practices (irrigation, fertilization, insects, weeds, nematodes, and disease control) were according to conventional grower practices. Agronomic metrics of crop health such as plant stand, final yield quantity, quality and tuber health were measured. Potato crops were harvested and individual treatments were weighed and graded. Foliage and plants were evaluated for potato early die severity. Tubers were assessed for scab. The study was conducted on a sandy loam soil at the Michigan State University Montcalm Potato Research Farm, Entrican at 10-inch spacing and 34-inch rows (Figures 1). The experiment was arranged as a randomized complete block design with four replications. Individual plots were 12 ft. wide by 50 ft. in length and planted with the potato (*Solanum tuberosum*) cultivar "Snowden". Foliar applications of Bravo WS 6SC 1.5 pt/A was applied on a seven-day interval, total of eight applications, for foliar disease control with a R&D spray boom delivering 25 gal/A (80 psi) and using three XR11003VS nozzles per row. Weeds were controlled by cultivation and with Dual 8E at 2 pt/A 10 DAP, Basagran at 2 pt/A 20 and 40 days after planting (DAP) and Poast at 1.5 pt/A 58 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Sevin 80S at 1.25 lb/A 31 and 55 DAP, Thiodan 3 EC at 2.33 pt/A 65 and 87 DAP and Pounce 3.2EC at 8 oz/A 48 DAP. Vines were killed with Reglone 2EC (1 pt/A on 6 Sep). Plots (1 x 50-ft row) were harvested on 28 Sept and individual treatments were weighed and graded. Potato tubers were harvested, graded, culled and internal defects were noted. Tuber numbers for each group and weights (CWT) were recorded. Severity of common scab was measured as surface area affected (1=1 lesion to 1%; 2= 1.1-10%; 3=10.1-20%; 4= 20.1-30%; 5= > 50% surface area). Potato early die (PED) visual assessment was done on 6 Aug (84 DAP) and 20 Aug (98 DAP) using the following scale: 0=No potato early die seen; 1=Small amounts of yellow and flagging of petioles; 2=Moderate amounts of yellowing and flagging of petioles, some of the the flagged petioles becoming necrotic; 3=Symptomatic plants are start to have stems stand straight up while the rest of the plant is laying down, the upright stems are yellow and petioles are wilted and necrotic; 4=Majority of the plot has upright necrotic stems; 5=Entire plot is necrotic, upright stems are brown and petioles are wilted and necrotic, tuber may have brown speckling throughout the stem-end. Data was analyzed using ANOVA and differences among treatments were determined using mean separation with Fisher's Protected LSD.

Meteorological Data

Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to the end of Sept. Average daily air temperature (^{o}F) from 10 June was 66.0, 66.1, 65.2, and 65.4 and the number of days with maximum temperature >90^{o}F was 0, 0, 0, 0 and 0 (May, Jun, Jul, Aug, Sep, respectively). Average daily relative humidity (%) over the same period was 71.6, 73.7, 70.5, 74.9 and 76.6%. Average daily soil temperature at 4" depth (^{o}F) over the same period was 63.2, 72.1, 69.7, 70.5, and 62.6. Precipitation (in.) over the same period was 0.98, 4.79, 1.72, 2.42, and 3.90. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

Results

Scab and early die severity and was significantly lower in all PicPlus treatments (Table 1). There was no difference in the total # of tuber per plant (Table 1). For all PicPlus treatments the total # of US1 tubers per plant was significantly higher than non-treated and the other treatments (Table 1). Total yield and US1 (cwt/A) was highest for PicPlus at 116 (lb/A) (Table 1). There was no difference in emergence and yield of b-sized tubers among treatments (Table 1). Environmental conditions were conducive to Verticillium wilt throughout the state, but heavy rainfall throughout the month of June had a negative impact on plot development. *Verticillium dahliae* populations were low to moderate throughout the growing season at this sight but differences between plots in PED ratings indicate that levels were sufficient to cause disease.

Figure 1. Potato soil fumigation disease management experimental research trial at Michigan State University Montcalm Potato Research Center.

Table 1. Effects of soil fumigation on emergence (%), potato early die ratings, mean # tuber/plant (Total), mean # of tuber/plant (US1), mean # of tuber/plant (B-size), total yield (cwt/A), US1 yield (cwt/A), B-size yield (cwt/A).

Treatment	Rate	Emergence	Potato Early Die[a,b] 8/6/15	Potato Early Die[a,b] 8/20/15	Potato Common Scab (%)[a,c]	Mean # Tuber/ Plant (Total)[a]	Mean # Tuber/ Plant (US1)[a]	Mean # Tuber/ Plant (B-size)[a]	Total Yield (cwt/A)[a]	US1 Yield (cwt/A)[a]	B-size Yield (cwt/A)[a]
Non-treated Check	N/A	81.7	3.5 a	4.0 a	69.1 a	8.1	2.8 c	5.2 ab	271.6 c	141.9 d	129.8
Vapam	45 (gal/A)	84.3	3.0 a	3.7 a	74.1 a	10.2	3.9 b	6.2 a	367.7 b	226.3 bc	141.4
Dominus	20 (gal/A)	84.8	3.2 a	3.8 a	65.8 a	9.9	3.6 bc	6.2 a	349.1 b	192.3 c	156.8
PicPlus	98 (lb/A)	83.0	2.2 b	2.7 b	44.5 b	9.4	4.6 ab	4.8 b	379.7 ab	253.1 ab	126.7
PicPlus	116 (lb/A)	82.8	2.3 b	2.8 b	44.6 b	9.7	4.8 ab	4.8 b	426.9 a	287.6 a	139.3
PicPlus	140 (lb/A)	81.8	1.8 b	2.3 b	45.4 b	10.3	4.9 ab	5.4 ab	398.5 ab	266.9 ab	131.6

[a]Means followed by same letter do not significantly differ (*P*=0.10, LSD)

[b] PED=Potato Early Die rating using the following scale: 0=No potato early die seen; 1=Small amounts of yellow and flagging of petioles; 2=Moderate amounts of yellowing and flagging of petioles, some of the the flagged petioles becoming necrotic; 3=Symptomatic plants are start to have stems stand straight up while the rest of the plant is laying down, the upright stems are yellow and petioles are wilted and necrotic; 4=Majority of the plot has upright necrotic stems; 5=Entire plot is necrotic, upright stems are brown and petioles are wilted and necrotic, tuber may have brown speckling throughout the stem-end

[e]Severity of common scab was measured as surface area affected (1=1 lesion to 1%; 2= 1.1-10%; 3=10.1-20%; 4= 20.1-30%; 5= > 50% surface area)

On-Farm Soil Health Action Research: With Special Reference to Bio-Based Systems

George Bird, Noah Rosenzweig , Lisa Tiemann , Bruno Basso, Roy Black, and Chris Long[1,2]

On-Farm Soil Health Action Research: With Special Reference to Bio-Based Systems is an eight-year project designed to employ the fundamentals of *Action Research*[3] to develop, validate and demonstrate one or more bio-based commercial-scale *Challenger* potato production systems, while enhancing or maintaining soil health in an economically profitable and environmentally sound manner. When compared with a conventional *Defender* system, the economics of the *Challenger* system must be equal to or better than that of the *Defender*.

The 2015 objective was to evaluate the impacts of the 2014 *Defender* and *Challenger* systems on soil health and potato production throughout the project's research site at Sackett Potatoes in Mecosta County, Michigan. The 2015 activities will also served as the basis for continued development/evolution of the bio-based *Challenger* system for comparison with the *Defender* system in 2017, the next potato production year for the project.

It is anticipated that this Action Research project will result in a significantly improved understanding of the dynamics of soil health in regards to Michigan potato production systems. It may also result in a new socio-economic-environmentally sound bio-based potato production system, through a process that could have major implications in regards to the way future agriculture is conducted.

Methods

Research Site.- Sackett Potatoes has provided a 54 acre *Challenger* potato production site (Field SP42) for the project. In 2014, compost and manure were applied to the *Challenger* site. It was divided into two subsites, each planted with pearl millet from a different source. *The Defender* site (SP26N) was used for seed corn in 2014. Potatoes were grown in both sites in 2015. In 2016, the Defender site will be used for seed corn. A brief history of the site is recorded in Appendix A. In addition, a highly productive (relatively new potato land) field will

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[2]Potato Industry Project Team. Alan, Brian and Tyler Sackett (Sackett Potatoes), Mark Otto and Casey Carr (Agri-Business Consultants), R.J. Rant (Nutrilink Biosystems LLC), Brad Morgan (Morgan Compost).

[3]*Action Research* for potato production is a practical problem solving process done by a team that involves both scientists, actors (potato growers) and actions (potato grower management practices). The term *Action Research* was first coned in 1946 by Professor Kurt Lewin of the Massachusetts Institute of

Technology. The process has the potential to have highly significant positive impacts on the future of local, regional, national and global food security systems.

be included in the project in 2016. It will be known as HPF (Highly Productive Field). In 2016, the *Challenger* will be divided into two subsites: a three-species cover crop blend, plus oats as a carrier and a six species blend plus oats. Potatoes will be grown in *Defender* and *Challenger* sites in 2017. Half of each of the Challenger subsystems will be treated with a yet to be identified bio-nematicide. Site management for the project is done by Sackett Potatoes interacting with Agri-Business Consultants, NurtriLink Biosystems LLC and Morgan Compost.

Above Ground System Monitoring.- In 2015, high resolution aerial canopy transect-based analyses of the *Defender* and two *Challenger* fields were made using drone aircraft technology. Conventional aircraft will be included in 2016. Dr. Bruno Basso is responsible for this part of the project. Mark Otto and Casey Carr of Agri-Business Consultants are responsible for the biological and environmental monitoring components of the pest management system.

Soil Health Biology Assessment.- Thirty transect-based soil samples were taken from the *Challenger* and *Defender* fields on each of six dates during 2015. The samples were analyzed for water stable aggregates, six extra cellular enzymes, soil respiration and inorganic nitrogen. Dr. Lisa Tiemann is responsible for this part of the project. It was funded in 2015 by MSPIC through a separate grant, but is being reported on in this document. In 2016, it is anticipated that the soil health biology assessment research will be funded as an integral component of the overall project. In 2014 and 2015, soil health at the HPF site was monitored by RJ Rant of Nutrilink Biosystems, using Ward Laboratories for soil processing.

Root Health and Cover Crop Biomass Assessment.- Thirty transect-based soil samples were taken from the *Challenger* and *Defender* fields on each of six dates during 2015 and are in the process of being analyzed through a modified nematode community structure analysis. The subsamples used are from the same soil samples collected to the Soil Health Biology Assessment. A more comprehensive assessment of root health and cover crop biomass is planned for 2016. George Bird is responsible for this part of the research, with assistance in the cover crop biomass assessment from both R. J. Rant and Sackett Potatoes

Soil-Borne Bacteria and Fungi Assessment.- Thirty transect-based soil samples were taken from the *Challenger* and *Defender* fields on each of six dates during 2015. The subsamples used are from the same soil samples collected to the Soil Health Biology Assessment. They were used for nucleic acid assessment in regards to the resident bacterial and fungal taxa and their dynamics associated with the three 2015 research sites. The samples are still in the process of being analyzed. Dr. Noah Rosenzweig is responsible for this aspect of the research. In addition, in 2016, spatial analysis and GIS maps will be employed for this research objective: Field boundaries and grid soil sampling schemes will be mapped. The fields will be examined for spatial continuity and variability using geostatistics. Specifically, geostatistics will be used to determine the best technique to estimate values for soil microbial diversity between measured points. This will be done so that the variables can be estimated across entire fields, not just at locations where data were collected, and to visualize how soil properties vary across fields. Using these maps, areas may be identified that are predisposed to high potato common scab disease intensity (MI) or Verticillium Wilt (all areas); require intensive disease management, and areas that have high counts of beneficial microbes.

Potato Growth and Development Model.- The DSSAT-CENTURY Model for Agricultural Systems is available and the 2015 soil health data will be used to simulate the basic characteristics of the 2015 Defender Field and two 2015 Challenger subsystems. The simulated results will be compared with the 2015 absolute results from the research project obtained from the cooperating scientists and Sackett Potatoes. Bruno Basso and George Bird are responsible for this part of the work.

Econometrics Analysis.- Preliminary econometric assessments of the 2011 through 2015 are being made for SP46 and SP26N. The results of this analysis will serve as the basis for determining the complete success, partial success or failure of this eight-year initiative in regards to the project's key objective. Dr. Roy Black is responsible for these assessments.

Database Management.- *On-Farm Soil Health Action Research: With Special Reference to Bio-Based Systems* is a transdisciplinary project requiring a comprehensive database management system. In 2016, Chris Long will be responsible for the database system. Based on the 2015 research results, George Bird, Bruno Basso and Roy Black will develop appropriate conceptual models of the system for presentation to the Action Research Team.

Communications.- Real-time communications among all members of the Action Research Team is imperative. The Drop Box File-Sharing approach initiated in 2015 will be continued in 2016. Each member of the Team will receive a weekly e-alert in regards to new information about the project. Casey Carr of Agri-Business Consultants, Inc. will be responsible for the coordination of this communications component of the project.

Results

Research Site.- The mean 2015 potato yield for Michigan was about 390 cwt per acre. The Challenger (SP42) had a potato tuber yield of 293 cwt per acre; whereas, the Defender (Field SP26) had a yield of 371per acre. The Defender soil was fumigated in the fall of 2014, with the nematicidal rate of metham (40 gallons per acre). The Challenger soil was not fumigated in 2014.

Above Ground System Monitoring.- Arial canopy transect-based analyses of the *Defender* and two *Challenger* fields were made in 2015 using drone technologies. Because of down-time associated with an accident with the high resolution drone, it was not possible to time this monitoring with the other research methodology technologies. Site comparisons of regular aerial and enhanced high resolution infrared vegetative index aerial assessments are presented in Figure 1.1-1.6. Images of the Challenger showed vegetative weaknesses, compared to the soil

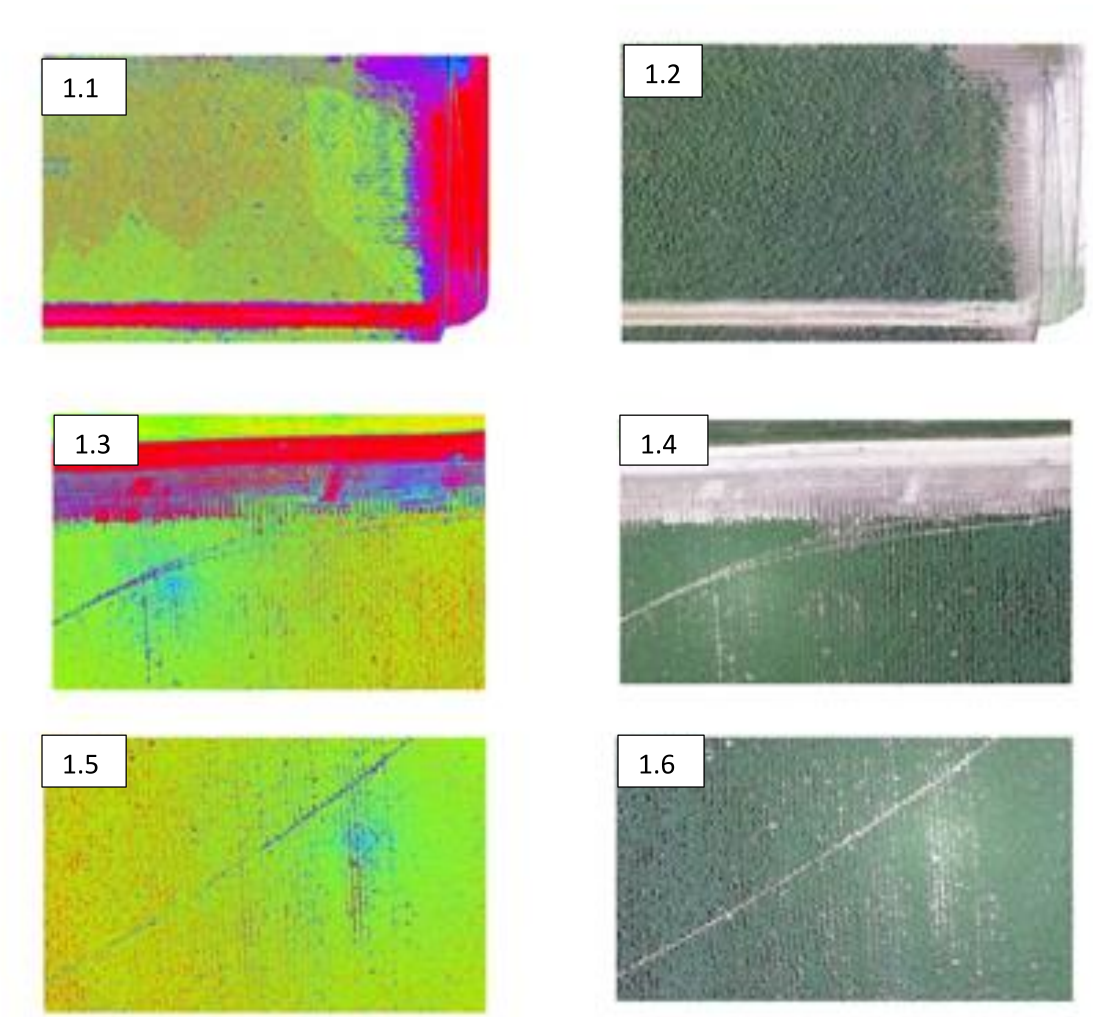


Figure 1.1. 2015 Enhanced high resolution infrared vegetative index aerial photograph of the Defender.
Figure 1.2. 2015 Regular aerial photograph of the Defender.
Figure 1.3. 2015 Enhanced high resolution infrared aerial photograph of the west half of the Challenger.
Figure 1.4. 2015 Regular aerial photograph of the west half of the Challenger.
Figure 1.5. 2015 Enhanced high resolution infrared aerial photograph of the east half of the Challenger.
Figure 1.6. 2015 Regular aerial photograph of the east half of the Challenger.

fumigated Defender. Mark Otto and Casey Carr of Agri-Business Consultants will be responsible for the biological and environmental monitoring components of the 2016 pest management.

Soil Health Biology Assessment.- Data associated with the 30 transect-based soil samples taken from the *Challenger* and *Defender* fields on six dates during 2015, and used assessment of water stable aggregates, extracellular enzyme activity, soil respiration and inorganic nitrogen are presented in Figures 2-5. Water stable aggregate dynamics associated with SP26 and SP46 were similar (Fig. 2). In general, enzymes associated with cellulose, chitin and protein decomposition, and P mineralization were higher in SP42 than in SP26 (Figs. 3 & 4). The situation associated with lignins and aromatic compounds appeared to be more complex (Fig. 3) Ina comparative analysis of SP26 and SP42, the dynamics of soil respiration seems to have reach a bifurcation point circa June 15, 2015 (Fig. 5). These data will form a sound baseline foundation for future comparisons of the Defender and Challenger sites.

Figure 2. Water stable aggregates associated with the Challenger (Field SP42) and Challenger (Field SP 26).

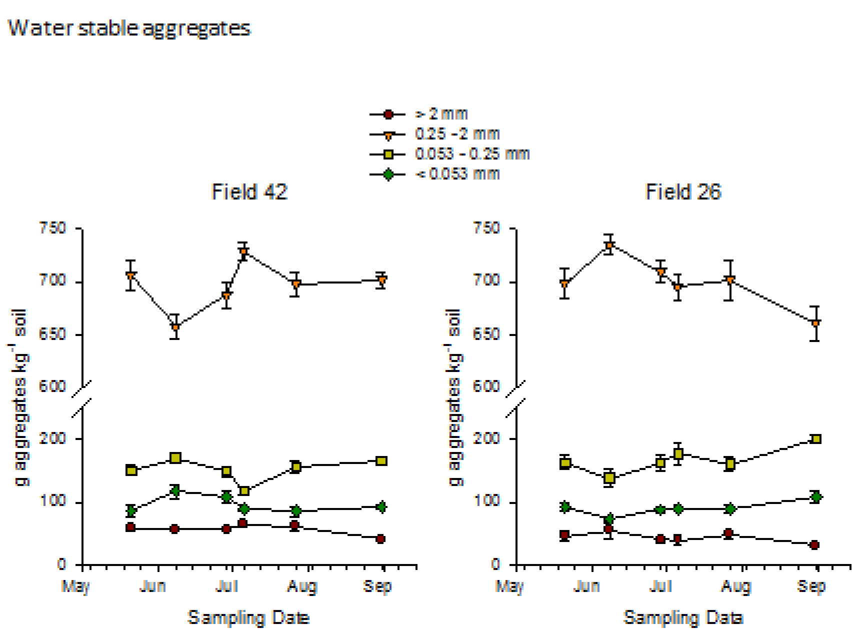
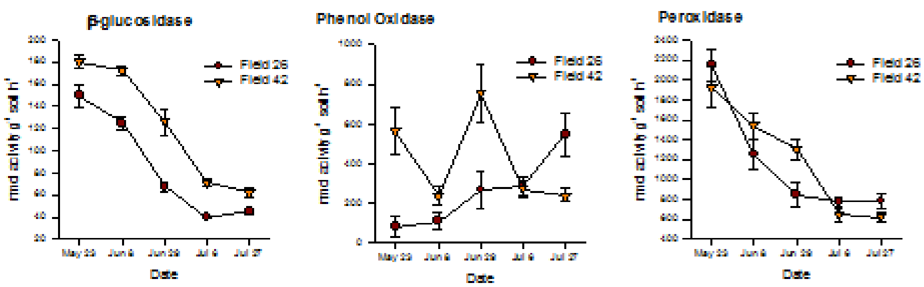


Figure 3 Temporal dynamics of three extra cellular enzymes associated with the Challenger (Field SP42) and Challenger (Field SP 26).

Extracellular Enzyme Activity (carbon acquisition)

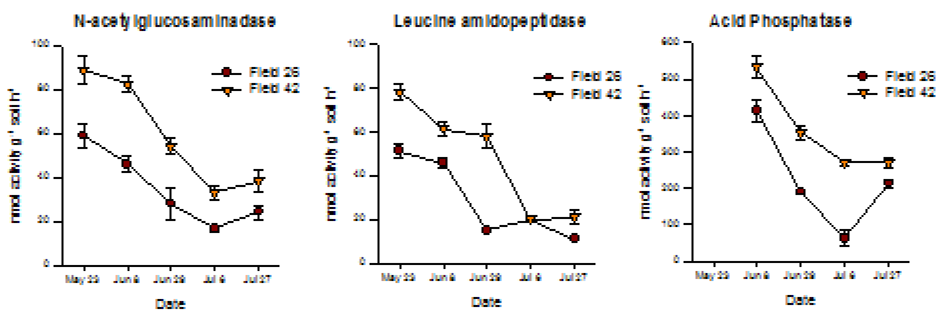


Cellulose breakdown

Breakdown of lignin and aromatic compounds

Figure 4. Temporal dynamics of three extra cellular enzymes associated with the Challenger (Field SP42) and Challenger (Field SP 26).

Extracellular Enzyme Activity (nutrient acquisition)

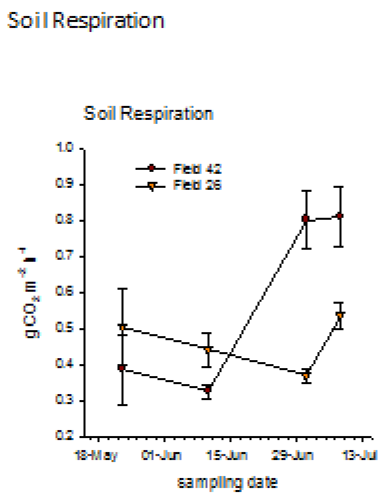


Chitin breakdown

protein breakdown

P mineralization

Figure 5. Temporal dynamics of soil respiration associated with the Challenger (Field SP 42) and the Defender (Field SP26).



Root Health and Cover Crop Biomass Assessment.- The 30 transect-based soil sample taken from the *Challenger* and *Defender* fields six times throughout the growing season and are in the process of being analyzed through a modified nematode community structure analysis. A more comprehensive assessment of root health and cover crop biomass is planned for 2016. George Bird is responsible for this part of the research, with assistance in the cover crop biomass assessment from both RJ Rant and Sackett Potatoes. The 2015 photographs associated with another soil health project and presented in Fig. 6. are included as an example of a highly diverse nine cultivar blend of cover crops, compared to a single cultivar brassica, as used in the Challenger in 2014. In an additional 2015 research project using 10 different soil health indicators, nitrogen mineralization, active carbon and water stable aggregates were the only assessment characteristics highly correlated with crop productivity.

Soil-Borne Bacteria and Fungi Assessment.- The 30 transect-based soil samples, from six 2015 sampling dates are in the process of being analyzed for nucleic acid assessment in regards to the resident bacterial and fungal taxa and their dynamics associated with the three research sites.   Dr. Noah Rosenzweig is responsible for this aspect of the research. It was decided that the best that the most appropriate available information for this 2015 research report is to provide a summary of pervious work associated with this objective, as presented below.

Figure 6,1- 6.2. Comparison of a highly diverse nine cultivar blend of cover crops (Fig 6.1), compared to a single cultivar brassica (Fig 6.2), as used in the Challenger in 2014.

Michigan potato fields were sampled during fall 2012, spring of 2013 and again during the 2015 growing season. Sections of approximately 50 acres of 20 fields affected by either PED or common scab, considered relatively new or mature in terms of production, but that are severely affected by the diseases, were sampled in blocks of approximately 5-10 acres in size, each of which yielded 10 aggregated samples. The soil samples were analyzed at the soils laboratory of MSU’s Department of Plant Soil and Microbial Sciences Soil Testing Laboratory. Total genomic DNA was extracted from 0.5 g of soil from each composite soil sample using the FastDNA SPIN Kit for Soil (MP Biomedicals LLC, Solon, OH) in accordance with the manufacturer’s instructions. DNA samples were stored at -20°C until analysis. Total environmental genomic DNA from the soil sample was used as a template for polymerase chain reaction (PCR) amplification of the bacterial 16S rRNA gene. Preparation of amplicons and library construction was performed according to the previously described standard operating procedure (SOP) protocol (Kozich, Westcott et al. 2013). PCR products were separated on 1% (w/v) agarose gel in 0.5×TBE stained with GelRed Nucleic Acid Stain (Phenix Research Products, Chandler, NC) by electrophoresis and visualized by UV exposure using the Gel Doc 2000 apparatus (Bio-Rad, Hercules, CA) (Figures 2). Amplicon libraries were submitted to the Michigan State University Research and Technology Support Facility for next-generation sequencing on the MiSeq Illumina platform

(San Diego, CA). The resulting sequence data were analyzed using the previously described SOP analysis pipeline (Kozich, Westcott *et al*., 2013) with the mother v.1.33.0 software package (Schloss, Westcott *et al*., 2009).

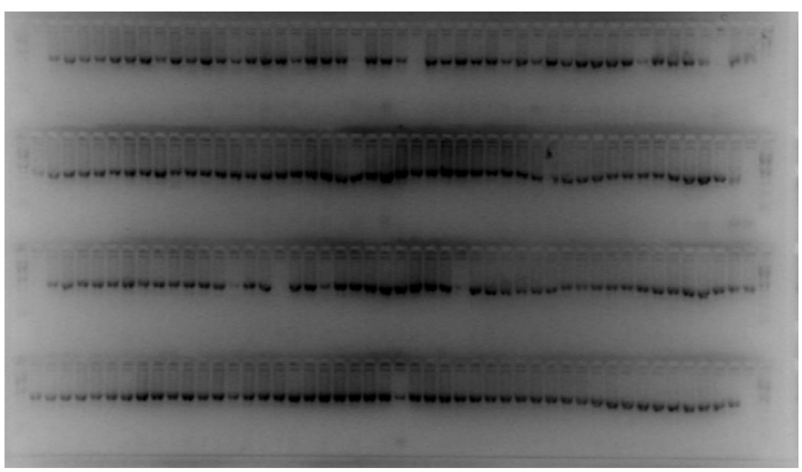


Fig. 7.   PCR amplification of soil genomic DNA from 2015 field sampling. Resulting products are used for soil microbial community DNA sequence analyses.

An additional phylotype assignment was determined by analysis of processed sequence data using the Ribosomal Database Project (RDP) 16S rRNA gene training set (version 9) (Cole, Wang et al. 2009, Cole, Wang et al. 2011). The 2013 results have been processed and integrated into a database that contained previous data from the Soil Testing Lab at MSU along with data from the DNA sequence analysis. Field boundaries and grid soil sampling schemes were mapped using Geographic Information Systems (GIS). Maps were generated for the fields sampled (Fig. 7). Currently the remaining DNA amplicon library from field sampling in 2015 is in the queue awaiting sequencing and microbial community analysis at the MSU RTSF.

Potato Growth and Development Model.- The DSSAT-CENTURY Model for Agricultural Systems will be used to simulate the characteristics of the 2015 Defender Field and two 2015 Challenger subsystems . This component of the project has not yet been initiated. Bruno Basso and George Bird are responsible for this part of the work.

Econometrics Analysis.- Dr. Roy Black is in the process of conducting the econometrics assessment of the 2011 through 2015 will be made for SP46 and SP26N. A partial budgeting approach is being used to compare the financial impacts of alternative strategies for managing the potato production system. We treat the current approach as the defender and alternatives as challengers that are targeting better biological and economic performance than the current system. We are only looking at the components that change when making comparisons and solving for what the performance of alternatives has to be to compete with the current management system. Since these systems are evolving over time, the analysis considers changes in costs and returns for each year and then converts them to a metric that converts annual changes into a current value. The analysis takes into account the sequence in crops and management of those crops over time. Thus, the focus is on a longer term focus on field, not a particular crop in a particular year. One of the break-even analyses looks at what prospective yields of components will have to be for an alternative challenger to be better than the current defender and other challengers. The teams are monitoring the tasks and timing of the task as well as materials and application costs in the development of these budgets. The results of these analyses will serve as the basis for determining the complete success, partial success or failure of this eight-year initiative in regards to the project's key objective.

Database Management.- *On-Farm Soil Health Action Research: With Special Reference to Bio-Based Systems* is a transdisciplinary project requiring a comprehensive database management system. In 2016, Chris Long will be responsible for the database system. George Bird, Bruno Basso and Roy Black will develop appropriate conceptual models of the system for presentation to the Action Research Team based on the 2015 results.

Communications.- Real-time communications among all members of the Action Research Team is imperative. The Drop Box File-Sharing approach will be continued. In 2016, each member of the Team will receive a weekly e-alert in regards to new information. Casey Carr of Agri-Business Consultants, Inc. will be responsible for the coordination of this communications component of the project.

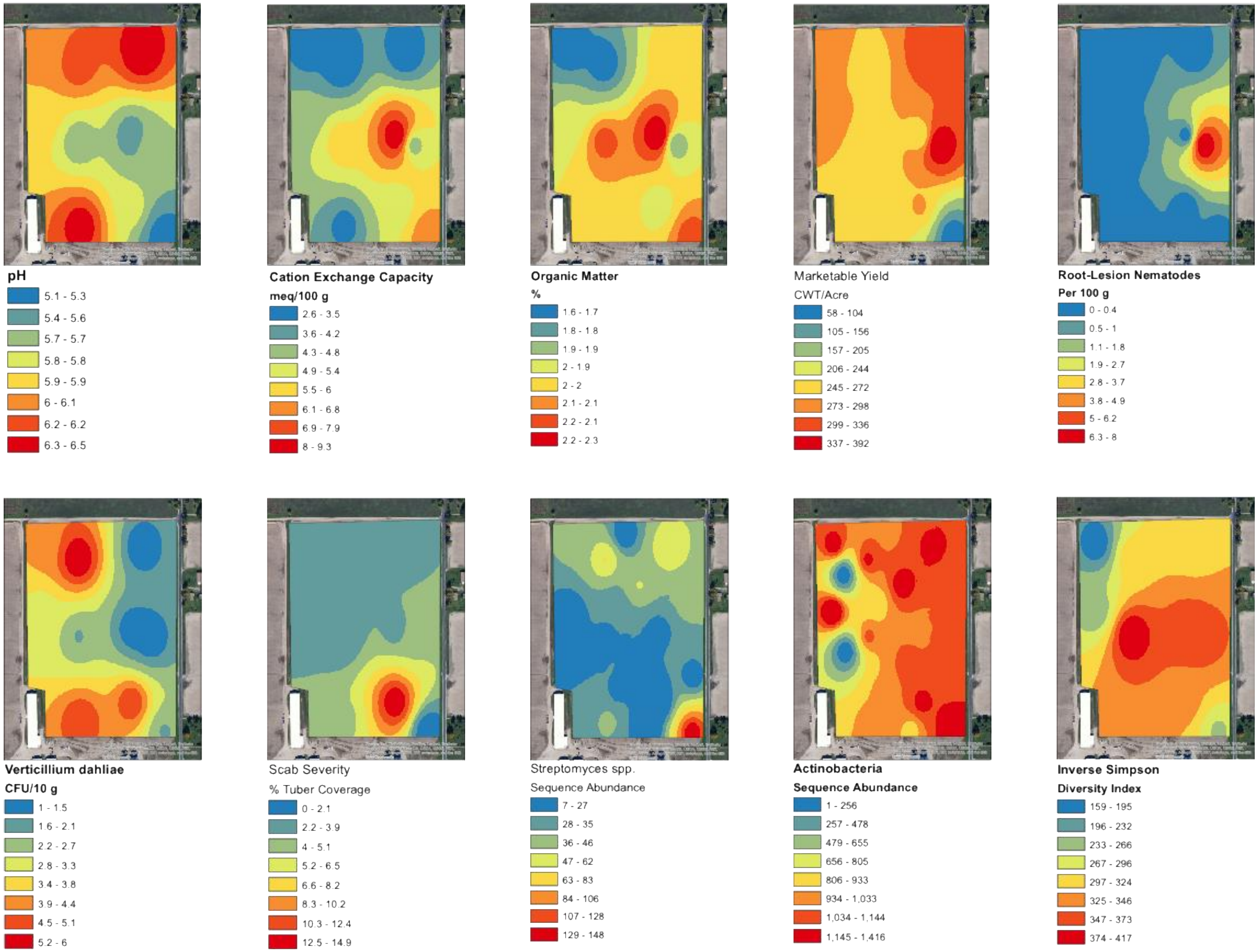


Figure 1. GIS maps of soil properties measured from 2013 Block Grant Soil Health Project.

Appendix 1. Sackett Potatoes, Biological Farming Transition Project Field History and Timeline of Activities Framework

Fields SP26 (north) and SP42 have been alternately planted to potatoes and seed corn since about 2000, when Sackett Potatoes bought Field 42. Field 26 would have been rotated between seed corn and potatoes since 1992, when Sackett Potatoes started growing seed corn.

Fumigation History.- Sackett Potatoes started fumigating on their home farm in about 1992. Most fields on the home farm were fumigated ahead of every potato crop, beginning in 2000. The first soil fumigation on SP42 was in 2005 or 2007. In 2009, both SP26 and SP42 were planted to FL1922. Both fields were fumigated. In 2011 The potatoes in SP26 were FL1833 and Pikes were grown in SP42., Yield data are not available. Both fields were fumigated.

General Site History.- In 2012, seed corn Variety 1F3S-P010 Pioneer was planted. As a general model, fertilizer application used in SP26 and SP42 were 125# K 2O, 20# P2O5, 125#N Defoliated, no rye cover, harvested yield 202 bu/A, crop average was 224 bu/A. Fall tillage: disked ahead of fumigation application. Compost: 1 Ton Fall 2012. Fumigation: 38 gal. Vapam. Specialty Crop Block Grant Sampling done by Loren Wernette 12/4/12

2013: Spring tillage: Field cultivator pre-plant chisel with sweeps w/fumigator?
SP26 planted 5/27 11.5 A on north 1833, most of field 2137
SP42 planted 6/3 to FL2137 Fertilizer applications as general model for potato fields: 200# K-Mag, 50 0# Pelletized Gypsum, 250# K20, 80# P2O5, 250#N
Harvested early-mid October, SP42 Yield: 344 cwt/A, SP26 Yield: 411cwt/A
1 Ton Poultry Manure mix applied to SP42, only N 10-15 acres of SP2
6 Fall Tillage: Disked, Field Cultivator following potato harvest
Rye planted late, wet poor growth both 42 and 26

2014 SP42 History
100 # urea in May 6/16/14 Rye crimped part done before the rain and part after the rain (See Appendix B) 1 ton compost blend applied , Disked lightly 7/3/14 Forage Pearl Millet CFPM-101 planted on the east half Pearl Millet, Hybrid TifLeaf 3 planted west half, minus short rows on west Mix of various small plots of different species in short rows on the west. 100# urea July 8/29/14 sampling, Nematode samples sent to MSU , Haney Soil Health Samples to Haney's Lab PLFA samples to Ward Labs in NE (Date?) One Ton Compost applied (totals 2 Two Tons during 2014) (Date?) Disked TifLeaf 3 pearl Millet and small plots (Date?) Planted cover crop mix West Central only, small plots bare 10/20/14 PLFA sampling from mixed small plot on west, West Central cover crop mix, East half, CFPM-,101disked lightly late October, Spread one ton Compost Blend, disked lightly Jawad Hasan, SP's Soil Fertility Consultant, pulled fertility samples in SP26 and SP42 in the fall that formed the basis of 2015 potato recommendations. Decisions were made to adjust for the effects of the cover/green manure cropping done in 2014. SP 26 was fumigated in the fall of 2014. SP42 was not fumigated and nematode sampling numbers did not indicate a need for a non-fumigant nematicide .

SP26 2014 History
2014 Seed Corn on SP26 , Fertility, tillage, defoliation, compost, fumigation match practices of seed corn general model from 2012. Seed corn stalks shredded

Appendix B. Photograph of the filed crimper used to kill the rye in SP42 on May 16, 2014.

2014-2015 MICHIGAN POTATO DEMONSTRATION STORAGE ANNUAL REPORT MICHIGAN POTATO INDUSTRY COMMISSION

Chris Long, Coordinator and Aaron Yoder

Introduction and Acknowledgements

Round white potato production for chip processing continues to lead the potato market in the state of Michigan. Michigan growers continue to look for promising, new, round white varieties that will meet necessary production and processing criteria. There are many variety trials underway in Michigan that are evaluating chipping varieties for yield, solids, disease resistance and chipping quality with the hope of exhibiting to growers and processors the positive attributes of these lines. Extended storage chip quality and storability are areas of extreme importance in round white potato production. Due to the importance of these factors, any new chip processing varieties that have the potential for commercialization will have storage profiles developed. Being able to examine new varieties for long-term storage and processing quality is a way to keep the Michigan chip industry at the leading edge of the snack food industry. The information in this report can position 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, provides the Michigan potato industry with the opportunity to generate storage and chip quality information on newly identified chip processing clones. This information will help to establish the commercial potential of these new varieties. This demonstration storage facility utilizes six, 550 cwt. bulk bins (bins 1-6) that have independent ventilation systems. The second structure, built in 2008, has three, 600 cwt. bulk bins that are independently ventilated. The first of these bulk bins, bin 7, has been converted into 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 level point into storage profiling that allows the industry to learn about a varieties' physical and chemical storability before advancing to the bulk bin level. We typically have 4-6 years of agronomic data on a variety 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, and chip color and defect values. In addition, each variety is evaluated for weight loss or shrinkage and pressure bruise. With this information, the storage history of a variety can be created, 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 designed to be used to evaluate the post-harvest physiology of the potato. The facility can be used to evaluate storage pathology or sprout inhibitor products. The Michigan industry recognizes the importance of being able to control disease and sprout development in storage and is committed to doing research in these areas.

This thirteenth annual Demonstration Storage Report contains the results of the storage work conducted in the facility during the 2014-2015 storage season. Section I, "2014-2015 New Chip Processing Variety Box Bin Report", contains the results and highlights from our 10 cwt. box bin study. Section II, "2014-2015 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 chair of the committee is Brian Sackett of Sackett Potatoes. Other members of the committee include: Steve Crooks, Todd Forbush, Chris Long, Dennis Iott, Keith Tinsey, Mike Wenkel, Duane Anderson, Tim Wilkes, Larry Jensen, Chase Young and Todd Young. The funding and financial support for this facility, and the research that is 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. Mark and Duane Andersen, Andersen Brothers, LLC; and Tim, Todd and Chase Young, Sandyland Farms; these are the growers that 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; Jim Allen of Shearer's Foods, Inc., Brewster, OH; 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), Larry Jensen (Chief Wabasis Potato Growers), and Tim Wilkes (Potato Services of Michigan). All played a role in making this facility useful to the Michigan potato industry.

Overview of the production season *

The overall 6-month average maximum and minimum temperatures during the 2014 growing season were slightly lower than the 15 year averages by a difference of 1 ^{o}F (Table 1). Average maximum temperatures during the months of April and July were noticeably lower than 15-year averages by 3 ^{o}F and 4 ^{o}F respectively. Extreme heat events were minimal in 2014 (Table 3); there were no records of temperatures exceeding 90 ^{o}F during the entire summer. The previous 5-year average is of 20 hours over 4 days. Additionally, high nighttime temperatures (over 70 ^{o}F) were much lower than normal; in 2014, 15 fewer days and 89 fewer nighttime hours were recorded when compared with the 5-year averages. In May, there were no recordings of temperatures below 32 ^{o}F; from September-October 15th, temperatures dropped below 32 ^{o}F on three days.

Rainfall for April through September was 20.84 inches, which was 2.66 inches above the 15-year average (Table 2). In general early season precipitation (April and May) was well above average, mid-season precipitation was above average (June-July) and late-season precipitation was below average (August-September).

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

Year	April		May		June		July		August		September		6-Month Average	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2000	56	34	70	49	75	57	77	56	79	57	70	49	71	50
2001	61	37	70	49	78	57	83	58	72	70	69	48	72	53
2002	56	36	63	42	79	58	85	62	81	58	77	52	73	51
2003	56	33	64	44	77	52	81	58	82	58	72	48	72	49
2004	62	37	67	46	74	54	79	57	76	53	78	49	73	49
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	73	48	73	49
2014	**55**	**33**	**68**	**45**	**78**	**57**	**77**	**54**	**79**	**56**	**72**	**47**	**72**	**49**
15-Year Average	58	35	68	46	78	56	81	58	79	58	73	49	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
2000	3.18	6.46	4.50	3.79	5.28	5.25	28.46
2001	3.28	6.74	2.90	2.49	5.71	4.43	25.55
2002	2.88	4.16	3.28	3.62	7.12	1.59	22.65
2003	0.70	3.44	1.85	2.60	2.60	2.06	13.25
2004	1.79	8.18	3.13	1.72	1.99	0.32	17.13
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**
15-Year Average	2.87	3.87	2.70	2.90	3.42	2.44	18.18

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

2014-2015 New Chip Processing Variety Box Bin Report

(Chris Long, Aaron Yoder and Brian Sackett)

Introduction

The purpose of this project is to evaluate new chip processing varieties from national and private breeding programs for their ability to process after being subjected to storage conditions. A variety's response to pile temperature, as reflected in sucrose and glucose levels, is evaluated. Weight loss and pressure bruise susceptibility of each variety is also evaluated. Bin 7 contained 36, 10 cwt. boxes. Thirty-six boxes were placed in six stacks of six. The boxes were designed for air to travel in from a header, or plenum wall, through the forklift holes of each box, up through the potatoes within it and onto the next box above until the air reaches the top and is drawn off the top of the chamber, 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 tubers can be removed to conduct bi-weekly quality evaluations.

Procedure

Seventeen new varieties were evaluated and compared to the check variety Snowden in 2014. Once the varieties were chosen, 1 cwt. of each variety was planted in a single 34 inch wide row, on May 5th at the MSU, Montcalm Research Center, Entrican, MI. The varieties were all planted at a 10" in-row seed spacing. All varieties received fertilizer in the rates of: 342 lb. N/Acre, 142 lb P_2O_5/A and 135 lb K_2O/A). The varieties were vine killed after 126 days and allowed to set skins for 21 days before harvest on September 29th, 2014; this was 147 days after planting. Variety maturity is not taken into account in the harvest timing due to storage and handling restrictions.

Approximately ten cwt. of each variety were placed in each box bin, labeled and stacked in bin 7. The average storage temperature for all the box bins (box bin 7) was 54.0 ºF for the 2014-2015 season. At harvest, nine, 20 lb. (approximately) samples from each variety were collected for weight loss and pressure bruise evaluation. A description of the varieties tested, their pedigree and scab ratings are listed in Table 1. Yield, size distribution, chip quality, and specific gravity were recorded at harvest (Table 2). All 17 varieties were graded to remove all "B" size tubers and pickouts, thus entering storage in good physical condition.

The storage season began September 29th, 2014, and ended June 8th, 2015. Bin 7 was gassed with CIPC on November 4th, 2014, and February 2nd, 2015. Variety evaluation began September 29th, followed by a bi-weekly sampling schedule until early June. Forty tubers were removed from each box every two weeks and sent to Techmark, Inc. for sucrose, glucose, chip color and defect evaluation. Nine pressure bruise sample bags were taken for each variety, weighed and placed in one of the bulk bins at the storage facility. Three bags were placed at each of 3', 8' and 14' from the pile floor. When that bin was unloaded, the sample bags were weighed and percent weight loss was calculated. A 25 tuber sample was taken from each of the nine bags and was evaluated for the presence or absence of pressure bruise. The number of tubers and severity of bruise was recorded. All pressure bruises were evaluated for discoloration.

This report is not intended to be an archive of all the data that was generated for the box bin trial, but 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 (517) 355-0271 ext. 1193.

2014 MPIC Demonstration Box Bin Variety Descriptions

Entry	Pedigree	2013 Scab Rating*	Characteristics
Elkton (B1992-106)	B1255-5 X B0564-9	1.8	Medium to medium-late maturity, high yield potential, round to oval tuber type, light netted skin
Lamoka (NY139)	NY120 X NY115	1.5	High yield, mid-late season maturity, medium specific gravity, oval to oblong tuber type, low internal defects, long term chip quality
Manistee (MSL292-A)	Snowden X MSH098-2	1.9	Average yield, scab tolerance similar to Snowden, late blight susceptible, medium specific gravity, long storage potential, uniform, flat round tuber type, heavy netted skin
Sebec (AF0338-17)	AF303-5 X SA8211-6	2.1	High yielding, round white, early bulking, moderately susceptible to common scab, resistant to verticillium wilt
Snowden (W855)	B5141-6 X Wischip	2.6	High yield, late maturity, mid-season storage, reconditions well in storage, medium to high specific gravity
A01143-3C	COA95070-8 X Chipeta	1.8	Average yielding, scaly buff chipper, smaller tuber size, late maturity, high incidence of sheep-nose
BNC182-5	Tacna X B0766-3	1.6	Short dormancy, above average yield potential, common scab tolerant, average chip quality, late blight susceptible, large round flat to oval tuber type
CO02024-9W	A91790-13W X CO95051-7W	2.0	Medium maturity, high yield potential, good chip color, medium to low specific gravity
MSR127-2	MSJ167-1 X MSG227-2	1.4	Scab tolerant, high specific gravity, good chip quality from storage, above average yield potential, medium-late maturity
MSS428-1	Snowden X NY121	2.0	Below average yield, early maturity, common scab susceptible, low specific gravity, high incidence of hollow heart
MSS934-4	ND6095-1 X ND7377Cb-1	2.9	High yield, oval to oblong tuber type, common scab susceptible
NY148	NY128 X Marcy	1.5	Full season maturity, high gravity, scab-resistant chip stock, good yield potential, medium to late season storage quality, black spot bruise susceptible

*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.

Entry	Pedigree	2013 Scab Rating*	Characteristics
NY152 (NYH15-5)	B38-14 X Marcy	2.8	Medium to high specific gravity, high yield potential, common scab susceptible, late maturing
NY154 (NYH15-17)	B38-14 X Marcy	1.6	High yield potential, high specific gravity, moderate common scab tolerant, late maturing
NYJ15-7	MSK061-4 X Marcy	2.4	High yield, late maturity, medium to high specific gravity, scab susceptible, high incidence of hollow heart
W5955-1	Pike X C31-5-120	1.6	Average yield, high specific gravity, size profile similar to Atlantic, long storage potential, pear-shaped
W6609-3	Pike X Dakota Pearl	0.9	Long term storage potential, common scab resistance, good specific gravity

*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. 2014 Michigan Potato Industry Commission Box Bin Processing Potato Variety Trial

2014 MPIC Box Bin Processing Potato Variety Trial
MSU Montcalm Research Center, Montcalm County, MI

Harvest date 29-Sep-14 147 days
DD, Base 40[6] 3170

LINE	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	CHIP SCORE[3]	TUBER QUALITY[2] HH	VD	IBS	BC	TOTAL CUT	VINE VIGOR[4]	VINE MATURITY[5]	COMMENTS
NY152	469	598	78	21	75	3	1	1.088	1.0	3	0	0	0	10	3.0	3.0	1.5 common scab
NY154	465	530	88	10	86	2	2	1.097	1.0	1	2	0	0	10	3.0	4.5	uniform netted skin, 0.0 common scab
Elkton	460	497	93	3	77	16	4	1.090	1.0	5	1	0	0	10	3.0	3.5	oval tuber type
NYJ15-7	457	480	95	4	81	14	1	1.088	1.0	4	2	0	0	10	3.0	4.5	1.0 common scab
W5955-1	439	520	84	5	74	10	11	1.090	1.0	6	1	0	0	10	3.5	3.5	0.5 common scab
MSR127-2	392	434	90	8	86	4	2	1.094	1.0	0	0	0	0	10	3.0	4.5	gc in pickouts
NY148	383	464	82	17	81	1	1	1.098	1.5	0	0	0	0	10	3.5	3.5	1.0 common scab
Manistee (MSL292-A)	370	404	91	6	84	7	3	1.088	1.0	2	0	0	0	10	3.5	3.0	1.0 common scab, flattened tuber shape
Sebec (AF0338-17)	370	421	88	10	88	0	2	1.084	1.5	0	1	0	0	10	3.5	2.5	1.0 common scab
A01143-3C	357	449	79	7	78	1	14	1.077	1.5	1	0	0	0	10	3.0	4.5	gc in pickouts, non-unifom tuber type 0.5 common scab
Snowden	**347**	**418**	**83**	**15**	**79**	**4**	**2**	**1.093**	**1.0**	**1**	**3**	**0**	**0**	**10**	**3.0**	**3.0**	1.5 common scab, misshapen pickouts
MSS934-4	330	398	83	11	73	10	6	1.081	2.0	0	2	0	1	10	3.0	3.0	1.5 common scab
W6609-3	306	381	81	14	76	5	5	1.090	1.0	0	0	0	0	10	2.5	3.0	sl pinkeye
Lamoka	281	330	85	12	80	5	3	1.088	1.0	0	5	0	0	10	3.5	3.0	pear shape pickouts, alligator hide, 0.5 common scab, bright skin
MSS428-1	267	334	80	13	67	13	7	N/A	2.0	6	2	0	0	10	2.5	3.0	0.5 common scab
BNC182-5	248	306	81	11	66	15	8	1.081	1.0	1	0	0	0	10	2.5	4.0	
CO02024-9W	242	359	67	33	67	0	0	1.079	1.0	0	0	0	0	10	3.5	3.5	1.5 common scab
MEAN	**364**	**431**						**1.088**									

tr = trace, sl = slight, NA = not available

SED = stem end defect, gc = growth crack

[1]SIZE
Bs: < 1 7/8"
As: 1 7/8" - 3.25"
OV: > 3.25"
PO: Pickouts

[2]TUBER QUALITY (number of tubers per total cut)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[3]CHIP COLOR SCORE - Snack Food Association Scale
(Out of the field)
Ratings: 1 - 5
1: Excellent
5: Poor

[4]VINE VIGOR RATING
Date Taken: 16-Jun-14
Ratings: 1 - 5
1: Slow Emergence
5: Early Emergence (vigorous vine, some flowering)

[5]VINE MATURITY RATING
Date Taken: 12-Aug-14
Ratings: 1 - 5
1: Early (vines completely dead)
5: Late (vigorous vine, some flowering)

Planted: 5-May-14
Vines Killed: 8-Sep-14
Days from Planting to Vine Kill: 126
Seed Spacing: 10"
No Fumigation

[6]MAWN STATION: Entrican
Planting to Vine Kill

Results: 2014-2015 New Chip Processing Box Bin Highlights

MSR127-2

This Michigan State University (MSU) chip processing variety has repeatedly demonstrated good common scab tolerance and has a uniform round tuber type. The specific gravity for this variety was 1.094, above the trial average of 1.088. The recorded US#1 yield for this variety was above the trial average in the 2014 Box Bin Trial at 392 cwt./A (Table 2), a trend repeated from 2012 and 2013. The variety appears to have a medium-late maturity with a good set of uniform size tubers. The internal quality was excellent with no hollow heart or vascular discoloration reported at harvest in the raw tubers. The out-of-the-field chip color appeared to be good, scoring a 1.0 SFA score (Table 2). A few minor chip defects were noted. During the 2014-2015 storage season, MSR127-2 was placed into storage on September 29th, 2014 and evaluated for sugar stability.   On that date, MSR127-2 had a percent (X10) sucrose value of 0.497 and a glucose value of 0.002 percent. The sucrose percent (X10) values remained relatively flat, ranging from 0.303 in late December to a peak of 0.929 in mid-May. The percent glucose remained low all season until April at which time it slowly started to rise although chip quality was maintained up through the middle part of the month. A chip picture is included from April 14th, 2015, to show the chip quality during this period. The sucrose and glucose values on this day were 0.602 percent (X10) and 0.004 percent, respectively. MSR127-2 appears to have good mid-season chip processing quality and similar late-season chip quality as observed in the previous storage year. Overall, this variety performed well in 2014, maintaining an above average US#1 yield for the third year in a row. This variety is on track for larger scale testing in 2016 where it will be evaluated in the bulk storage bin environment.

NY152

This Cornell University developed variety was evaluated for the first time in 2014. It exhibited an average specific gravity at 1.088 and was the top yielding line weighing in at 469 cwt/A US#1, 105 cwt above the trial average. This variety exhibited mid-season maturity in 2014. The out-of-the-field chip sample scored a 1.0 SFA score with 6.6% defects reported. On September 29th, 2014, the percent sucrose (X10) was 0.785 and percent glucose was 0.002. Sucrose and glucose levels came down to their lowest points in mid-February at 0.398 percent (X10) and 0.001, respectively. Sucrose values remained low until late May, when they rose to 0.854 percent (X10). After leveling out at around 0.002 percent in December, glucose levels hovered close to 0.001 percent, only rising at the very last sample date in early June to 0.005 percent. Total defects recorded for this variety in early June 2014 were 3.2 percent. The picture above captured NY152 at its last acceptable chip quality point from storage on June 9th, 2015. The percent sucrose (X10) and glucose were 0.664 and 0.005 on this date. While only the first year of evaluation, NY152 has demonstrated excellent yield potential and excellent chip quality from out-of-the-field through late-season storage into June. It did not demonstrate strong tolerance to potato common scab in 2014, and there was some hollow heart observed. Further storage and chip quality testing from commercially harvested, bulk-stored tubers is required before this clone can be considered for commercialization. It is scheduled to be evaluated in the bulk storage bin environment in the 2016-2017 storage year.

W5955-1

This variety was developed at the University of Wisconsin. 2014 was the second year that this variety was evaluated in the Box Bin Trials at the Montcalm Research Center. The specific gravity was above average at 1.090 and the yield was above average at 439 cwt/A US#1 (Table 2). It has demonstrated good tolerance to common scab in both 2014 and 2013. The variety exhibited mid-season maturity in 2014. It had excellent out-of-the-field chip quality, with a 1.0 chip score. At the onset of storage on September 29th, 2014, tuber samples tested at 0.477 (X10) percent sucrose and 0.003 percent glucose. Glucose levels remained between 0.002 and 0.003 throughout the winter months and started to rise to 0.005 on March 31tst, and 0.012 the following sample date, April 13th, 2015. Across the same dates, sucrose levels had increased from 0.860 to 1.107 (X10) percent. The picture above captures W5955-1 at the last acceptable chip quality sample from storage on March 17th, 2015. As can be seen in the picture, hollow heart was observed in chip samples throughout the sampling season and represents a potential drawback of this variety. This observation differs from the previous year's data, where hollow heart was not observed. To further assess the commercial potential for W5955-1, it will be evaluated again in the 2015-2016 box bin trial, followed by evaluation in the bulk storage bin environment in the 2016-2017 growing/storage year. It has exhibited many positive attributes including a high yield potential, consistent tolerance to potato common scab, excellent out-of-the-field and mid-late season chip quality, and nice tuber shape, although potential issues with hollow heart could limit the adoption of this line if it proves to be an issue in subsequent years.

Snowden

This variety was included as a commercial standard for the 2014 Box Bin Trial. The recorded yield for the Snowden variety was below average for the 3rd year in a row at 347 cwt./A US#1 with an above average specific gravity at 1.093 (Table 2). On September 29th, 2014, this variety was put into storage and was analyzed for sucrose and glucose concentration. On October 7th, 2014, a 0.765 percent sucrose (X10) and a 0.003 percent glucose value was recorded. Sucrose and glucose levels came down to their lowest points in early March at 0.413 percent (X10) and 0.001, respectively. From this point in storage, the sucrose values began to rise to 1.430 percent (X10) in late-April 2015. The percent glucose level was at 0.012 on this date. The chip picture above depicts Snowden during its last acceptable chip quality period taken on March 31st, 2015. Total defects recorded for this variety on March 31st, 2015, were 0.0 percent with a percent sucrose (X10) of 0.869 and a percent glucose of 0.003.

II. 2014 - 2015 Bulk Bin (500 cwt. Bin) Report

(Chris Long, Aaron Yoder and Brian Sackett)

Overview

The goal of the MPIC Storage and Handling Committee for the 2014-2015 bulk bin storage season was to explore three different storage temperature protocols for Manistee (MSL292-A) that would preserve chip quality, but slow or eliminate pathogen development in early storage. The second goal was to develop storage profiles for the advanced clone NY148, a line which had shown high potential for commercialization in previous years' on-farm and box bin storage trials. Lastly, three bulk bins were utilized to evaluate newly released lines in development from the J.R. Simplot Company which included a standard 'Snowden' bin, and two bins filled with the novel Innate™ Snowden Gen 1 "V11" potatoes which were filled from two different locations (Michigan and Wisconsin). This new line is reported to have lower asparagine (and consequently lower acrylamide following processing) in addition to a lower potential for black-spot bruising. Evaluation of this variety was done in conjunction with the J.R. Simplot Company with the purpose of assessing the performance of this line in a commercial storage environment.

Section A. Introduction to Variety Commercialization

The primary variety tested for storage profiling in the 2014-2015 storage season was 'Manistee' (MSL292-A), a clone from the potato breeding program at Michigan State University. This variety has a good yield potential, average specific gravity, excellent late-season chip quality and resistance to black-spot bruising. It has been evaluated extensively in the Potato Outreach Program over the course of several years and has gained substantial traction as a commercialized variety. In the previous storage year, Manistee had excellent chip quality from very late in the storage season when stored at both 50°F and 48°F. The primary objective with this variety in 2014-2015 was to determine the impact of an even lower storage temperature on Manistee chip quality. With lower storage temperatures, the physical quality of the stored potato crop can be improved as pathogen development is slowed, however potatoes stored for chip processing must maintain sufficiently low reducing sugars so as not to negatively impact chip quality. The effects of low storage temperatures on chip quality vary substantially among varieties and consequently remains an important storage parameter that should be determined for the successful adoption of a novel variety. Storage temperatures evaluated in 2014-2015 for Manistee were at 50ºF, 48ºF, and 46ºF.

The second variety evaluated was NY148, a new chip processing clone from the potato breeding program at Cornell University, Ithaca, NY. This clone has displayed a superior yield potential, high specific gravity, tolerance to potato common scab, and long-term storage potential over several years of evaluation in the Potato Outreach Program. Based on these positive attributes, NY148 was selected for evaluation in two bulk storage bins in 2014-2015 upon which storage profiles could be generated at two different storage-temperature regimes.

For each of the varieties listed above, a brief description of agronomic and storage performance is provided below. In addition, a short description of pressure bruise susceptibility, chip color and color defects, sugar accumulation and overall chip quality is given. With this information, a more distinct perspective can be obtained regarding the viability of these varieties in commercial production.

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 a warmer temperature, in most cases, 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 bin assignments are described as follows: bins 1, 2 and 3 were filled with Manistee (MSL292-A) and were grown by Sandyland Farms; bins 4 and 5 were filled with NY148 and were grown by Andersen Brothers, LLC; bin 9 was filled with Innate™ Snowden Gen 1 “V11” while bin 8 was filled with the standard Snowden variety. Bins 8 and 9 were both grown on the same farm in Central Michigan.

Bins 1, 2 and 3 were filled on September 30th, 2014. The seed was planted May 31st, 2014 and vine killed on September 8th, 2014 (100 DAP, 2699 GDD_{40}). The variety was harvested September 30th, 2014, 122 days after planting. The pulp temperature for tubers at the time of bin loading was around 57°F. Bins 1-3 were gassed with CIPC on three dates throughout the storage season: November 11th, 2014, March 2nd, 2015 and April 22nd, 2015. All three bins were unloaded on June 8th, 2015 and were shipped to: Utz Quality Foods, Hanover, PA (Bin 1), Shearer's Snack Foods, Massillon, OH (Bin 2), and Better Made Snack Foods, Detroit, MI (Bin 3) upon which the commercial quality of the bins were evaluated individually by each processor.

Bins 4 and 5 were filled on October 8th, 2014. The NY148 crop was planted May 19th, 2014, and vine killed on September 3rd, 2014 (107 DAP, 2852 GDD_{40}). The variety was harvested October 8th, 2014; 142 days after planting. The pulp temperature of the tubers at the time of bin loading in bins 4 and 5 was 53.5 °F. Due to the apparently high susceptibility to black spot bruising, these bins were unloaded earlier than anticipated on October 27th, 2014 and sent to be dehydrated. The details of this are expounded upon in the bin descriptions below.

Bins 8 and 9 were both grown on a farm in Central Michigan. Bin 8 was filled with the standard Snowden chip variety, while bin 9 was filled with Innate™ Snowden Gen 1 potatoes. They were both filled on October 8th, 2014 and gassed once with CIPC on November 4th, 2014. They were unloaded on February 18th, at which time pulp temperatures reached 50.4°F and 50.6°F respectively.

Bin sugar monitoring began the day tubers were placed into storage and tubers were sampled 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 is an access door that allows samples to be taken 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.

The pressure bruise samples were evaluated 3 to 5 days after the bin was unloaded. A set of 25 tubers was randomly selected from each bag and visually inspected for pressure bruise. Each bruise was evaluated for discoloration by removing the tuber skin with a knife. A visual rating was given to the bruise for the presence or absence of flesh color (blackening of flesh). Percent weight loss in each tuber sample was calculated as it was removed from the storage.

Objectives

The Storage and Handling Committee’s objective in evaluating Manistee in bulk bins 1-3 was to determine the effect of storage temperatures on simple sugar accumulation to better establish minimum temperature thresholds for the variety. For bulk bins 4 and 5, the objective was to establish preliminary sugar profiles for NY148 at two temperatures in a commercial storage environment. Objectives for bins 8 and 9 were developed in conjunction with The J.R. Simplot Company to evaluate general storage performance of novel Innate™ varieties in comparison with standard, non-transformed varieties.

Bulk Bin 1, Manistee (MSL292-A); 48 ºF

As previously mentioned, Manistee is a Michigan State University line that is known most notably for its long storage potential. In 2014 on-farm variety trials, it averaged 480 cwt/A US#1, slightly above the trial average, with a specific gravity of 1.084, also slightly above the trial average. Tubers are slightly compressed from apical to stem end with a thick-buff skin. It has shown susceptibility to potato common scab similar to Snowden.

Figure 1. Techmark-Inc. chip picture, bulk bin 1 Manistee, 6.9.15

The tuber quality was generally good at bin loading with an estimated 85-90% bruise-free. Tuber pulp temperature at the time of loading was 57.4^{o}F; from there, temperatures were gradually decreased during the suberization period to an eventual 48^{o}F in December where they remained until May when temperatures were raised prior to shipment. At the time of bin unloading, tuber weight loss was 5.27 percent with 0.0 percent of tubers expressing pressure bruise and discoloration under the skin.

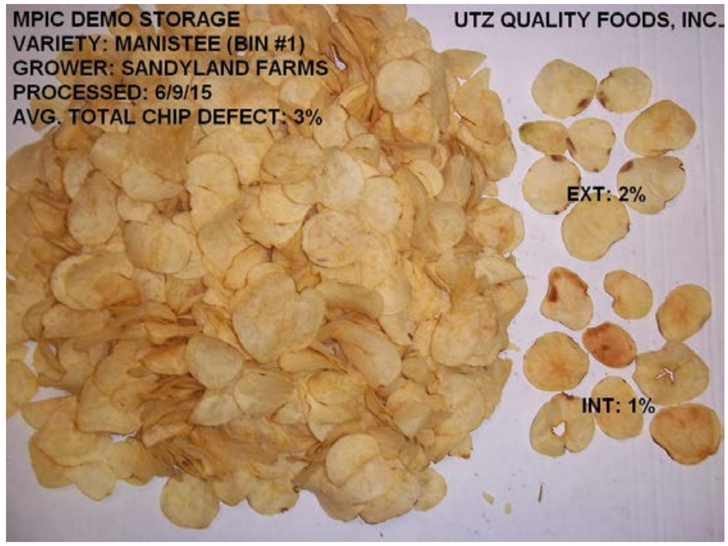


Figure 2. Finished bag sample processed at UTZ Quality Foods on 6.9.2015. Manistee tubers from Bulk Bin number 1

Chip quality out of the field was excellent, with only 3.4 percent total defects reported on the first sample date, of September 30th, 2014. On this date, sucrose and glucose concentrations were 0.890 percent (X10) and 0.003 percent respectively. Sucrose levels remained relatively flat throughout the storage season, although they rose slightly in early January up to a peak of 0.899 (X10) on January 5th. Glucose levels were also flat, the exception being an increase of up to 0.011 percent on February 16th, 2015. Though chip quality seemed to be negatively impacted to some extent on this sample day, sugar levels dropped off to acceptable levels from the following sample date in late February until they were shipped for processing in June. The bin was shipped out on June 8th, 2015 to Utz Quality Foods in Hanover, PA to be processed. The picture above (figure 2) shows a finished bag sample following processing. Reviews of Manistee from the processor was good, with only 3 percent total defects reported and good chip color. One potential drawback to this variety is the slightly recessed ends which led to ‘hollow heart-like’

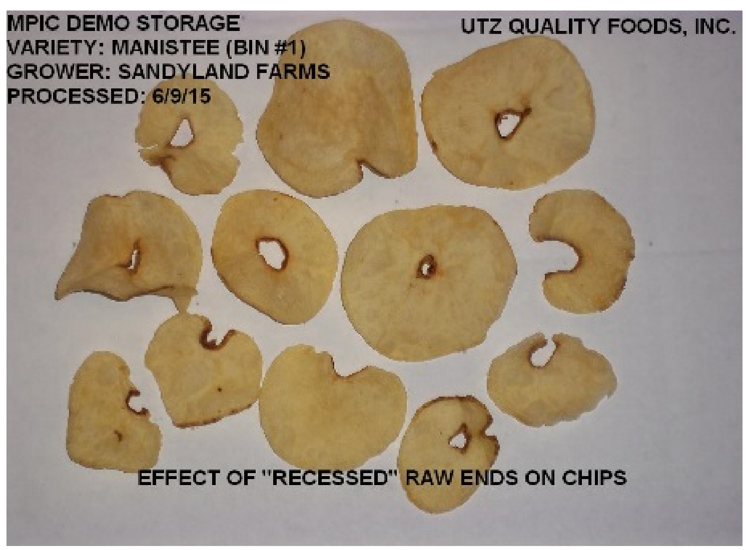


Figure 3. Picture showing the potential effect of recessed ends of some tubers and the impact that it can have on finished chip quality

symptoms following slicing (figure 3) although this was not reported as a serious enough issue to discourage adoption of the variety. Further discussion on commercial adoption of Manistee is provided following the bin 3 summary.

Bulk Bin 2, Manistee (MSL292-A); 50 ºF

Manistee potatoes in bulk bin 2 were grown under identical conditions as the tubers in bulk bin 1 and 3, all three bulk bins being produced by Sandyland Farms, Howard City, MI. The tuber pulp temperature of tubers in bin 2 upon arrival on September 30th, 2014 was 54.4 ºF. Sucrose and glucose levels at the time of bin loading were 0.905 percent (X10) and 0.003 percent, respectively. The tubers were tested and found to be 85-90 percent black spot bruise free after bin filling. The tuber quality was acceptable, with 5.9 percent defects reported. Similar to bulk bin 1, bin 2 was held at around 56.0 ºF for a two-week suberization period, after which it was cooled 0.2^{o}F per day. Following suberization, the pile was cooled to an eventual storage temperature of 50.0^{o}F where it was maintained through the majority of the storage season. Glucose levels remained flat throughout the entire storage season, peaking at 0.006 percent in mid-May, but dropped back to under 0.005 until the bin was shipped on June 8th, 2015. Figure 4 is a photo taken from the day the bin was shipped in June. At the time of bin unloading, tuber weight loss was 4.91 percent with 3.1 percent of tubers expressing pressure bruise and discoloration

Figure 4. Techmark-Inc. chip picture, bulk bin 2 Manistee, 6.9.15


Figure 5. Raw tuber quality at bin unloading from bin 2 on 6.8.15

under the skin. These numbers are similar to those observed by the other two Manistee bins held at lower temperatures indicating that storage temperature did not have a major impact on pressure bruising or tuber weight loss. There was no evidence of physical deterioration within the pile as it was unloaded as can be seen in figure 5.

Bin 2 was chip processed at Shearer's Snack Foods, in Massillon, OH on June 9th, 2014. The specific gravity was reported at 1.079, with a total of 5% finished chip defects (2% greening, 2% stem end, 1% internal discoloration). Agtron readings of the finished chips were 65.1. Visual inspections of tubers yielded overall very positive comments, comparing favorably to a shipment of 'Snowden' from a southern U.S. location. Finished chip samples were collected and taken back to the MSU chip lab for visual representation of finished chip quality. As can be seen in figure 6, overall chip quality was very good, with a low incidence of bruising and internal discoloration. As with bin 1, there was some incidence of hollow heart-like symptoms caused by slightly recessed ends of some tubers and contributed to the 'internal defects' shown in the picture above. Discussion on the overall performance of Manistee at the three storage temperatures takes place following the bin 3 summary.

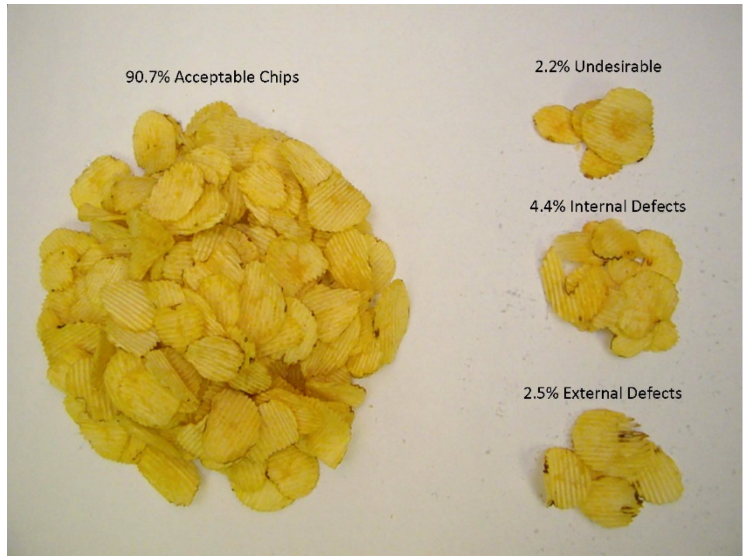


Figure 6. Finished bag sample of Manistee from bin 2 processed at Shearer's Snack Foods on 6.9.2015.

Bulk Bin 3, Manistee (MSL292-A); 46ºF

Manistee potatoes in bulk bin 3 were grown under identical conditions as those in bulk bins 1 and 2. Tuber pulp temperature at the time of bin loading was 59.6ºF. Similar to bins 1 and 2, tubers were determined to be 85-90 percent black spot bruise free after bin loading. Suberization protocols were also followed in similar fashion with bins 1 and 2, where for two weeks following bin loading, the pile was kept at 56ºF and subsequently cooled 0.2ºF per day to an eventual pile temperature of 46ºF, the lowest storage temperature of the three bins. Chip quality at the time of bin loading was comparable to bins 1 and 2, with 6.4 percent total defects reported. Sucrose levels at bin loading were at 0.860 percent

(X10) and glucose levels were low at 0.002 percent. After reaching a pile temperature of 46°F in mid-December, sucrose levels rose up to 1.004 (X10) and glucose rose to 0.008. Because of the simultaneous rise in internal discoloration (12.1% up from 0.0%), it was determined that the pile temperature should be raised up to 48°F. Following the temperature increase, sucrose and glucose levels dropped, and chip quality was restored. Internal coloring throughout the rest of the storage season seemed to be more variable compared with bins 1 and 2 where it remained relatively flat throughout the storage season. Temperatures were raised an additional 5°F near the end of the storage season in early May, 2015 to prepare the bin for shipment in June. The bin was shipped on June 8th, 2015 to Better Made Snack Foods in Detroit, MI. Figure 7 shows a finished chip picture from Techmark-Inc. on the day of shipment. Sucrose levels at shipment were at 0.639 percent (X10) and glucose at 0.004 percent. Pressure bruise data mirrored that for the other Manistee bins, where weight loss and bruising with color were reported at 4.84 and 2.7 percent respectively.

Figure 7. Techmark-Inc. chip picture, bulk bin 3 Manistee, 6.9.15

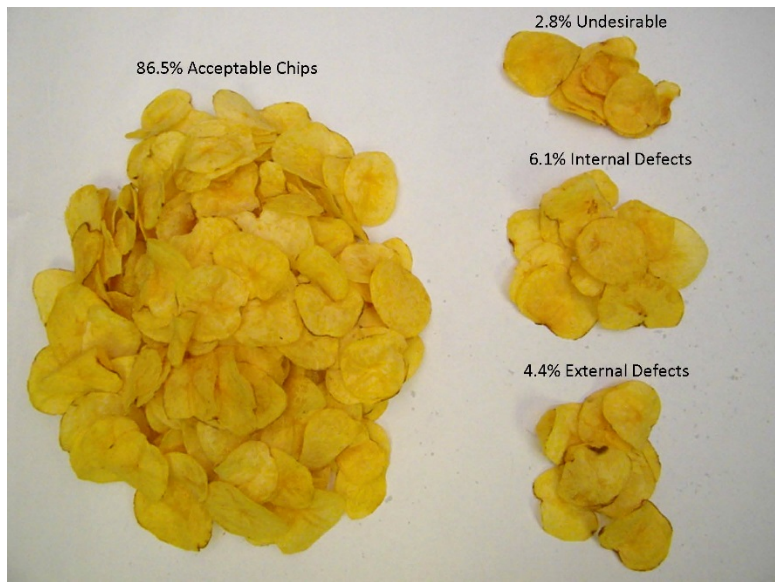


Figure 8. MSU grade sample from bin 3 processed at Better Made Snack Foods on 6.9.15

Reviews from the processor were similar to those as reported for bins 1 and 2; overall they were positive. An Agrtron color rating of 65.3 was reported, with 6.87% total defects (all of which were described as internal defects). Again as with bins 1 and 2, the flattened shape with deep set ends was observed. Figure 8 shows a sample of finished chips that were processed at Better Made Snack Foods and brought to the MSU chip lab for visual documentation.

Based on the results of the 2014-2015 the 2013-2014, and the 2012-2013 bulk bin evaluations, Manistee appears to be an excellent storage candidate for late-season chip processing. Positive attributes of the variety include resistance to pressure bruising and sustained low-levels of reducing sugars throughout the storage season. All three processors that aided in the evaluation process had overall positive reviews regarding the varietal performance, particularly due to the fact that it was processed so late in the storage season. Because of cold-induced sugar accumulation, storage at 46^{o}F was deemed to be too low for this variety. While lower temperatures can slow the progression of tuber diseases, storage at 48^{o}F and 50^{o}F (bins 1 and 2) did not appear to negatively impact the physical quality of the tubers, but did help to maintain long-term chemical quality of the potatoes. Data from MPIC storage trials across the past three storage seasons suggest that the physiological age of Manistee tubers plays a major role in the variety's ability to maintain low reducing sugars at cooler temperatures. As tubers become more mature, it seems that storage temperatures can be lowered without having negative impacts on sugar quality from cold-induced sugar accumulation. Therefore, understanding the physiological age of this crop prior to storage is important in achieving successful long term storage at low temperatures.

Bulk Bins 4 and 5, NY148

Figure 9. Techmark-Inc. chip picture of NY148 from the 2013-2014 box bin trial. The sample shown here is from 5.5.14

Bulk bins 4 and 5 were both filled with NY148, an advanced clone out of the potato breeding program at Cornell University, Ithaca, NY. NY148 was selected for bulk bin evaluation based on the clone's superior performance in on-farm trials and the MRC box bin trial in previous years. In 2014, NY148 averaged a 574 cwt/A US#1 yield across nine locations, 100 cwt/A above the trial average of 474 cwt/A US#1. The clone has also exhibited a high specific gravity (1.089 average in 2014), tolerance to potato common scab, good raw tuber internal quality, and a nice, round tuber shape. It has also chipped well from box bin storage late in the season

Figure 10. Techmark-Inc. chip picture of NY148 taken at bin loading on 10.8.14. Only 4.3% defects were reported on this date

Figure 11. Techmark-Inc. finished chip picture of NY148 taken one week after bin loading on 10.14.14. Note severe blackspot bruising

as seen in figure 9 above. In for the 2014-2015 storage season, NY148 was grown in a bulk planting at Andersen Brothers, LLC in Montcalm County, MI. The crop was planted on May 19th, 2014 and were vine killed on September 3rd, 2014 (2853 GDD_{40}, 107 DAP). The tubers were harvested on October 8th, 2014 (142 DAP) and subsequently loaded into storage bins 4 and 5 at the MRC. Pulp temperature at the time of bin loading was 53.5°F. Samples were submitted at bin filling to Techmark Inc. for chip quality evaluation. Sucrose levels were at 0.780 percent (X10) and glucose at 0.003 percent. Figure 10 shows a finished chip picture from this sample date. Issues began to arise shortly after bins were loaded, when black spot bruise reports estimated that only 2-4% of tubers sampled were **bruise free**. To ensure that mistakes had not been made with regards to sampling, tubers were sampled again and yielded the same results as the first evaluation. The results from the subsequent sampling date on October 14th, 2014 revealed that chip quality had been compromised by black spot bruising with 91.1 percent total chip defects reported (Figure 11). Shipment of bins 4 and 5 at this time was expedited, and they were shipped to be dehydrated at a co-op in Pennsylvania. Tuber quality was very poor by the time the shipment reached the processor and is illustrated in figure 12.

Due to the high susceptibility of blackspot bruising as witnessed in 2014-2015, the Storage and Handling Committee decided to discontinue testing of NY148 for commercialization. 2014 represented a year in which specific gravity was particularly high across the state which led to extremely high specific gravity values in varieties such as NY148, compounding blackspot bruise issues. The results of this project illustrate the importance of commercial testing to diagnose potential varietal pitfalls prior to commercial adoption.

Figure 12. Raw tuber quality at Pennsylvania dehydration plant Co-op, shortly after bin unloading on 10.27.14

Innate™ Snowden storage results

Two bulk bins were filled in cooperation with The J.R. Simplot Company to evaluate new chip-processing varieties being developed by the company in regards to storability. Two bins were filled with V11 Innate™ Snowden potatoes from Wisconsin (bin 6) and Michigan (bin 9) while bin 8 was filled with a standard, control 'Snowden' grown in Michigan. Sugar profiles were generated for each bin and are described individually below. Overall results are summarized at the end of the bin descriptions. Summaries are only presented for bins 8 and 9 at the request of the company.

Bulk Bin 8, Standard ‘Snowden’, 48°F, Michigan

Bin 8 was filled and first sampled on October 27th, 2014 for chip quality and sugar analysis. Both bins 8 and 9 were grown under the same conditions and on the same location in central Michigan. As can be seen in figure 15 on the right, the condition of the tubers at bin loading was good and blackspot bruising did not appear to be an issue. At bin loading, sucrose levels were at 0.591 percent (X10) and glucose at 0.006 percent. Initial pulp temperature was 53.0°F and the bin was subsequently cooled to 48°F over the next 4 weeks. Sucrose and glucose concentrations remained low for the rest of the storage season until the bins were unloaded on February 17th, 2015. Chip quality at the time of bin unloading was acceptable, with 3.1 percent total defects.

Figure 15.Techmark-Inc. photo of standard ‘Snowden’ tubers taken at bin loading on 10.28.14

Figure 16.Techmark-Inc. photo of standard ‘Snowden’ tubers taken at bin unloading on 2.17.15

Bulk Bin 9, Innate™ Snowden, 48°F, Michigan

Bin 9 was filled and first sampled on October 27th, 2014 for chip quality and sugar analysis. Both bins 8 and 9 were grown under the same conditions and on the same location in central Michigan. As can be seen in figure 15 on the right, the condition of the tubers at bin loading was good and blackspot bruising did not appear to be an issue. At bin loading, sucrose levels were at 0.589 percent (X10) and glucose at 0.011 percent. Initial pulp temperature was 53.0^{o}F and the bin was subsequently cooled to 48^{o}F over the next 4 weeks. Sucrose and glucose concentrations remained low for the rest of the storage season although there were sporadic peaks in glucose in late December where glucose concentrations jumped up to 0.014 percent. It subsequently dropped and remained low for the rest of the storage season until bins were shipped on February 16th, 2015. Chip quality at the time of bin unloading was good, with 0.0 percent defects reported. Pressure bruise and shrink were evaluated upon storage removal. Conventional 'Snowden' tubers from bin 8 showed 3.2% shrink while bin 9 tubers showed 2.9% shrink. Black spotting that typically accompanies pressure bruising was not observed in either bin.

Figure 18. Techmark-Inc. photo of Innate™ Snowden tubers taken at bin loading on 10.28.14

Figure 19. Techmark-Inc. photo of Innate™ Snowden tubers taken at bin unloading on 2.17.15

After evaluating the sugar profiles and finished chip photographs, it does not appear that bins 8 and 9 differed significantly from the other. Both bins were in good condition upon arrival to the storages, although there was some minor glucose accumulation and coloration in the Innate™ Snowden bin tubers initially, glucose levels dropped quickly and chip quality was maintained for most of the rest of the sampled period. The results of this storage trial imply that the management of Innate™ Snowden Gen 1 in storage can be accomplished in a similar manner as a standard 'Snowden' storage crop, at least when done so under similar conditions and circumstances described above.