Michigan State University
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In Cooperation With

Michigan Potato Industry Commission

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MICHIGAN POTATOES
MICHIGAN POTATO INDUSTRY COMMISSION

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PGMI
Potato Growers of Michigan, Inc.

February 2015

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. Research is a platform for testing ideas and 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. Through research we are able to achieve so many things.

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 2014 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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2014 MICHIGAN POTATO RESEARCH REPORT

C. M. Long, Coordinator

INTRODUCTION AND ACKNOWLEDGMENTS

The 2014 Potato Research Report contains reports of the many potato research projects conducted by Michigan State University (MSU) potato researchers at several locations. The 2014 report is the 46th 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 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) where essentially there was no record 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). A total of 4.4” of irrigation water was applied at the MRC during the months of July and August. 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

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

Year	Temperatures > 90°F Hours	Temperatures > 90°F Days	Night (10pm-8am) Temperatures > Hours	Night (10pm-8am) Temperatures > 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**
Average	20	4	147	30

GROWING DEGREE DAYS

Table 4 summarizes the cumulative growing degree days (GDD) for 2014 while providing historical data from 2004-2014 as well. GDD are presented from May 1st – September 30th using the Baskerville-Emin method using a base temperature of 40 °F. The total GDD base 40 by the end of September in 2014 was 3552 (Table 4), which is slightly lower than the 11-year average of 3736 at the same time. This appears to be the case due to lower temperatures during the months of May and later in July.

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

	Cumulative Monthly Totals				
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**
Average	551	1328	2251	3114	3736

*2004-2014 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 2014 was rented from Steve Comden, directly to the West of the Montcalm Research Center in the field referred to as 'Comden 3'. This acreage was planted to a field corn crop in the spring of 2013 and harvested fall 2013 with crop residue disked into the soil. In the spring of 2013, the recommended rate of potash was 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 was applied in-furrow at planting. Early potato vine senescence was not an issue in 2014.

The soil test analysis for the general crop area (taken in 2012) was as follows:

	lbs/A			
pH	P_2O_5	K_2O	Ca	Mg
6.0	336 (146 ppm P)	150 (125 ppm K)	1130 (565 ppm)	146 (73 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 ($N-P_20_5-K_20-Mg-Ca$)
Broadcast at plow down	0-0-21-10	200 lbs/A	0-0-42-20
	10%B	6 lbs/A	0.6 lb. B
	0-0-62	150 lbs/A	0-0-93
	0-0-0-0-20	150 lbs/A	0-0-0-0-30
At planting	28-0-0	30 gpa	90-0-0
	10-34-0	20 gpa	23-79-0
At cultivation	28-0-0	24 gpa	72-0-0
	10-34-0	16 gpa	19-63-0
At hilling	46-0-0	100 lbs/A	46-0-0
Late side dress (late varieties)	46-0-0	150 lbs/A	92-0-0

Calcium and Nitrogen were applied at spring plow down in the form of Calcium Sulfate (gypsum, with an analysis of 20% Ca and 16% S) for a total application of 150 lbs/A. This translates to 30 lbs of actual Ca and 24 lbs of S being applied per acre on the potato production area.

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.

Admire Pro and Vydate were applied in-furrow at planting at a rate of 8 fl oz/A and 2 quarts/A, respectively. Vydate was also applied as a foliar spray at a rate of 1.5 quarts/A.

Fungicides used were: Bravo, Tanos, Elixir, Omega, Supertin, Chloronil for a total rate of 9 pts., 24 oz., 11.2 lbs, 24 oz., 18 oz., and 10 pts/A respectively. Insecticides/miticides used were: Agri-Mek, Rimon, Blackhawk, Baythriod, and Coragen for a total rate of 10, 16, 5.5, 1.5 and 14 oz./A respectively.

Potato vines were desiccated with Reglone on September 8th and 16th at a rate of 2 pints/A each date.

2014 MSU POTATO BREEDING AND GENETICS RESEARCH REPORT
January 22, 2015

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INTRODUCTION

At Michigan State University, we are dedicated to developing improved potato varieties for the chip-processing and tablestock markets. The program is one of four integrated breeding programs in the North Central region supported through the Potato Special Grant. At MSU, we conduct a multi-disciplinary program for potato breeding and variety development that integrates traditional and biotechnological approaches to breed for disease and insect resistance. In Michigan, it 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 Soils 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, and late blight resistance, beetle resistance, specific gravity). The SolCAP project has developed a new set of genetic markers (8,303) called SNPs that are located in the 39,000 genes of potato. This USDA-funded SolCAP translational genomics project is 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 also funded through the USDA/SCRI Acrylamide project to link genetic markers with lower acrylamide traits. We also have funding to develop genome editing technologies that may not be classified as genetic engineering through a USDA/BRAG grant. 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. These include the establishment and expansion of the scab nursery, the development of the Clarksville Research Center for late blight testing, the incorporation of no-choice caged studies for Colorado potato beetle assessment, the Michigan Potato Industry Commission (MPIC)-funded construction of the B.F. (Burt) Cargill Demonstration Storage adjacent to the Montcalm Research Center, new land at the Lake City Experiment Station along with a well for irrigation and expanded land at the Montcalm Research Center and Lake City Experiment Station, the new plot harvester, the development of the grading line at the MSU campus facility, and expansion of the tissue culture operation so that small amounts certified seed of minitubers can be produced. In 2012 we relocated our research lab in the new Molecular Plant Sciences addition on the MSU campus.

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 2014 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 2014 harvest, over 1,200 selections were made from the 60,000 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 2014 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 300 and 120 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 Colorado potato beetle, 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 in 2014 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), MSL007-B (scab resistance), MSQ086-3, (verticillium wilt resistant), Manistee, MSM246-B and MSR061-1 (scab, late blight and PVY resistant). We have some newer lines to consider, but we are removing virus from those lines. We are using the NCPT trials to more effectively identify promising new selections.

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 released three lines for the specialty market: MSN215-2P (Colonial Purple), MSR226-1RR (Raspberry) and MSQ425-4PY (Spartan Splash). 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 dual-purpose 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 2014, while others were tested under replicated conditions at the Montcalm Research Center. Promising tablestock lines include MSL211-3, MSQ440-2, MSQ086-3, MSS487-2 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. MSM288-2Y is a bright yellow flesh selection similar in type to Yukon Gold. Some new specialty pigmented lines are MSS576-05SPL (red splash) and Michigan Purple Sport 1. 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.

Disease and Insect Resistance Breeding

Scab: In 2014 we had two locations to evaluate scab resistance: a commercial field with a history of severe scab infection 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. Some of results are summarized in **Table 1**. The susceptible checks of Snowden and Atlantic were highly infected with pitted scab. Promising resistant selections were McBride,

MSL007-B, MSR061-1, MSR127-2, MSU383-A, MSQ440-2, MST252-1Y, MSV179-1, MST424-6 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

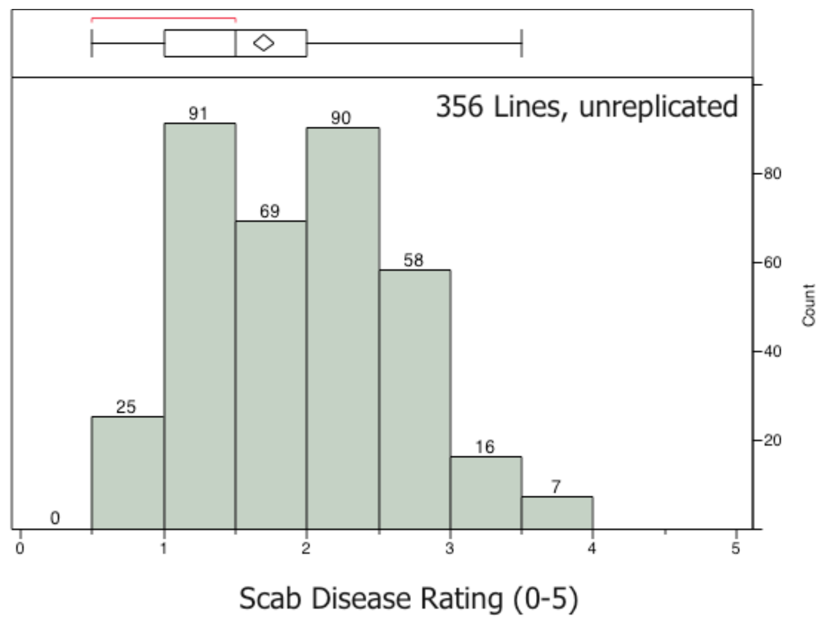
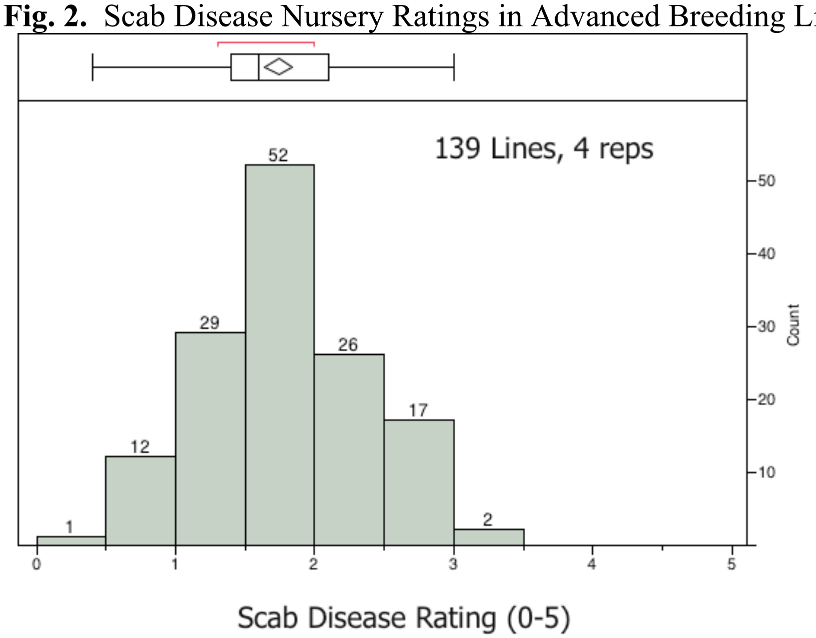


Fig. 2. Scab Disease Nursery Ratings in Advanced Breeding Lines



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.

For two years we collected replicated (4 times) scab infection data from our Montcalm Research Center scab field on 200 progeny from a cross between resistant and susceptible varieties. Of the 200 progeny, about 40% were highly to moderately resistant. Most importantly, we are also using this field data to conduct genome wide QTL analysis with the SolCAP 8300 Potato SNP data in search of genetic markers linked to scab resistance. The data collected from this trial has led us to identify some genetic markers linked to scab resistance that we will test for marker-assisted selection for scab resistance. In 2014 we also made 40 scab-resistant chip-processing selections. The most most-promising selections are listed in Table 1. These lines are being placed in tissue culture for further testing.

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

Priority	Line	Scab	Total	US#1	US#1	Bs	As	OV	PO	SPGR
Check	Kalkaska	1.0	315	282	90	10	74	15	1	1.084
Check	Lamoka	1.3	345	319	93	7	93	0	0	1.089
Check	P270-1	0.5	144	114	79	21	79	0	0	1.079
1	Z022-07	0.8	352	328	93	7	85	8	0	1.085
1	Z052-11	0.8	438	402	91	9	88	3	0	1.082
1	Z052-13	0.3	332	313	94	6	88	6	0	1.088
1	Z062-10	0.5	355	325	92	8	91	1	0	1.091
1	Z062-50	0.5	332	320	97	3	75	22	0	1.083
1	Z068-02	1.0	345	319	93	6	86	7	1	1.091
1	Z096-03	1.0	406	370	91	9	83	8	0	1.087
1	Z118-19	0.5	282	275	98	2	58	40	0	1.084
1	Z169-01	0.8	425	371	87	12	75	12	2	1.082
1	Z219-01 PVYR	0.3	319	299	94	5	91	3	1	1.085
1	Z219-13 PVYR	1.0	352	334	95	4	87	8	1	1.094
1	Z219-14 PVYR	0.5	403	382	95	5	91	4	0	1.090
1	Z219-46 PVYR	0.3	268	251	94	5	61	33	1	1.082
1	Z242-03	0.8	399	369	93	7	88	5	0	1.090
1	Z242-12	1.5	373	332	89	11	85	4	0	1.099
1	Z242-13	0.8	288	261	92	7	91	1	1	1.104
1	Z242-14	1.3	306	284	93	5	90	3	2	1.083
1	Z242-15	0.8	308	295	96	4	95	1	0	1.094
1.5	Z020-08	0.5	282	270	96	4	82	14	1	1.081
1.5	Z052-40	1.0	352	294	83	16	75	8	1	1.086
1.5	Z062-31	1.0	416	378	91	9	82	9	0	1.080
1.5	Z222-19	1.8	325	303	93	6	82	11	1	1.093
1.5	Z242-07	1.5	323	301	93	7	87	6	0	1.099

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 2014 we conducted late blight trials at the Clarksville Research Center. We inoculated with the US23 genotype, but the foliar reaction to the *Phytophthora infestans* has been different from all previous years using US8. In some cases lines that were classified as resistant were susceptible. On the other hand, some of the lines with moderate resistance in previous years were highly resistant this past year (Figs. 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. The distribution of the late blight reaction in the 2014 trials is summarized in Figures 3 and 4.

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

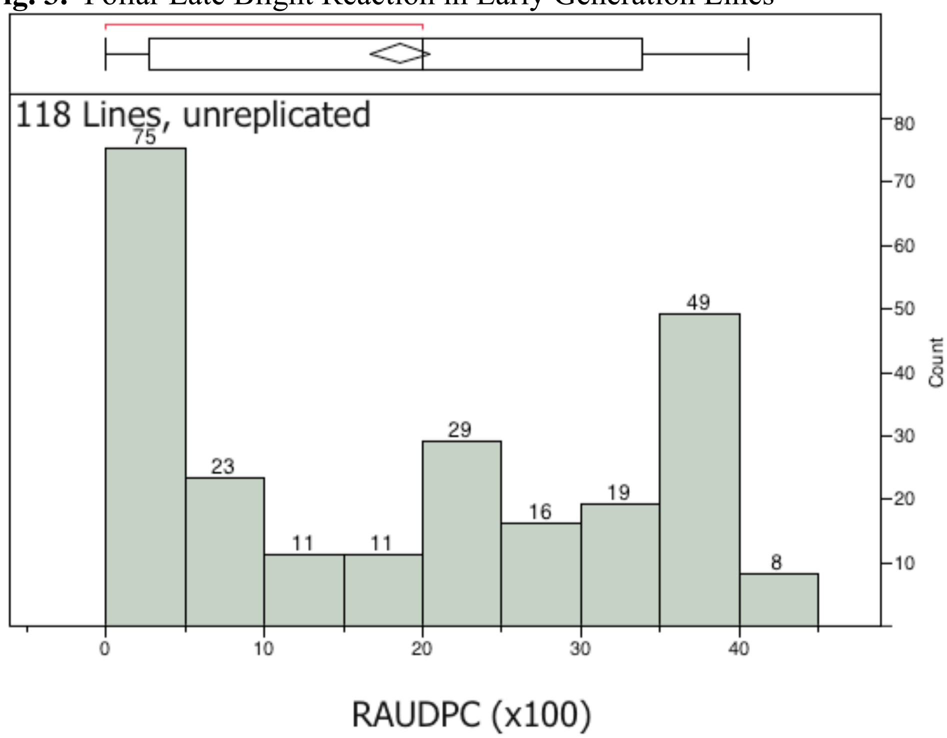
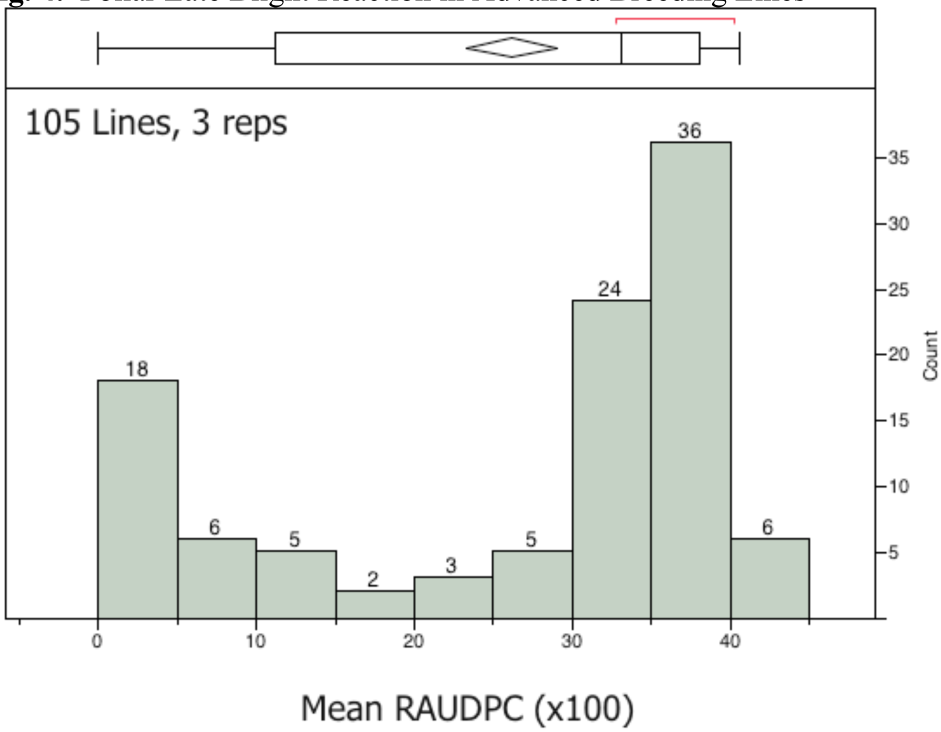


Fig. 4. Foliar Late Blight Reaction in Advanced Breeding Lines



McBride (MSJ126-9Y)

Parentage: Penta x OP
Developers: Michigan State University and the Michigan Agricultural Experiment Station
Plant Variety Protection: To Be Applied For.

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: Will be 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.

MSL007-B

Parentage: MSA105-1 x MSG227-2
Developers: Michigan State University and the Michigan Agricultural Experiment Station
Plant Variety Protection: Will be considered.

Strengths: MSL007-B is a chip-processing potato with an attractive, uniform round appearance with shallow eyes. This variety has resistance to *Streptomyces scabies* (common scab) stronger than Pike, with a strong, netted skin. MSL007-B was the most highly merit rated line in the National Chip Processing Trial across eight locations in 2010.

Incentives for production: Chip-processing quality with common scab resistance superior to Pike, and a uniform, round tuber type.

MSR061-1

Parentage: MegaChip x NY121
Developers: Michigan State University and the Michigan Agricultural Experiment Station
Plant Variety Protection: Will be considered.

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.

MSR127-2

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.

II. Germplasm Enhancement

In 2010 we developed genetic mapping populations (both at diploid and tetraploid levels) for late blight resistance, beetle resistance, scab resistance and also for tuber quality traits. We have started to characterize these populations in 2011 and conduct the linkage analysis studies using the SNP genotyping. 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.

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 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 extensive field screening for resistance to Colorado potato beetle at the Montcalm Research Farm. We made crosses with late blight resistant diploid lines derived from *S. microdontum* to our tetraploid lines. We have conducted lab-based detached leaf bioassays and have identified resistant lines. These lines are being used crosses to further transmit resistance. We are also using some inbred lines of *S. chacoense* that have fertility and vigor to initiate our efforts to develop inbred lines with our own diploid germplasm. We have over 40 populations to make selections and we selected Atlantic haploids to cross to this material so we can develop chip-processing diploid lines. This new diploid potato breeding project is expanding to develop promising lines to use as parents in the future.

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 three years. A number of lines with PVY resistance were identified. These lines have been increased for seed production so that agronomic trials were conducted in 2014. The best performing lines are being advanced for more testing. In an inoculated field test in Idaho the MSE149-5Y line was resistant to PVY. We identified a number of Silverton Russet lines with increased PVY resistance but none with complete resistance to all three PVY strains.   Regarding late blight resistance, we have many lines with the RB gene for late blight resistance transformed into MSU lines. In many cases the transformed parent line is a late blight resistance source. The addition of the RB gene allows us to test the effect of multiple resistance genes on the durability of resistance. We have also generated over 70 lines with the gene for nitrogen use efficiency and water use efficiency. Field trials were conducted for a subset of these lines in 2014. The best lines will be re-tested in 2015. 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 that are being grown to produce tubers for cold storage testing.

Funding: Fed. Grant/MPIC

2014 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 2014, we tested over 140 varieties and breeding lines in the replicated variety trials, plus over 150 lines in the National Chip Processing Trial. 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. 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 Bruce Sackett, Chris Long and the Potato Breeding Team (especially N. Garrity, M. Alhashany, S. Islam, F. Enciso, S. Mambetova and A. Sardarbekova) 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 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 trial, representing selections at a stage after the Adaptation Trial. The other field trials were the North Central, Russet, Adaptation (chip-processors and tablestock), Preliminary (chip-processors and tablestock), the NCPT and the early observational trials. This year, the Advanced and Adaptation chip-processing trials were combined as a single trial.

2014 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 10 sites (North: NY, MI, WI, ND, OR and South: NC, FL, MO, CA, TX) in addition to a scab trial in MN.

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, chipping, 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). The chip color was measured visually with the SFA 1-5 color chart. Tuber samples were also stored at 45°F (7.2°C) and 50°F (10°C) for chip-processing out of storage in January and March. 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 Farm. There has been very strong scab disease pressure at the new Montcalm Scab Disease Nursery for four years now. The 2014 late blight trial was again 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)

The Advanced Trial and the Adaptation Chip-Processing Trial were combined in 2014. A summary of the 20 entries evaluated in the trial results is given in **Table 1**. Overall, the yields for the Advanced trial (133 days) were average, however the Snowden and Atlantic yield was below average. The check varieties for this trial were Snowden, Atlantic, and FL1879. The highest yielding lines were MSV093-1, NY148 and MSR127-2. Vascular discoloration and hollow heart were the predominant internal defects. Specific gravity was very high with all 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 moderate to strong scab resistance, including: MSL007-B, MSR127-2, McBride, MSR061-1and Lamoka. MSR061-1, NY148 and MSS428-2 showed resistance to late blight at the CRC trials. The promising MSU chip-processing lines are Manistee (chip quality, high yield, good specific gravity, and shows potential as a long-term storage chipper), MSM246-B (good yield, chip quality and shows potential as a long-term storage chipper) and MSR127-2 (strong yield, high specific gravity, scab resistance, and good chip quality).

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-eight entries were tested in Michigan in 2014. The results are presented in **Table 2**. The best performing MSU line in the trial was MST500-1. It is high yielding with round white table potato with moderate late blight resistance. There was a high percentage of oversize tubers that tended to form hollow heart. Other MSU lines that looked promising were MSS176-1 (late blight resistant), MSQ131-A (late blight resistant) and MSX540-4 (scab and PVY resistant chipper). There are some promising red-skinned entries from Minnesota and North Dakota. Wisconsin has some promising yellow-fleshed lines (W9577-6Y and W6703-1Y).

C. Russet Trial (Table 3)

We continue to increase our russet breeding efforts to reflect the growing interest in russet types in Michigan. In 2014, 17 lines were evaluated after 125 days. The results are summarized in **Table 3**. 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 very low yield. The highest yielding lines were AF3362-1Rus and ATX91137-1Rus, which were also high yielding in 2013. There was incidence of hollow heart in Silverton Russet, W8516-1Rus, W9433-1Rus, W8152-1Rus and Russet Norkotah. Specific gravity measurements were high to above average to below average with Russet Norkotah at 1.073. Off type and cull tubers were found in nearly all lines tested, with the highest being AF4320-7, A03921-2 and AF4124-7. Scab resistance was common among the lines but high susceptibility was observed in A03921-2. No late blight resistance was observed in the lines at the CRC trial.

D. Adaptation Trial (Table 4)

The Adaptation Trial of the tablestock lines was harvested after 126 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. Two reference cultivars (Reba and Red Norland) and 15 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 (MST500-1, MSS176-1, MSS487-2 and Reba). The highest yielding lines were MST500-1, MSS176-1 and MSQ086-3. These lines have been consistent high yielding lines over the past few years. MSQ086-3 is also verticillium resistant in Wisconsin field experiments, while the other two lines have some late blight resistance. The promising and attractive yellow-fleshed table selection is MSM288-2Y. MSL211-3 is round-oval white with bright skin, early maturity, and excellent internal quality with some late blight resistance. Other promising late blight resistant lines are

MSS576-5SPL, MSS206-2, MSS487-2, MSL211-3 and MSQ131-AS487-2. Besides MSQ440-2 there was little scab resistance observed in these lines tested. We continue to evaluate breeding lines with specialty market potential (purple skin such as MSR186-3P; splashes of color such MSS576-05SPL and Smiley).

E. Preliminary Trials (Tables 5 and 6)

The Preliminary trial is the first replicated trial 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. The chip-processing Preliminary Trial (**Table 5**) had 48 entries was harvested after 132 days. Most lines chip-processed well from the field. Specific gravity values were high with Atlantic at 1.088 and Snowden at 1.099. All selections had 1.074 or higher specific gravity with some lines over 1.100. Internal quality was compromised by hollow heart and vascular discoloration. Atlantic has 60% hollow heart and Snowden had 30% vascular discoloration. Promising MSU lines are MSMST191-2Y, MSV507-012, MST094-1, MSV507-001, QSMSU10-02, MSV396-4, MSV507-040, MSV507-198 and MSS167-6 combining yield, specific gravity, and chip quality. We continue to make progress selecting chip-processing with scab resistance with 25 lines in the trial. Three lines had late blight resistance (MSV396-4, QSMSU10-02 and MSV440-6).

Table 6 summarizes 15 tablestock entries evaluated in the Preliminary Trial. Onaway and Reba were the check varieties. This tablestock trial was harvested and evaluated after 125 days. MST148-3, MST386-1P, Granola, MST145-2 and MSU161-1 were the highest yielding lines. This trial also had a low incidence of internal defects. The number of tablestock selections with scab resistance (8) and late blight resistance (6) continue to increase.

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

Each year, a replicated field trial is conducted to assess resistance to common scab. The scab trial is now located at the Montcalm Research Center where high common scab disease pressure was observed in the previous four years. This location is being used for the early generation observational scab trial (356 lines) and the scab variety trial (139 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 2011-2013 scab ratings are based upon the Montcalm Research Center site. **Table 7** categorizes many of the varieties and advanced selections tested in 2013 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 7**). The table is sorted in ascending order by 2014 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 42 lines, of the 139 tested, had a scab rating of 1.5 or lower in 2014. Most notable scab resistant MSU lines are MSU358-3, McBride, MSL007-B, MSX540-4, MSQ440-2, MSQ279-1, MSR061-1, MSR127-2 and MSV301-2; as well as some earlier generation lines 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. There are also an increasing number of scab resistant lines that also have late blight resistance and PVY resistance such as MSR061-1 and MSX540-4. We also continue to conduct early generation scab screening on selections in the breeding program beginning after two years of selection. Of the 356 early generation selections that were evaluated, over 116 had scab resistance (scab rating of ≤ 1.0). Scab results from the disease nursery for the advanced selections are also found in the Trial Summaries (**Tables 1-6**).

H. Late Blight Trial (Tables 9 and 10)

In 2014, 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 (105 lines) and 118 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 2014 the replicated variety trial 18 lines had strong late blight resistance, while 98 lines in the early generation observation plots had strong 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.). **Tables 9 and 10** 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 11)

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 11**. 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 2014 the bruise levels were higher than previous years. The most bruise resistant MSU breeding lines this year from the trials were McBride, Manistee, MSM288-2Y, MSS576-05SPL, MSQ131-A, MSQ086-3, MSV344-2, MST202-5, V358-3, MSV111-1 and MSV307-2. The most susceptible lines from the trials were NY148, Elkton, NY152, NY154, Atlantic and Snowden.

ADVANCED CHIP-PROCESSING TRIAL
MONTCALM RESEARCH FARM
May 06 to September 16, 2014 (133 days)
DD Base 40°F 3162[9]

LINE	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]	BRUISE[7]	LB[8]	LB RAUDPC x100	3-YR AVG US#1 CWT/A
MSV093-1	484	507	95	4	75	20	1	1.081	1.0	1.0	0	5	0	0	1.4	1.0	LBS	33.7	-
MSR127-2	417	458	91	5	72	20	3	1.092	1.0	1.0	10	8	0	0	1.4	3.3	LBS	-	392
FL1879	**376**	**393**	**96**	**4**	**81**	**14**	**0**	**1.089**	**1.0**	**1.0**	**40**	**43**	**0**	**0**	**2.5**	**3.2**	**LBS**	**-**	**330**
NY148	363	404	90	9	80	9	1	1.099	1.0	1.0	3	8	0	0	1.5	4.8	LBMR	8.1	378
W5955-1	347	386	90	8	77	13	2	1.094	1.0	0.0	33	13	0	0	1.6	1.4	LBS	31.1	-
NY152	338	427	77	23	76	1	0	1.092	1.0	1.0	23	23	0	0	2.8	3.4	LBMS	28.1	-
Elkton	335	367	91	7	84	7	2	1.095	1.0	1.0	15	15	0	0	1.8	3.6	LBS	32.9	-
MSR061-1	324	358	90	10	82	8	0	1.092	1.0	1.0	13	20	0	0	1.0	2.2	LBMR	11.6	261
BNC182-5	322	347	93	7	72	21	0	1.090	1.0	2.0	13	20	0	0	1.6	1.8	LBMS	20.5	-
Sebec (AF0338-17)	321	350	92	8	88	4	0	1.091	1.0	1.0	0	30	0	0	2.1	2.2	LBS	38.2	-
MSM246-B	315	342	92	8	77	15	0	1.097	1.0	1.0	10	38	0	0	2.3	3.2	LBS	-	310*
Lamoka	284	312	91	9	82	9	0	1.096	1.0	1.0	0	23	0	0	1.5	1.8	LBS	34.1	319
Snowden	**280**	**330**	**82**	**17**	**78**	**4**	**1**	**1.096**	**1.0**	**1.0**	**18**	**38**	**0**	**0**	**2.6**	**3.6**	**LBS**	**35.4**	**261**
MSS428-2	279	319	87	13	74	12	0	1.090	1.0	1.0	53	18	0	0	2.5	2.8	LBR	1.0	-
McBride	269	299	90	10	80	10	1	1.089	1.0	1.0	0	25	0	0	1.1	1.5	LBS	-	259*
W6822-3	261	316	81	19	79	2	0	1.101	1.0	1.0	5	25	8	0	1.8	2.2	LBS	35.2	-
Atlantic	**251**	**295**	**84**	**12**	**74**	**10**	**3**	**1.093**	**1.0**	**1.0**	**35**	**18**	**0**	**0**	**2.6**	**3.0**	**LBS**	**31.4**	**277**
Manistee	239	279	85	15	81	4	1	1.092	1.0	1.0	3	10	0	0	1.9	2.0	LBS	-	270
MSL007-B	222	258	85	14	85	1	1	1.095	1.0	1.0	8	10	0	0	1.9	2.6	LBS	-	275
W6609-3	163	221	73	27	71	2	0	1.095	1.0	1.0	0	25	3	0	0.9	1.6	LBS	38.6	-
MEAN	309	349						1.093							1.8	2.6		27.1	307
$HSD_{0.05}$	183	168						0.007							1.5			15.0	

* 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: 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.
[8]2014 Late Blight: LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible

Plant Date:	5/6/14
Vine Kill:	9/8/14
Days from planting to vine kill:	125

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

Table 2

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

NORTH CENTRAL REGIONAL TRIAL
MONTCALM RESEARCH FARM
May 6 to September 11, 2014 (128 days)
DD Base 40°F 3032[7]

	CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]							LB	3-YR AVG
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	LB[6]	RAUDPC x100	US#1 CWT/A
ND7132-1R	498	526	94	5	79	16	1	1.072	10	10	0	10	NA	2.0			454*
MST500-1	461	485	95	3	49	46	2	1.078	45	5	0	0	2.7	4.0	LBMR	11.4	-
MN10003PLWR-06R	405	444	91	7	72	19	1	1.073	5	15	0	0	0.9	1.5			-
ND6002-1R	393	418	93	7	79	14	0	1.077	0	10	0	0	1.5	1.5			366*
Red Lasoda	**376**	**394**	**94**	**5**	**62**	**32**	**1**	**1.071**	**5**	**60**	**0**	**0**	**2.9**	**1.0**	**LBS**	**38.5**	**-**
MSS176-1	366	443	84	6	53	31	10	1.079	15	10	0	0	1.6	3.5	LBR	1.1	-
W9577-6Y	363	396	92	8	91	1	1	1.083	15	10	0	0	2.0	1.5			-
W6703-1Y	361	382	94	6	75	19	0	1.077	10	20	0	0	1.2	3.0	LBS	30.4	-
ND113207-1R	328	370	88	11	72	16	1	1.063	0	0	0	0	1.5	1.0			-
MSX540-4	315	355	89	10	88	1	1	1.105	0	20	0	0	0.9	3.5			-
MSQ131-A	297	299	99	1	40	60	0	1.076	0	0	0	0	1.9	2.5	LBR	1.1	-
MSS576-5SPL	291	312	93	6	77	16	0	1.085	0	5	0	0	1.6	1.5	LBR	2.7	366
W8405-1R	287	356	81	17	74	7	2	1.073	0	10	0	0	NA	2.5			342
ND092242C-1R	287	324	88	11	81	7	1	1.076	0	20	0	0	NA	1.0			-
MSM288-2Y	285	359	79	19	77	2	2	1.083	0	0	0	0	2.5	1.0	LBS		-
Yukon Gold	**265**	**276**	**96**	**3**	**73**	**23**	**1**	**1.091**	**15**	**20**	**0**	**0**	**2.3**	**1.0**	**LBS**	**39.6**	**-**
MSX007-4RR	238	372	64	19	58	6	17	1.065	0	0	0	0	2.1	2.0	LBS	38.9	-
Red Norland	**223**	**249**	**90**	**10**	**86**	**3**	**0**	**1.068**	**5**	**0**	**0**	**0**	**1.4**	**2.0**	**LBS**	**40.3**	**252**
ND102784B-3R	205	296	69	31	67	2	1	1.074	0	20	0	0	NA	1.0			-
MN10013PLWR-04	204	292	70	30	69	1	1	1.081	45	0	0	0	2.6	1.5	LBS	40.2	139*
MSR186-3P	190	237	80	12	74	6	8	1.071	0	15	0	0	1.5	1.5	LBMS	26.8	-
MN10003PLWR-02R	183	254	72	27	72	0	1	1.069	0	15	0	0	1.3	1.0	LBS	38.6	-
MN10025PLWR-07R	177	208	85	8	82	3	7	1.068	0	20	0	0	2.5	1.0			-
MN10003PLWR-07R	140	165	83	17	83	0	0	1.064	0	0	0	0	2.4	2.0	LBS	39.9	150*
MN10003PLWR-03R	131	192	68	24	67	1	9	1.058	0	0	0	0	3.0	1.0	LBS	40.5	166*
MN10020PLWR-04R	128	244	52	35	52	0	12	1.067	0	20	0	0	1.4	1.0	LBS	39.7	-
W8886-3R	114	144	79	16	68	11	5	1.068	0	0	0	0	1.0	1.0			-
MN10020PLWR-05R	57	95	61	37	61	0	2	1.055	0	10	0	0	1.6	1.0	LBS	39.9	-
MEAN	270	317						1.074					1.8	1.7		29.4	320
$HSD_{0.05}$	223	222						0.019					1.5			15.0	

* 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: September 3, 2014; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.
[6]2014 Late Blight: LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible
[7]Enviroweather: Entrican Station. Planting to vine kill

Plant Date: 5/6/14
Vine Kill: 9/3/14
Days from planting to vine kill: 120

Table 3

RUSSET TRIAL
MONTCALM RESEARCH FARM
May 6 to September 8, 2014 (125 days)
DD Base 40°F 3005[7]

	CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]							LB RAUDPC	3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	BRUISE[5]	LB[6]	x100	CWT/A
AF3362-1Rus	401	428	94	3	43	50	4	1.088	3	35	0	0	1.0	1.3	LBS	34.8	-
ATX91137-1Rus	400	454	87	6	50	37	7	1.079	0	0	0	0	1.1	0.2	LBS	35.1	-
AF4320-7	347	432	80	5	48	33	15	1.085	0	8	0	0	2.4	1.9	LBS	33.8	-
W9433-1Rus	331	371	89	4	39	51	6	1.085	0	13	0	0	1.3	1.5	LBS	32.4	-
A06021-T	310	363	85	11	66	19	4	1.084	3	5	0	0	1.5	1.2	LBS	32.7	-
Silverton Russet	**288**	**328**	**87**	**8**	**51**	**35**	**6**	**1.077**	**33**	**10**	**0**	**0**	**1.6**	**1.3**	**LBS**	**33.2**	**363**
W9433-1Rus (NCR)	279	298	94	6	56	38	1	1.079	0	20	0.0	0.0	1.3	ND			-
A03921-2	254	348	72	17	56	16	11	1.097	8	33	3	0	2.5	1.5	LBS	32.8	-
W8516-1Rus (NCR)	237	260	91	8	78	13	1	1.084	30	30	0.0	0.0	1.2	ND			-
ND7882b-7Rus (NCR) (1 rep)	213	312	68	24	62	6	8	1.080	0	30	0.0	0.0	NA	ND			-
MSU285-1Rus (2 reps)	203	267	74	14	68	6	11	1.076	35	10	0	0	2.0	0.6	LBS	32.3	-
W9759-1Rus (NCR)	200	246	81	17	77	5	2	1.077	5	20	0.0	0.0	0.4	ND			-
W8152-1Rus	198	264	75	21	67	8	5	1.091	33	5	0	0	1.6	0.7	LBS	30.3	242*
AF4124-7	197	255	77	14	68	9	10	1.085	5	58	0	0	1.8	0.8	LBS	39.2	-
W9133-1Rus	168	216	77	20	66	11	3	1.073	5	0	0	0	1.0	0.9	LBS	38.0	215*
W9133-1Rus (NCR)	158	193	82	17	69	13	1	1.073	10	5	0.0	0.0	NA	ND			-
Russet Norkotah (3 reps)	**138**	**196**	**69**	**29**	**64**	**5**	**2**	**1.073**	**30**	**8**	**0**	**0**	**1.8**	**0.6**	**LBS**	**37.5**	**178**
MEAN	254	308						1.082					1.5	1.0		34.3	271
$HSD_{0.05}$	177	177						0.005					1.5			15.0	

* 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 19, 2013; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.
[6]2014 Late Blight: LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible
[7]Enviroweather: Entrican Station. Planting to vine kill

Plant Date:	5/6/14
Vine Kill:	9/2/14
Days from planting to vine kill:	119

Table 4

ADAPTATION TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 6 to September 9, 2014 (126 days)
DD Base 40°F 3005[7]

LINE	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]	BRUISE[5]	LB[6]	LB RAUDPC x100
MST500-1	491	540	91	3	32	58	6	1.075	40	3	3	0	2.7	1.0	LBMR	11.4
MSS176-1	462	540	85	4	55	30	11	1.085	15	5	3	0	1.6	1.4	LBR	1.1
MSQ086-3	433	465	93	6	79	14	1	1.087	3	5	0	0	1.9	1.0	LBS	33.1
MSS487-2	365	398	92	8	73	19	0	1.085	13	3	0	0	2.6	2.8	LBR	0.4
MSS576-5SPL	347	370	94	6	78	16	0	1.082	0	5	0	0	1.6	0.8	LBR	2.7
MSS206-2	338	344	98	1	53	45	1	1.083	3	3	0	0	2.5	1.5	LBR	0.0
Reba	**335**	**347**	**96**	**2**	**69**	**28**	**1**	**1.084**	**10**	**18**	**0**	**0**	**2.3**	**2.1**	**LBS**	**40.4**
Smiley	328	382	86	13	72	14	2	1.080	3	8	0	0	1.4	0.7	LBS	31.8
MSL211-3	313	351	89	9	75	15	2	1.081	0	8	5	0	1.6	1.2	LBMR	8.2
MSM288-2Y	301	363	83	15	81	2	2	1.080	0	5	0	0	2.5	0.3	LBS	
MSQ131-A	273	281	97	1	25	72	2	1.071	3	5	0	0	1.9	0.2	LBR	1.1
Alegria	271	387	70	11	63	7	19	1.083	0	18	0	0	1.8	0.7	LBS	35.9
Agila	267	340	79	18	69	9	3	1.069	0	10	3	0	2.1	0.3	LBS	37.7
Red Norland	**229**	**278**	**81**	**19**	**81**	**0**	**0**	**1.064**	**0**	**3**	**0**	**0**	**1.4**	**0.2**	**LBS**	**40.3**
MSR186-3P	196	258	76	10	70	5	14	1.071	0	8	3	0	1.5	0.4	LBMS	26.8
CO05228-4R	177	259	67	33	67	0	0	1.078	0	3	0	0	2.9	0.4	LBS	40.0
W6703-1Y	138	191	71	28	71	0	1	1.087	0	8	3	0	1.2	0.6	LBS	30.4
MEAN	310	358						1.079					2.0	0.9		21.3
$HSD_{0.05}$	116	110						0.009					1.5			15.0

[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 19, 2013; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.
[6]2014 Late Blight: LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible
[7]Enviroweather: Entrican Station. Planting to vine kill

Plant Date:	5/6/14
Vine Kill:	9/2/14
Days from planting to vine kill:	119

Table 5

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 6 to September 15, 2014 (132 days)
DD Base 40°F 3162[9]

LINE	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]	BRUISE[7]	LB[8]	LB RAUDPC x100
Dakota Diamond	613	649	94	6	82	12	0	1.093	1.0	0.0	60	0	0	0	2.0	2.1	LBMS	26.0
MST191-2Y	539	595	91	9	82	9	0	1.092	1.0	0.0	0	0	0	0	2.9	1.7		
MSV033-1	531	557	95	5	63	32	0	1.090	1.0	0.0	55	45	0	0	2.0	3.4		
NY154 (H15-17)	477	524	91	9	88	3	0	1.097	2.0	0.0	15	10	0	0	1.6	4.3	LBMS	23.1
MST186-1Y	470	492	96	4	67	28	0	1.083	1.0	2.0	90	0	0	0	1.6	ND		
MSV498-1	459	493	93	7	80	13	0	1.089	1.0	3.0	95	15	0	0	1.6	2.8		
QSMSU08-04	411	455	90	3	64	26	6	1.085	1.0	2.0	5	5	0	0	1.6	1.2	LBS	37.9
MST178-2	389	424	91	8	68	23	0	1.074	1.0	0.0	30	5	0	0	2.0	1.5		
NYJ15-7	380	403	94	6	88	6	0	1.096	1.5	0.0	5	25	0	0	2.4	2.7	LBS	34.1
MSV507-012	353	386	92	8	78	14	0	1.099	1.5	0.0	25	10	0	0	1.8	3.7		
MST441-1	350	390	90	10	82	8	0	1.084	1.5	2.0	0	10	0	0	0.9	2.5		
MSV507-129	337	391	86	12	83	3	2	1.106	1.0	2.0	75	25	0	0	0.9	4.4		
MST094-1	336	360	93	6	79	14	1	1.084	1.0	1.0	5	55	0	0	1.6	ND		
Beacon Chipper	332	353	94	6	80	14	0	1.092	1.5	1.0	20	30	0	0	1.8	2.4	LBS	30.2
MSV507-001	330	345	96	4	74	22	0	1.092	1.0	1.0	5	15	0	0	1.9	3.0		
MSV434-1Y	327	371	87	11	73	14	1	1.075	1.0	0.0	5	0	0	0	1.5	0.7		
MSV396-4	313	380	82	18	82	1	0	1.091	1.5	0.0	0	20	0	0	1.8	2.4	LBMR	6.3
QSMSU01-10	310	356	87	13	77	10	0	1.098	1.0	0.0	35	5	5	0	2.2	1.8	LBS	39.1
MSV507-056	307	329	94	6	88	5	0	1.098	1.5	0.0	40	15	0	0	2.4	2.2		
Snowden	**306**	**375**	**82**	**18**	**78**	**4**	**0**	**1.099**	**1.0**	**0.0**	**20**	**30**	**0**	**0**	**2.6**	**2.5**	**LBS**	**35.4**
MST184-3	300	330	90	6	73	17	4	1.093	1.0	1.0	70	5	0	0	2.4	3.8		
Pike	**300**	**343**	**86**	**14**	**81**	**6**	**0**	**1.097**	**1.0**	**0.0**	**0**	**15**	**0**	**0**	**1.3**	**3.6**	**LBS**	**34.3**
QSMSU10-02	299	324	92	5	69	23	2	1.081	2.0	2.0	0	5	0	0	1.0	1.4	LBR	0.1
MSV030-4	293	340	86	13	79	7	1	1.099	1.0	1.0	5	5	0	0	1.9	2.7		
MSU358-2	290	312	93	3	74	19	4	1.096	1.5	0.0	5	0	0	10	0.8	3.1	LBS	38.6
MSV301-2	290	310	93	6	87	6	1	1.093	1.0	0.0	0	20	0	0	1.5	1.7		
MSV358-3	284	329	86	14	84	2	0	1.093	1.0	0.0	0	5	0	0	1.5	1.0		
MSV507-040	281	304	92	6	67	25	2	1.093	1.5	0.0	0	0	0	0	1.3	2.4		
QSMSU10-15	279	307	91	9	86	5	0	1.100	1.0	0.0	5	15	10	0	1.8	1.6	LBS	33.7
MST458-4	274	279	98	2	61	37	0	1.082	1.0	0.0	0	30	0	0	1.5	3.3	LBS	39.6
MSV507-198	268	307	87	13	80	6	0	1.089	1.0	0.0	35	10	0	0	1.3	1.4		
Atlantic	**265**	**301**	**88**	**8**	**65**	**23**	**3**	**1.088**	**2.0**	**2.0**	**60**	**15**	**0**	**0**	**2.6**	**3.8**	**LBS**	**31.4**
MSV440-6	263	292	90	10	86	4	0	1.076	1.5	3.0	0	5	0	0	2.4	1.2	LBMR	7.6
MSV507-073	260	298	87	13	85	2	0	1.101	1.0	0.0	0	10	0	0	1.6	2.9		
MSV505-2	256	293	87	13	86	1	0	1.092	1.0	0.0	0	15	0	0	0.9	2.8	LBS	39.7
MST096-2Y	248	269	92	8	81	11	0	1.085	1.0	0.0	0	0	0	0	1.7	0.6		
MSV507-052	239	288	82	18	80	3	0	1.088	1.0	0.0	0	20	0	0	1.0	2.6	LBS	38.3
MST424-6	237	268	88	5	71	17	7	1.084	1.0	0.0	0	5	0	0	1.5	3.7		

Table 5

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 6 to September 15, 2014 (132 days)
DD Base 40°F 3162[9]

	CWT/A		PERCENT OF TOTAL[1]								PERCENT (%) TUBER QUALITY[4]							LB
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	CHIP SCORE[2]	OTF SED[3]	HH	VD	IBS	BC	SCAB[5]	BRUISE[7]	LB[8]	RAUDPC x100
MSV307-2	234	330	71	28	70	1	1	1.085	1.0	0.0	0	10	0	0	1.5	1.2		
MSV394-3	233	298	78	21	76	2	1	1.091	1.0	3.0	15	5	10	0	1.6	1.6		
MST443-1Y	225	263	85	11	79	6	3	1.086	1.0	0.0	10	10	0	0	1.4	1.2	LBS	37.3
MSS167-6	222	283	79	16	72	7	6	1.087	1.5	0.0	35	5	5	0	1.7	2.1		
MSV344-2	215	240	88	4	70	18	8	1.077	1.5	3.0	10	20	5	0	1.5	0.5		
MSS108-1	213	261	81	17	74	8	2	1.084	1.0	0.0	15	15	20	0	1.4	1.8		
MSV507-140	207	240	86	14	86	0	0	1.095	1.0	0.0	0	0	0	0	1.0	1.5		
MSV380-1	203	224	91	9	91	0	0	1.091	1.5	0.0	0	20	0	0	0.9	2.8	LBS	31.8
MST202-5	198	244	81	17	81	0	2	1.083	1.0	1.0	0	20	0	0	1.0	0.5	LBS	36.4
MSV507-121	180	225	80	18	78	2	1	1.097	1.5	0.0	0	5	0	0	0.9	1.7		
MSV507-003	141	223	63	37	63	0	0	1.103	1.5	0.0	0	0	0	0	2.0	2.1		
MSV507-020	136	208	66	34	66	0	0	1.101	1.5	0.0	0	15	5	0	1.4	2.9	LBS	35.1
MEAN	304	343						1.091							1.6	2.3		30.3
$HSD_{0.05}$	239	234						0.010							1.5			15.0

[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 19, 2013; 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.
[8]2014 Late Blight: LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible

Plant Date: 5/6/14
Vine Kill: 9/8/14
Days from planting to vine kill: 125

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

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 6 to September 8, 2014 (125 days)
DD Base 40°F 3005[7]

	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]	BRUISE[5]	LB[6]	x100
MST148-3	425	465	91	4	62	30	5	1.086	0	0	0	0	2.4	2.0	LBR	2.5
MST386-1P	378	420	90	4	54	36	5	1.085	0	0	5	0	1.0	1.2		
Granola	372	438	85	10	80	5	5	1.074	0	10	0	0	0.8	0.2	LBMS	19.2
MST145-2	368	426	86	12	73	13	2	1.085	5	0	0	0	2.8	1.2	LBR	0.4
MSU161-1	364	394	92	6	73	19	2	1.083	5	0	0	0	1.8	1.9	LBMR	7.3
Michigan Purple Sport I	360	388	93	4	66	27	3	1.074	0	0	0	0	1.5	0.9	LBS	
Reba	**340**	**359**	**95**	**5**	**80**	**15**	**1**	**1.084**	**0**	**0**	**0**	**0**	**2.3**	**2.5**	**LBS**	**40.4**
MSW239-3SPL	332	362	92	8	86	5	0	1.066	10	0	0	0	2.4	0.0		
Onaway	**322**	**352**	**91**	**8**	**84**	**8**	**1**	**1.074**	**0**	**10**	**0**	**0**	**2.0**	**1.8**	**LBS**	**40.3**
MSV111-1	313	353	89	11	81	8	0	1.084	0	0	0	0	1.6	0.1	LBMR	10.7
MSS164-1	291	350	83	15	78	5	2	1.093	25	0	0	0	1.3	0.8	LBR	0.0
Purple Haze	250	275	91	7	91	0	2	1.089	0	0	0	0	1.5	0.8	LBS	38.9
MST252-1Y	236	316	75	10	69	6	15	1.076	0	0	0	0	0.8	0.9	LBS	36.8
MSU202-1P	215	251	86	12	81	4	2	1.075	0	0	0	0	1.1	0.2	LBS	35.1
MSV235-2PY	141	262	54	45	54	0	1	1.082	5	0	0	0	2.8	0.9	LBR	2.7
MEAN	314	361						1.081					1.7	1.0		19.5
$HSD_{0.05}$	151	145						0.009					1.5			15.0

[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: Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[5]BRUISE: Simulated blackspot bruise test average number of spots per tuber.
[6]2014 Late Blight: LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible
[7]Enviroweather: Entrican Station. Planting to vine kill

Plant Date: 5/6/14
Vine Kill: 9/2/14
Days from planting to vine kill: 119

Table 7

2012-2014 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N	2012 RATING	2012 WORST	2012 N
Sorted by ascending Average Rating;										
W9759-1Rus	0.4	0.4	0.5	4	-	-	-	-	-	-
Granola	0.8	0.8	1.0	4	-	-	-	-	-	-
MST441-1	0.8*	0.9	1.5	4	-	-	-	0.6	1	4
MSU358-2	0.8	0.8	1.0	3	-	-	-	-	-	-
McBride	0.9	1.1	1.5	4	0.8	1.5	4	0.8	2	4
MN10003PLWR-06R	0.9	0.9	1.5	4	-	-	-	-	-	-
MSV380-1	0.9	0.9	1.5	4	-	-	-	-	-	-
MSV505-2	0.9	0.9	1.0	4	-	-	-	-	-	-
MSV507-010	0.9	0.9	1.0	4	-	-	-	-	-	-
MSV507-121	0.9	0.9	1.0	4	-	-	-	-	-	-
MSV507-129	0.9	0.9	1.0	4	-	-	-	-	-	-
MSX540-4	0.9	0.9	1.0	4	-	-	-	-	-	-
W6609-3	0.9	0.9	1.0	4	-	-	-	-	-	-
A06021-T	1.0	1.0	1.5	4	-	-	-	-	-	-
MST202-5	1.0	1.0	1.0	4	-	-	-	-	-	-
MST386-1P	1.0	1.0	1.5	4	-	-	-	-	-	-
MSV507-052	1.0	1.0	1.5	3	-	-	-	-	-	-
MSV507-140	1.0	1.0	1.0	4	-	-	-	-	-	-
QSMSU10-02[LBR]	1.0	1.0	1.0	4	-	-	-	-	-	-
W8886-3R	1.0	1.0	1.0	2	-	-	-	-	-	-
AF3362-1Rus	1.1*	1.0	1.0	4	-	-	-	1.3	2	4
MST252-1Y	1.1*	0.8	1.0	4	1.5	2	4	-	-	-
W6703-1Y	1.1	1.2	2.0	7	1.0	1.5	4	1.1	2	4
ATX91137-1Rus	1.1	1.1	2.0	4	-	-	-	-	-	-
MSU202-1P	1.1	1.1	1.5	4	-	-	-	-	-	-
Silverton Russet	1.2	1.6	2.0	4	1.1	2	4	0.8	2	4
W8516-1Rus	1.2	1.2	2.0	3	-	-	-	-	-	-
MSS164-1[LBR]	1.3	1.3	1.5	4	-	-	-	-	-	-
MSV507-040	1.3	1.3	1.5	4	-	-	-	-	-	-
MSV507-198	1.3	1.3	2.0	4	-	-	-	-	-	-
Pike	**1.3**	**1.3**	**1.5**	**4**	**1.4**	**2**	**4**	**1.1**	**2**	**8**
W9433-1Rus	1.3	1.3	2.0	4	-	-	-	-	-	-
MSR127-2	1.3	1.4	2.0	4	1.0	1.5	4	1.5	2	4
MST096-2Y	1.3*	1.7	2.0	3	-	-	-	0.9	2	4
MSV093-1[LBMR]	1.3*	1.4	2.0	4	1.3	2	4	-	-	-
MN10003PLWR-02R	1.3	1.3	2.0	4	-	-	-	-	-	-
MN10020PLWR-04R	1.4	1.4	2.5	4	-	-	-	-	-	-
MST443-1	1.4	1.4	2.0	4	-	-	-	-	-	-
MSV507-020	1.4	1.4	2.0	4	-	-	-	-	-	-
Smiley	1.4	1.4	2.0	4	-	-	-	-	-	-
MST424-6	1.4*	1.5	1.5	4	1.3	1.5	4	-	-	-
QSMSU10-15	1.4*	1.8	2.5	4	1.1	2	4	-	-	-
Lamoka	1.5	1.5	2.0	4	1.5	2	4	1.5	2	4
MSV301-2	1.5	1.5	2.0	4	-	-	-	-	-	-
MSV307-02	1.5	1.5	2.0	4	-	-	-	-	-	-
MSV344-2	1.5	1.5	2.5	4	-	-	-	-	-	-
MSV358-3	1.5	1.5	2.5	3	-	-	-	-	-	-
MSV434-1Y	1.5	1.5	2.0	4	-	-	-	-	-	-
ND113207-1R	1.5	1.5	2.0	2	-	-	-	-	-	-
W9133-1Rus	1.5*	1.0	2.0	4	2.0	2.5	4	-	-	-
MST178-2	1.5	2.0	3.0	4	1.5	2	4	1.1	2	4
MSV498-1	1.6	1.6	2.0	4	-	-	-	-	-	-
MSV507-073	1.6	1.6	2.5	5	-	-	-	-	-	-
W5955-1	1.6*	1.6	2.0	4	1.5	2	4	-	-	-
BNC182-5	1.6	1.6	2.0	4	-	-	-	-	-	-
MN10020PLWR-05R	1.6	1.6	2.0	4	-	-	-	-	-	-
MSL007-B	1.6	1.9	2.5	4	1.5	2	4	1.5	2	4

2012-2014 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N	2012 RATING	2012 WORST	2012 N
Sorted by ascending Average Rating;										
MSR061-1[LBMR,PVYR]	1.6	1.0	1.5	4	2.0	2	4	1.9	2	4
MST094-1	1.6	1.6	2.0	4	-	-	-	-	-	-
MST186-1Y	1.6	1.6	2.0	4	-	-	-	-	-	-
MSV394-3	1.6	1.6	2.0	4	-	-	-	-	-	-
NY154[LBMS]	1.6	1.6	2.0	4	-	-	-	-	-	-
Red Norland	**1.6**	**1.4**	**2.0**	**9**	**2.0**	**2.5**	**4**	**1.5**	**3**	**4**
MSS167-6[LBR]	1.7	1.7	2.0	4	-	-	-	-	-	-
Purple Haze	1.7	1.5	2.0	4	-	-	-	1.9	2	4
Elkton	1.7*	1.8	2.0	5	1.6	2	4	-	-	-
MSS108-1[LBMS]	1.7*	1.4	1.5	4	2.0	2.5	4	-	-	-
MSS176-1[LBR]	1.7*	1.6	2.0	7	1.8	2	4	-	-	-
MST458-4	1.7*	1.5	1.5	3	1.9	2	4	-	-	-
AF4124-7	1.8	1.8	2.0	4	-	-	-	-	-	-
Alegria	1.8	1.8	2.0	4	-	-	-	-	-	-
Beacon Chipper	1.8	1.8	2.0	4	-	-	-	-	-	-
MST154-3	1.8	1.8	2.0	4	-	-	-	-	-	-
MSU161-1[LBMR]	1.8	1.8	2.0	4	-	-	-	-	-	-
MSV396-4Y[LBMR]	1.8	1.8	2.5	4	-	-	-	-	-	-
MSV507-012	1.8	1.8	2.0	4	-	-	-	-	-	-
W6822-3	1.8	1.8	2.0	4	-	-	-	-	-	-
NY148[LMBR]	1.8	1.5	2.0	4	2.1	2.5	4	1.8	2	4
MSR186-3P[LBMS]	1.8*	1.5	2.0	8	2.0	2.5	4	-	-	-
MSV111-2[LBMR]	1.8*	1.6	2.0	4	1.9	2	4	-	-	-
ND6002-1R	1.8*	1.5	2.0	2	2.1	2.5	4	-	-	-
QSMSU08-04	1.8*	1.6	2.0	4	2.0	2.5	4	-	-	-
MSQ131-A[LBR]	1.9	1.9	2.5	7	1.8	2.5	3	1.9	3	4
A03921-2	1.9	1.9	2.5	4	-	-	-	-	-	-
MSH228-6	1.9	1.9	2.5	4	-	-	-	-	-	-
MSV030-4	1.9	1.9	2.0	4	-	-	-	-	-	-
MSV507-001	1.9	1.9	2.0	4	-	-	-	-	-	-
MSS576-05SPL[LBR]	1.9	1.6	2.0	8	2.2	2.5	8	1.9	2	4
MSQ130-4[LBR]	1.9*	1.9	2.0	4	2.0	2	4	-	-	-
W8152-1Rus	1.9*	1.6	2.0	4	2.1	2.5	4	-	-	-
MSL211-3[LBR]	1.9	1.6	2.0	4	2.3	2.5	4	1.9	2	4
Dakota Diamond	2.0	2.0	2.5	4	-	-	-	-	-	-
MST184-3	2.0	2.4	2.5	4	2.0	2.5	4	1.6	2	4
MSU285-1Rus	2.0	2.0	2.5	4	-	-	-	-	-	-
MSV033-1	2.0	2.0	2.5	4	-	-	-	-	-	-
MSV507-003	2.0	2.0	2.0	4	-	-	-	-	-	-
W9577-6Y	2.0	2.0	2.0	3	-	-	-	-	-	-
MSQ086-3	2.0	1.9	2.0	4	2.4	3	4	1.9	2	4
Onaway	**2.0**	**2.0**	**2.5**	**4**	**2.3**	**2.5**	**4**	**1.9**	**2**	**8**
Russet Norkotah	**2.1**	**1.8**	**2.5**	**7**	**2.5**	**3**	**4**	**1.9**	**3**	**4**
Sebec	2.1	2.1	3.0	5	-	-	-	-	-	-
Michigan Purple Sport I	2.1*	1.5	2.0	4	2.6	3	4	-	-	-
Agila	2.1	2.1	2.5	4	-	-	-	-	-	-
MSS206-2[LBR]	2.1	2.5	3.0	4	2.3	3	4	1.6	2	4
MSX007-4RR	2.1	2.1	2.5	4	-	-	-	-	-	-
Jingshu	2.3	2.3	2.5	4	-	-	-	-	-	-
Reba	**2.4**	**2.3**	**2.5**	**6**	**2.6**	**3**	**4**	**2.2**	**3**	**8**
AF4320-7	2.4	2.4	2.5	4	-	-	-	-	-	-
MN10003PLWR-07R	2.4	2.4	2.5	4	-	-	-	-	-	-
MSV440-6[LBMR]	2.4	2.4	2.5	4	-	-	-	-	-	-
MSW239-3SPL	2.4	2.4	3.0	4	2.3	3	4	2.5	3	4
NYJ15-7	2.4	2.4	2.5	4	-	-	-	-	-	-
MSV507-056	2.4	2.4	3.0	5	-	-	-	-	-	-

Table 7

2012-2014 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	3-YR* AVG.	2014 RATING	2014 WORST	2014 N	2013 RATING	2013 WORST	2013 N	2012 RATING	2012 WORST	2012 N
Sorted by ascending Average Rating;										
FL1879	**2.4***	**2.5**	**3.0**	**4**	**-**	**-**	**-**	**2.3**	**3**	**4**
MST359-3[LBR]	2.4*	2.1	2.5	4	2.6	3.5	4	-	-	-
QSMSU01-10	2.4*	2.2	2.5	3	2.6	3	4	-	-	-
MST065-1[LBMS]	2.5	2.4	2.5	4	2.4	3	4	2.6	3	4
MN10025PLWR-07R	2.5	2.5	3.0	4	-	-	-	-	-	-
MSS428-2[LBR]	2.5	2.5	3.0	4	-	-	-	-	-	-
MST148-3	2.5*	2.4	3.0	4	2.6	4	4	-	-	-
Manistee	2.5	1.9	2.0	4	3.3	3.5	4	2.5	3	4
MSM180-3	2.6*	2.3	2.5	4	3.0	3	4	-	-	-
MSS487-2[LBR]	2.7	2.6	3.0	4	3.3	3.5	4	2.1	3	4
MST145-2[LBR]	2.8	2.8	3.0	4	-	-	-	-	-	-
NY152[LBMS]	2.8	2.8	3.5	5	-	-	-	-	-	-
Yukon Gold	**2.8**	**2.3**	**3.5**	**8**	**3.0**	**3.5**	**4**	**3.0**	**3**	**4**
Snowden	**2.8**	**2.6**	**3.0**	**8**	**3.1**	**3.5**	**12**	**2.6**	**3**	**8**
MSM288-2Y	2.8	2.5	2.5	3	3.1	3.5	4	2.8	3	4
MSS483-1[LBMR]	2.8	2.9	3.5	4	3.0	4	4	2.5	3	4
MSM246-B	2.8*	2.3	3.0	4	3.3	3.5	4	-	-	-
Atlantic	**2.9**	**2.6**	**3.0**	**8**	**3.2**	**3.5**	**12**	**2.8**	**4**	**12**
CO05228-4R	2.9	2.9	3.5	4	-	-	-	-	-	-
MST191-2Y	2.9	2.9	3.0	4	-	-	-	-	-	-
Red Lasoda	2.9	2.9	3.5	4	-	-	-	-	-	-
MST500-1[LBMR]	2.9*	2.7	3.0	7	3.1	3.5	4	-	-	-
MSV235-2PY[LBR]	2.9*	2.8	3.0	4	3.1	3.5	4	-	-	-
MSK136-2	3.0	3.0	3.5	4	-	-	-	-	-	-
MN10013PLWR-04	3.0*	2.6	3.5	4	3.4	4	4	-	-	-
MN10003PLWR-03R	3.1*	3.0	3.5	4	3.3	3.5	4	-	-	-
$HSD_{0.05}$ =		**1.5**			**1.5**			**1.4**		

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

Table 8

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSM270-BY	0.5	1	84SD22	W5337.3
MSV383-B	0.5	1	Pike	MSN238-A
MSV407-2	0.5	1	MSQ070-1	MSP239-1
MSW474-01	0.5	1	MSN190-2	MSP516-A
MSX324-1P	0.5	1	MSN105-1	MSN215-2P
MSY044-1	0.5	1	MSK061-4	MST096-2Y
MSY046-3	0.5	1	Manistee	MSS026-2Y
MSY256-A2	0.5	1	Kalkaska	Manistee
MSY517-8YSPL	0.5	1	Spartan Splash	Bison
MSY543-2	0.5	1	Dakota Diamond	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
MSZ063-02	0.5	1	MSR148-4	McBride
MSZ109-05RR	0.5	1	COMN07-W112BG1	MSU200-5PP
MSZ147-05	0.5	1	M5	MSS297-3
MSZ267-4	0.5	1	MSU278-1Y	Kalkaska
MSZ268-1	0.5	1	MSU278-1Y	Pike
MSZ412-2RR	0.5	1	Colonial Purple	MST406-2RR
MSZ413-3PP	0.5	1	Colonial Purple	MSU200-5PP
MSZ413-7PP	0.5	1	Colonial Purple	MSU200-5PP
MSZ414-1	0.5	1	MSN230-1RY	Colonial Purple
MSZ427-1R	0.5	1	MSQ440-2	NDTX4271-5R
MSZ464-3	0.5	1	MSQ070-1	Alca Tarma
MSZ709-09	0.5	1	MSM269-HORG	84SD22
Red Norland	1.0	1		
MSU379-01	1.0	1	MSP238-1	Missaukee
MSY027-2	1.0	1	MST096-2Y	Pike
MSY042-1	1.0	1	MSJ147-1	W2133-1
MSY089-2	1.0	1	MSS176-1	B2731-2
MSY156-2	1.0	1	MSK061-4	Kalkaska
MSY169-4	1.0	1	Boulder	MSR102-3
MSY468-16	1.0	1	NYL235-4	MSL211-3
MSY489-1	1.0	1	MSL211-3	MSQ279-1
MSY507-2	1.0	1	Superior	MSL211-3
MSZ010-9	1.0	1	Atlantic	MSV229-2
MSZ034-4	1.0	1	M5	MSU383-1
MSZ063-13Y	1.0	1	MSR148-4	McBride
MSZ069-11	1.0	1	Snowden	MSS297-3
MSZ069-13	1.0	1	Snowden	MSS297-3
MSZ073-2Y	1.0	1	MSU278-1Y	MSR169-8Y
MSZ074-2	1.0	1	W2978-3	W2310-3
MSZ075-3	1.0	1	W6609-3	McBride
MSZ075-4Y	1.0	1	W6609-3	McBride
MSZ088-03	1.0	1	Atlantic	MSV310-2
MSZ092-2	1.0	1	Elkton	MSQ086-3
MSZ100-1	1.0	1	Boulder	MSV477-5
MSZ103-4	1.0	1	CO95051-7W	McBride
MSZ107-1PP	1.0	1	COMN07-W112BG1	MSR127-2
MSZ107-2PP	1.0	1	COMN07-W112BG1	MSR127-2
MSZ109-03PP	1.0	1	COMN07-W112BG1	MSU200-5PP
MSZ109-07PP	1.0	1	COMN07-W112BG1	MSU200-5PP
MSZ109-08PP	1.0	1	COMN07-W112BG1	MSU200-5PP
MSZ109-10PP	1.0	1	COMN07-W112BG1	MSU200-5PP

Table 8

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSZ124-5	1.0	1	Manistee	MSS297-3
MSZ144-03Y	1.0	1	M5	McBride
MSZ144-04Y	1.0	1	M5	McBride
MSZ144-07	1.0	1	M5	McBride
MSZ144-10Y	1.0	1	M5	McBride
MSZ146-9	1.0	1	M5	Manistee
MSZ147-03	1.0	1	M5	MSS297-3
MSZ172-3	1.0	1	MSP270-1	W6609-3
MSZ199-1	1.0	1	MSQ070-1	Kalkaska
MSZ200-3	1.0	1	MSQ070-1	Lamoka
MSZ204-1P	1.0	1	MSQ070-1	MSU200-5PP
MSZ205-1	1.0	1	MSQ070-1	MSU383-1
MSZ213-2P	1.0	1	MSQ279-1	Colonial Purple
MSZ216-4	1.0	1	MSR058-1	MSS297-3
MSZ218-5	1.0	1	MSR061-1	MSQ086-3
MSZ220-01	1.0	1	MSR061-1	MSS297-3
MSZ223-2	1.0	1	MSR148-4	MSS297-3
MSZ223-5	1.0	1	MSR148-4	MSS297-3
MSZ245-07	1.0	1	Snowden	Elkton
MSZ246-1	1.0	1	Snowden	Dakota Diamond
MSZ248-01	1.0	1	Snowden	MSV229-2
MSZ248-02	1.0	1	Snowden	MSV229-2
MSZ248-10	1.0	1	Snowden	MSV229-2
MSZ250-1	1.0	1	MSS070-B	McBride
MSZ269-08Y	1.0	1	MSU278-1Y	MSR127-2
MSZ269-12	1.0	1	MSU278-1Y	MSR127-2
MSZ269-17	1.0	1	MSU278-1Y	MSR127-2
MSZ269-18	1.0	1	MSU278-1Y	MSR127-2
MSZ270-1	1.0	1	MSU278-1Y	MSR157-1Y
MSZ274-1	1.0	1	MSU383-1	Kalkaska
MSZ279-1Y	1.0	1	MSV229-2	McBride
MSZ282-6	1.0	1	MSV502-3	Kalkaska
MSZ291-6Y	1.0	1	W2978-3	MSN191-2Y
MSZ296-1	1.0	1	W6609-3	MSR127-2
MSZ302-1	1.0	1	Snowden	Lamoka
MSZ407-2	1.0	1	Montanosa	Colonial Purple
MSZ407-7	1.0	1	Montanosa	Colonial Purple
MSZ413-6P	1.0	1	Colonial Purple	MSU200-5PP
MSZ416-8RY	1.0	1	MSN230-1RY	NDTX4271-5R
MSZ427-10R	1.0	1	MSQ440-2	NDTX4271-5R
MSZ428-1PP	1.0	1	MSQ461-2PP	MSS544-1R
MSZ435-03R	1.0	1	MSS576-05SPL	NDTX4271-5R
MSZ436-1	1.0	1	MSS576-05SPL	MSQ440-2
MSZ437-7RR	1.0	1	MSS576-05SPL	MST406-2RR
MSZ437-9RR	1.0	1	MSS576-05SPL	MST406-2RR
MSZ452-1	1.0	1	Atlantic	Chaposa
MSZ453-1	1.0	1	McBride	Alca Tarma
MSZ462-1R	1.0	1	OG-08-168	MSL211-3
MSZ539-3	1.0	1	MSL211-3	MSL268-D
MSZ551-1	1.0	1	MSM182-1	MSL268-D
MSZ599-1	1.0	1	MST386-1P	NDTX4271-5R
MSZ599-2	1.0	1	MST386-1P	NDTX4271-5R
MSZ609-1P	1.0	1	386056.2	Colonial Purple
MSZ612-3	1.0	1	Basadre	MSQ086-3

Table 8

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSZ618-1	1.0	1	Muziranzara	MSQ440-3
MSZ622-1	1.0	1	Satina	MSL211-3
MSZ702-01	1.0	1	CIP575045	84SD22
MSZ709-03Y	1.0	1	MSM269-HORG	84SD22
MSZ714-1	1.0	1	RH	RH
MSZ744-1	1.0	1	MSM185-1	MSP091-1
MSZ801-035	1.0	1	Atlantic	Atlantic
MSZUNK-6	1.0	1		
MSR159-02	1.5	1	MSL766-1	McBride
MST033-02	1.5	1	Atlantic	MSL211-3
MSV114-2	1.5	1	MSJ316-A	MSQ070-1
MSX035-WP	1.5	1	Beacon Chipper	ARS10091WP
MSY001-4	1.5	1	Boulder	Manistee
MSY008-3	1.5	1	MSP515-2	Manistee
MSY041-1	1.5	1	Dakota Diamond	MSP368-1
MSY209-1	1.5	1	Pike	MSN170-A
MSY483-03	1.5	1	MSL505-3	MSN105-1
MSY491-2Y	1.5	1	MSL183-AY	MSL211-3
MSY520-1	1.5	1	MSQ440-2	MSN105-1
MSY544-5R	1.5	1	Bison	MSS544-1R
MSY557-2Y	1.5	1	Torridon	Silverton Russet
MSY712-2	1.5	1	MSS703-5	84SD22
MSY719-1	1.5	1	MSL316-EY	MSA160-3
MSY728-1	1.5	1	523-3-S7	84SD22
MSZ004-1	1.5	1	Atlantic	MSL211-3
MSZ005-1	1.5	1	Atlantic	Manistee
MSZ006-08	1.5	1	Atlantic	M5
MSZ025-2	1.5	1	Lamoka	M5
MSZ037-1Y	1.5	1	NDU030-1 (NY121)	McBride
MSZ037-5	1.5	1	NDU030-1 (NY121)	McBride
MSZ044-5Y	1.5	1	NYF57-3	McBride
MSZ047-1	1.5	1	MSN148-A	McBride
MSZ051-5	1.5	1	Pike	Chaposa
MSZ063-04	1.5	1	MSR148-4	McBride
MSZ100-4	1.5	1	Boulder	MSV477-5
MSZ105-1	1.5	1	CO95051-7W	Lenape
MSZ105-3	1.5	1	CO95051-7W	Lenape
MSZ107-6PP	1.5	1	COMN07-W112BG1	MSR127-2
MSZ111-1	1.5	1	McBride	Dakota Diamond
MSZ119-1	1.5	1	Kalkaska	M5
MSZ147-04	1.5	1	M5	MSS297-3
MSZ147-09	1.5	1	M5	MSS297-3
MSZ149-6	1.5	1	MSN148-A	MSQ086-3
MSZ159-3	1.5	1	NDU030-1 (NY121)	MSV477-5
MSZ186-2	1.5	1	Pike	M5
MSZ189-3	1.5	1	Pike	MSS297-3
MSZ212-3	1.5	1	MSQ279-1	Kalkaska
MSZ235-4	1.5	1	MSR157-1Y	MSV477-5
MSZ235-7	1.5	1	MSR157-1Y	MSV477-5
MSZ251-1	1.5	1	MSS070-B	Lamoka
MSZ252-1	1.5	1	MSS165-2Y	W6609-3
MSZ263-4	1.5	1	MSU088-1	McBride
MSZ280-7	1.5	1	MSV310-2	M5
MSZ405-1PP	1.5	1	MSM182-1	MSU200-5PP

Table 8

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSZ427-3R	1.5	1	MSQ440-2	NDTX4271-5R
MSZ443-1PP	1.5	1	MSU200-5PP	NDTX4271-5R
MSZ453-4	1.5	1	McBride	Alca Tarma
MSZ454-1	1.5	1	Atlantic	Enfula
MSZ456-2	1.5	1	McBride	Chaposa
MSZ459-5Y	1.5	1	Lamoka	Alca Tarma
MSZ513-2	1.5	1	MSL268-D	MSL211-3
MSZ519-3	1.5	1	MSQ440-2	MSU320-2Y
MSZ533-7	1.5	1	A00ETB12-2	MSL211-3
MSZ537-4	1.5	1	MSL211-3	Chaposa
MSZ553-1	1.5	1	MSM182-1	MSQ176-5
MSZ562-4	1.5	1	Muruta	MSL211-3
MSZ578-1Y	1.5	1	Nicola	Santa Ana
MSZ590-1	1.5	1	Superior	Picasso
MSZ602-2PP	1.5	1	MSU200-5PP	MST406-2RR
MSZ602-7PP	1.5	1	MSU200-5PP	MST406-2RR
MSZ610-1	1.5	1	Chaposa	MSQ176-5
MSZ615-2	1.5	1	Sieglinde	MSL211-3
MSZ616-1	1.5	1	Nicola	MSL211-3
MSZ620-1	1.5	1	Muziranzara	MSL211-3
MSZ709-01Y	1.5	1	MSM269-HORG	84SD22
MSZ739-3	1.5	1	MSL505-3	CO00188-4W
MSZ801-051	1.5	1	Atlantic	Atlantic
MST075-01R	2.0	1	Dakota Jewel	MSL211-3
MSU088-1	2.0	1	MSK061-4	Missaukee
MSW122-12	2.0	1	MSM185-1	MSP085-2
MSW122-3	2.0	1	MSM185-1	MSP085-2
MSX125-5Y	2.0	1		
MSX137-6	2.0	1	Eva	MSL211-3
MSY012-2	2.0	1	MSQ070-1	ND8304-2
MSY071-1	2.0	1	MST220-08	MSR102-3
MSY076-13	2.0	1	MST443-1	B2731-2
MSY111-1	2.0	1	MSQ086-3	McBride
MSY192-2PP	2.0	1	MSQ405-1PP	MSQ461-2PP
MSY193-1	2.0	1	MSQ279-1	B2731-2
MSY452-1	2.0	1	MSQ176-5	MSL211-3
MSY474-08	2.0	1	MSM182-1	Haig Ind 98
MSY480-3RY	2.0	1	MN96013-1RY	MSS544-1R
MSY515-1	2.0	1	Reba	Haig Ind 98
MSZ001-1	2.0	1	1989-86061	Manistee
MSZ003-4	2.0	1	Atlantic	McBride
MSZ007-09	2.0	1	Atlantic	MSQ086-3
MSZ007-10	2.0	1	Atlantic	MSQ086-3
MSZ013-3	2.0	1	CO00188-4W	Atlantic
MSZ017-1	2.0	1	McBride	Lenape
MSZ022-1	2.0	1	Kalkaska	W2310-3
MSZ030-4	2.0	1	M5	MSQ089-1
MSZ034-1	2.0	1	M5	MSU383-1
MSZ037-2Y	2.0	1	NDU030-1 (NY121)	McBride
MSZ037-6	2.0	1	NDU030-1 (NY121)	McBride
MSZ040-1	2.0	1	NDU045-1	MSR036-5
MSZ049-2	2.0	1	MSN251-1Y	Lamoka
MSZ051-1	2.0	1	Pike	Chaposa
MSZ054-2	2.0	1	MSQ070-1	Lenape

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSZ057-3	2.0	1	MSQ070-1	ND8334Cb-3
MSZ063-07Y	2.0	1	MSR148-4	McBride
MSZ076-2Y	2.0	1	W6822-3	McBride
MSZ091-3	2.0	1	Elkton	MSL211-3
MSZ091-4	2.0	1	Elkton	MSL211-3
MSZ097-1	2.0	1	Boulder	Lamoka
MSZ107-4	2.0	1	COMN07-W112BG1	MSR127-2
MSZ124-7	2.0	1	Manistee	MSS297-3
MSZ128-1	2.0	1	Lenape	CO00188-4W
MSZ129-1	2.0	1	Lenape	Kalkaska
MSZ146-1	2.0	1	M5	Manistee
MSZ147-10	2.0	1	M5	MSS297-3
MSZ152-1	2.0	1	ND8307c-3	MSR036-5
MSZ154-1	2.0	1	NDU022-1	MSQ086-3
MSZ157-3	2.0	1	NDU030-1 (NY121)	Missaukee
MSZ210-08	2.0	1	MSQ131-A	MSL211-3
MSZ215-2	2.0	1	MSR058-1	MSQ086-3
MSZ215-7	2.0	1	MSR058-1	MSQ086-3
MSZ245-08	2.0	1	Snowden	Elkton
MSZ253-1Y	2.0	1	Snowden	McBride
MSZ256-1	2.0	1	Snowden	W6609-3
MSZ264-1	2.0	1	MSU128-2	ARS10241-2W
MSZ269-13	2.0	1	MSU278-1Y	MSR127-2
MSZ269-19	2.0	1	MSU278-1Y	MSR127-2
MSZ269-22	2.0	1	MSU278-1Y	MSR127-2
MSZ280-2	2.0	1	MSV310-2	M5
MSZ290-1	2.0	1	W2978-3	Kalkaska
MSZ413-4PP	2.0	1	Colonial Purple	MSU200-5PP
MSZ428-2R	2.0	1	MSQ461-2PP	MSS544-1R
MSZ431-1RY	2.0	1	MSR241-4RY	NDTX4271-5R
MSZ431-5RY	2.0	1	MSR241-4RY	NDTX4271-5R
MSZ433-3P	2.0	1	MSS483-1	MSU200-5PP
MSZ435-09	2.0	1	MSS576-05SPL	NDTX4271-5R
MSZ436-2SPL	2.0	1	MSS576-05SPL	MSQ440-2
MSZ502-1Y	2.0	1	MSI005-20Y	MSQ440-2
MSZ515-1Y	2.0	1	MSM288-2Y	MSU320-2Y
MSZ516-6	2.0	1	Montanosa	MSL211-3
MSZ522-5	2.0	1	MSS070-B	MSS297-3
MSZ533-5	2.0	1	A00ETB12-2	MSL211-3
MSZ537-3	2.0	1	MSL211-3	Chaposa
MSZ547-3	2.0	1	MSL505-3	MSL211-3
MSZ552-2P	2.0	1	MSM182-1	Colonial Purple
MSZ558-1Y	2.0	1	MSM183-1	MSQ086-3
MSZ570-1	2.0	1	ND8331cb-3	MSL211-3
MSZ571-3R	2.0	1	NDTX4271-5R	Colonial Purple
MSZ596-2	2.0	1	MSS483-1	MSQ440-2
MSZ598-2	2.0	1	MSS576-05SPL	Superior
MSZ599-3	2.0	1	MST386-1P	NDTX4271-5R
MSZ602-4PP	2.0	1	MSU200-5PP	MST406-2RR
MSZ610-7	2.0	1	Chaposa	MSQ176-5
MSZ611-2	2.0	1	Perkoz	MSL211-3
MSZ620-3	2.0	1	Muziranzara	MSL211-3
MSZ702-03	2.0	1	CIP575045	84SD22
MSZ702-04	2.0	1	CIP575045	84SD22

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSZ708-6	2.0	1	MSL316-EY	84SD22
MSZ709-04	2.0	1	MSM269-HORG	84SD22
MSZ740-1	2.0	1	MSL505-3	McBride
MSZ801-099	2.0	1	Atlantic	Atlantic
MSZ801-200	2.0	1	Atlantic	Atlantic
MSQ176-5	2.5	1	MSI152-A	Missaukee
MSV284-1	2.5	1	Monserrat	MSP239-1
MSV440-6	2.5	1	MSQ335-2	McBride
MSW068-04	2.5	1	MSK061-4	MSM246-B
MSW092-01	2.5	1	MSL106-AY	Montserrat
MSW286-02	2.5	1	MSP102-5	MSP084-3
MSY256-A1	2.5	1	Kalkaska	Manistee
MSY494-6	2.5	1	Dakota Diamond	MSL211-3
MSY569-1RusY	2.5	1	Torridon	CO99053-3RUS
MSY733-1	2.5	1	MSL316-EY	84SD22
MSZ006-02	2.5	1	Atlantic	M5
MSZ025-5	2.5	1	Lamoka	M5
MSZ030-2	2.5	1	M5	MSQ089-1
MSZ030-3	2.5	1	M5	MSQ089-1
MSZ038-1	2.5	1	NDU030-1 (NY121)	M5
MSZ042-5	2.5	1	ND8331Cb-3	MSQ086-3
MSZ055-3	2.5	1	MSQ070-1	M5
MSZ057-5	2.5	1	MSQ070-1	ND8334Cb-3
MSZ073-1	2.5	1	MSU278-1Y	MSR169-8Y
MSZ074-3	2.5	1	W2978-3	Tundra
MSZ088-04	2.5	1	Atlantic	MSV310-2
MSZ088-05	2.5	1	Atlantic	MSV310-2
MSZ091-6	2.5	1	Elkton	MSL211-3
MSZ109-11PP	2.5	1	COMN07-W112BG1	MSU200-5PP
MSZ125-1	2.5	1	MSL505-3	Manistee
MSZ144-06Y	2.5	1	M5	McBride
MSZ146-4	2.5	1	M5	Manistee
MSZ194-2	2.5	1	MSQ035-3	MSU383-1
MSZ210-06	2.5	1	MSQ131-A	MSL211-3
MSZ235-5	2.5	1	MSR157-1Y	MSV477-5
MSZ245-06	2.5	1	Snowden	Elkton
MSZ269-15	2.5	1	MSU278-1Y	MSR127-3
MSZ300-1	2.5	1	W6822-3	MSU205-4
MSZ407-5P	2.5	1	Montanosa	Colonial Purple
MSZ419-1PY	2.5	1	MSN230-1RY	MSU200-5PP
MSZ421-3PY	2.5	1	ND039036-2R	Colonial Purple
MSZ427-6	2.5	1	MSQ440-2	NDTX4271-5R
MSZ431-4RY	2.5	1	MSR241-4RY	NDTX4271-5R
MSZ439-1PP	2.5	1	MST386-1P	ND039036-2R
MSZ465-1	2.5	1	MSQ279-1	1989-86061
MSZ507-2	2.5	1	MSL211-3	NY121
MSZ509-5	2.5	1	MSL211-3	MSQ086-3
MSZ510-2	2.5	1	MSL211-3	MSQ440-2
MSZ510-4	2.5	1	MSL211-3	MSQ440-2
MSZ518-2	2.5	1	MSP091-1	MSQ440-2
MSZ526-1	2.5	1	Superior	MSL211-3
MSZ526-2	2.5	1	Superior	MSL211-3
MSZ540-2	2.5	1	MSL211-3	Muziranzara
MSZ587-1	2.5	1	MSR241-4RY	MSL211-3

2014 SCAB DISEASE EARLY GENERATION TRIAL SUMMARY
SCAB NURSERY, MONTCALM RESEARCH CENTER , MI

LINE	2014 RATING	2014 N	FEMALE	MALE
Sorted by ascending 2014 Rating;				
MSZ589-2R	2.5	1	Superior	Colonial Purple
MSZ610-3	2.5	1	Chaposa	MSQ176-5
MSZ612-1	2.5	1	Basadre	MSQ086-3
MSZ615-4	2.5	1	Sieglinde	MSL211-3
MSZ620-7	2.5	1	Muziranzara	MSL211-3
MSZ705-3	2.5	1	HS66	BER83
MSZ706-3	2.5	1	J138K6A22	MSV020-2
MSZ722-5	2.5	1	MSM246-B	MSM246-B
Atlantic	2.8	3		
AF4157-06	3.0	1		
MSW360-18	3.0	1	MSR061-1	MSN238-A
MSY077-5	3.0	1	MST220-08	MSR169-8Y
MSZ063-06	3.0	1	MSR148-4	McBride
MSZ100-3	3.0	1	Boulder	MSV477-5
MSZ103-1	3.0	1	CO95051-7W	McBride
MSZ109-01PP	3.0	1	COMN07-W112BG1	MSU200-5PP
MSZ263-1Y	3.0	1	MSU088-1	McBride
MSZ280-3	3.0	1	MSV310-2	M5
MSZ303-1	3.0	1	NYE50-8	Lenape
MSZ457-4	3.0	1	Kalkaska	Alca Tarma
MSZ512-1	3.0	1	MSL211-3	MSV477-5
MSZ613-1	3.0	1	386056.17	MSL211-3
MSZ619-3	3.0	1	Chaposa	MSL211-3
MSZ706-1	3.0	1	J138K6A22	MSV020-2
MSZ706-5	3.0	1	J138K6A22	MSV020-2
B2727-02	3.5	1		
Dubloon	3.5	1		
MSZ409-1R	3.5	1	Muruta	MSR217-1R
MSZ424-1	3.5	1	NY121	MSR217-1R
MSZ457-9	3.5	1	Kalkaska	Alca Tarma
MSZ738-2	3.5	1	MSL316-EY	MSP091-1
MSZ748-1	3.5	1	MSP091-1	MSQ086-3

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

Table 9

2014 MSU LATE BLIGHT VARIETY TRIAL
CLARKSVILLE RESEARCH CENTER, MI

Line Sort:

LINE	N	RAUDPC[1] MEAN	*
AF3362-1Rus	3	34.8	LBS
AF4124-7	3	39.2	LBS
AF4320-7	3	33.8	LBS
Agila	3	37.7	LBS
Alegria	3	35.9	LBS
AO3921-2	3	32.8	LBS
AO6021-T	3	32.7	LBS
ARS102411-2	1	33.2	LBS
Atlantic	3	31.4	LBS
ATX91137-1Rus	3	35.1	LBS
Beacon Chipper	3	30.2	LBS
BNC182-5	3	20.5	LBMS
CO05228-4R	2	40.0	LBS
Dakota Diamond	3	26.0	LBMS
Elkton	3	32.9	LBS
Granola	3	19.2	LBMS
J138K6A22	3	0.5	LBR
Jacqueline Lee	3	0.0	LBR
Lamoka	3	34.1	LBS
MN10003PLWR-02R	3	38.6	LBS
MN10003PLWR-03R	3	40.5	LBS
MN10003PLWR-07R	2	39.9	LBS
MN10013PLWR-04	3	40.2	LBS
MN10020PLWR-04R	3	39.7	LBS
MN10020PLWR-05R	2	39.9	LBS
MSK136-2	3	0.2	LBR
MSL211-3	3	8.2	LBMR
MSM180-3	3	39.6	LBS
MSM270-BY	2	38.5	LBS
MSQ086-3	3	33.1	LBS
MSQ130-4	3	1.2	LBR
MSQ131-A	3	1.1	LBR
MSR061-1	3	11.6	LBMR
MSR186-3P	3	26.8	LBMS
MSS108-1	3	18.7	LBMS
MSS164-1	3	0.0	LBR
MSS176-1	3	1.1	LBR
MSS176-6	3	0.7	LBR
MSS206-2	3	0.0	LBR
MSS428-2	3	1.0	LBR
MSS483-1	3	11.1	LBMR
MSS487-2	3	0.4	LBR
MSS576-5SPL	3	2.7	LBR
MSS810-23	3	0.0	LBR
MST065-1	3	23.6	LBMS
MST145-2	3	0.4	LBR
MST202-5	3	36.4	LBS
MST252-1Y	3	36.8	LBS
MST359-3	3	38.0	LBS
MST443-1	3	37.3	LBS
MST458-4	3	39.6	LBS
MST500-1	3	11.4	LBMR
MSU161-1	3	7.3	LBMR
MSU202-1P	3	35.1	LBS
MSU285-1RUS	3	32.3	LBS
MSU358-2	3	38.6	LBS
MSV093-1	3	33.7	LBS

RAUDPC Sort:

LINE	N	RAUDPC[1] MEAN	*	Female	Male
MSS164-1	3	0.0	LBR	MSM188-1	Missaukee
MSS206-2	3	0.0	LBR	UEC	Missaukee
MSS810-23	3	0.0	LBR	Jacqueline Lee	MCR1-205
VSB16LBR8	3	0.0	LBR		
Jacqueline Lee	3	0.0	LBR	Tollocan	Chaleur
VSB2186F-302-8	3	0.1	LBR		
QSMSU10-02	3	0.1	LBR	MSN106-2	MSL211-3
MSK136-2	3	0.2	LBR	Greta	B0718-3
MSS487-2	3	0.4	LBR	Stirling	Missaukee
MST145-2	3	0.4	LBR	MSI152-A	MSL211-3
J138K6A22	3	0.5	LBR		
MSS176-6	3	0.7	LBR	ND5822C-7	MSL211-3
MSS428-2	3	1.0	LBR	Snowden	NY121
MSQ131-A	3	1.1	LBR	MSF373-8	Missaukee
MSS176-1	3	1.1	LBR	ND5822C-7	MSL211-3
MSQ130-4	3	1.2	LBR	MSF373-8	MSJ456-4Y
MSS576-5SPL	3	2.7	LBR	MSI005-20Y	MSL211-3
MSV235-2PY	3	2.7	LBR	Malinche	Colonial Purple
MSV396-4Y	3	6.3	LBMR	MSQ070-1	McBride
MSU161-1	3	7.3	LBMR	MSM182-1	MSL211-3
MSV440-6	3	7.6	LBMR	MSQ335-2	McBride
NY148	3	8.1	LBMR		
MSL211-3	3	8.2	LBMR	MSG301-9	MSG274-3
MSV114-2	2	8.4	LBMR	MSJ316-A	MSQ070-1
MSV111-1	3	10.7	LBMR	MSJ316-A	MSN105-1
MSS483-1	3	11.1	LBMR	MSM171-A	Missaukee
MST500-1	3	11.4	LBMR	Stirling	Boulder
MSR061-1	3	11.6	LBMR	W1201	NY121
Olalla	2	14.7	LBMR		
MSS108-1	3	18.7	LBMS	McBride	Stirling
Granola	3	19.2	LBMS		
BNC182-5	3	20.5	LBMS		
NY154	3	23.1	LBMS		
MST065-1	3	23.6	LBMS	Boulder	MSL211-3
Dakota Diamond	3	26.0	LBMS		
MSW128-2	2	26.2	LBMS	MSM171-A	MSQ176-5
MSV482-6	2	26.7	LBMS	Rosilin Eburu	MSP239-1
MSR186-3P	3	26.8	LBMS	MN19525R	MSK034-1
NY152	3	28.1	LBMS		
Beacon Chipper	3	30.2	LBS		
W8152-1Rus	3	30.3	LBS		
W6703-1Y	3	30.4	LBS		
W5955-1	3	31.1	LBS		
Atlantic	3	31.4	LBS		
Smiley	3	31.8	LBS		
MSV380-1	3	31.8	LBS	Pike	McBride
MSU285-1RUS	3	32.3	LBS	TXDH99-1RU	Silverton Russet
W9433-1Rus	3	32.4	LBS		
AO6021-T	3	32.7	LBS		
MSX324-1P	3	32.7	LBS	MSN105-1	Colonial Purple
AO3921-2	3	32.8	LBS		
Elkton	3	32.9	LBS		
MSQ086-3	3	33.1	LBS	Onaway	Missaukee
ARS102411-2	1	33.2	LBS		
Silverton Russet	2	33.2	LBS		
MSV093-1	3	33.7	LBS	McBride	MSP408-14Y
QSMSU10-15	3	33.7	LBS	MSN106-2	MSL211-3

2014 MSU LATE BLIGHT VARIETY TRIAL
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Line Sort:				***RAUDPC Sort:***					
		RAUDPC[1]				RAUDPC[1]			
LINE	N	MEAN	*	LINE	N	MEAN	*	Female	Male
MSV111-1	3	10.7	LBMR	AF4320-7	3	33.8	LBS		
MSV114-2	2	8.4	LBMR	NYWJ15-7	3	34.1	LBS		
MSV235-2PY	3	2.7	LBR	Lamoka	3	34.1	LBS		
MSV380-1	3	31.8	LBS	MSX125-5Y	3	34.2	LBS		
MSV383-B	2	37.0	LBS	Pike	3	34.3	LBS		
MSV396-4Y	3	6.3	LBMR	AF3362-1Rus	3	34.8	LBS		
MSV407-2	3	36.8	LBS	MSU202-1P	3	35.1	LBS	Colonial Purple	MSL211-3
MSV440-6	3	7.6	LBMR	MSV507-020	3	35.1	LBS	Tundra	Kalkaska
MSV482-6	2	26.7	LBMS	ATX91137-1Rus	3	35.1	LBS		
MSV505-2	3	39.7	LBS	W6822-3	3	35.2	LBS		
MSV507-020	3	35.1	LBS	Snowden	3	35.4	LBS		
MSV507-052	3	38.3	LBS	MSX035-WP	2	35.7	LBS	Beacon Chipper	ARS10091WP
MSW128-2	2	26.2	LBMS	Alegria	3	35.9	LBS		
MSX007-4RR	3	38.9	LBS	MST202-5	3	36.4	LBS	MSJ147-1	McBride
MSX035-WP	2	35.7	LBS	MST252-1Y	3	36.8	LBS	MSL024-AY	MSL211-3
MSX125-5Y	3	34.2	LBS	MSV407-2	3	36.8	LBS	MSQ070-1	MSP239-1
MSX137-6	3	38.3	LBS	MSV383-B	2	37.0	LBS	Pike	MSN238-A
MSX324-1P	3	32.7	LBS	MST443-1	3	37.3	LBS	MSM070-1	OP
NY148	3	8.1	LBMR	Russet Norkotah	6	37.5	LBS		
NY152	3	28.1	LBMS	Agila	3	37.7	LBS		
NY154	3	23.1	LBMS	QSMSU08-04	3	37.9	LBS	MSM037-3	MSL211-3
NYWJ15-7	3	34.1	LBS	MST359-3	3	38.0	LBS	MSM185-1	Missaukee
Olalla	2	14.7	LBMR	W9133-1Rus	3	38.0	LBS		
Onaway	3	40.3	LBS	Sebec	3	38.2	LBS		
Pike	3	34.3	LBS	MSX137-6	3	38.3	LBS	Eva	MSL211-3
Purple Haze	3	38.9	LBS	MSV507-052	3	38.3	LBS	Tundra	Kalkaska
QSMSU01-10	3	39.1	LBS	Red LaSoda	3	38.5	LBS		
QSMSU08-04	3	37.9	LBS	MSM270-BY	2	38.5	LBS	84SD22	W5337.3
QSMSU10-02	3	0.1	LBR	MN10003PLWR-02R	3	38.6	LBS		
QSMSU10-15	3	33.7	LBS	W6609-3	3	38.6	LBS		
Reba	3	40.4	LBS	MSU358-2	3	38.6	LBS	MSN170-A	W4013-3
Red LaSoda	3	38.5	LBS	MSX007-4RR	3	38.9	LBS	ARS10117RR	Raspberry
Red Norland	4	40.3	LBS	Purple Haze	3	38.9	LBS		
Russet Norkotah	6	37.5	LBS	QSMSU01-10	3	39.1	LBS	Beacon Chipper	MSJ147-1
Sebec	3	38.2	LBS	AF4124-7	3	39.2	LBS		
Silverton Russet	2	33.2	LBS	MSM180-3	3	39.6	LBS	Stirling	MSH098-2
Smiley	3	31.8	LBS	Yukon Gold	6	39.6	LBS		
Snowden	3	35.4	LBS	MST458-4	3	39.6	LBS	Pike	Missaukee
VSB16LBR8	3	0.0	LBR	MSV505-2	3	39.7	LBS	Tundra	Missaukee
VSB2186F-302-8	3	0.1	LBR	MN10020PLWR-04R	3	39.7	LBS		
W5955-1	3	31.1	LBS	MN10003PLWR-07R	2	39.9	LBS		
W6609-3	3	38.6	LBS	MN10020PLWR-05R	2	39.9	LBS		
W6703-1Y	3	30.4	LBS	CO05228-4R	2	40.0	LBS		
W6822-3	3	35.2	LBS	MN10013PLWR-04	3	40.2	LBS		
W8152-1Rus	3	30.3	LBS	Red Norland	4	40.3	LBS		
W9133-1Rus	3	38.0	LBS	Onaway	3	40.3	LBS		
W9433-1Rus	3	32.4	LBS	Reba	3	40.4	LBS		
Yukon Gold	6	39.6	LBS	MN10003PLWR-03R	3	40.5	LBS		
$HSD_{0.05}$		15.0				15.0			

[1]Ratings indicate the average plot RAUDPC (Relative Area Under the Disease Progress Curve).

*LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible

LB Isolate used: US-23

2014 LATE BLIGHT EARLY GENERATION TRIALS
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Line Sort:				***RAUDPC Sort:***					
LINE	N	RAUDPC[1] MEAN	*	LINE	N	RAUDPC[1] MEAN	*	Female	Male
2XLB-17	1	0.0	LBR	2XLB-17	1	0.0	LBR		
2XLB-60	1	2.6	LBR	Missaukee	1	0.0	LBR	NY88	Tollocan
Barbara	1	20.0	LBMS	MSQ176-5	1	0.0	LBR	MSI152-A	Missaukee
Chiloe Ancud	1	24.4	LBMS	MSQ440-2	1	0.0	LBR	MSK214-1R	Missaukee
Loman	1	6.9	LBR	MSS810-23	1	0.0	LBR	Jacqueline Lee	MCR1-205
LT-7	1	33.3	LBS	MST235-5SPL	1	0.0	LBR	MSK128-A	MSN188-1
Missaukee	1	0.0	LBR	MSU016-2	1	0.0	LBR	Boulder	MSN105-1
MSBB699-27	1	21.5	LBMS	MSV235-2PY	1	0.0	LBR	Malinche	Colonial Purple
MSP497-1	1	1.0	LBR	MSV282-4Y	1	0.0	LBR	Monserrat	MSN105-1
MSQ086-3	1	33.2	LBS	MSV284-1	1	0.0	LBR	Monserrat	MSP239-1
MSQ176-5	1	0.0	LBR	MSV482-6	1	0.0	LBR	Rosilin Eburu	MSP239-1
MSQ440-2	1	0.0	LBR	MSW092-1	1	0.0	LBR	MSL106-AY	Montserrat
MSR058-1	1	9.2	LBMR	MSW151-5	1	0.0	LBR	Montanosa	MSL211-3
MSS165-2Y	1	24.9	LBMS	MSW464-3	1	0.0	LBR	MSM246-B	MSR102-3
MSS428-1	1	22.7	LBMS	MSX293-1Y	1	0.0	LBR	MSM288-2Y	MSQ176-5
MSS805-08	1	4.2	LBR	MSY437-1Y	1	0.0	LBR	Torridon	MSQ440-2
MSS810-23	1	0.0	LBR	MSZ057-3	1	0.0	LBR	MSQ070-1	ND8334Cb-3
MST075-1R	1	39.9	LBS	MSZ263-4	1	0.0	LBR	MSU088-1	McBride
MST148-3	1	2.5	LBR	MSZ427-10R	1	0.0	LBR	MSQ440-2	NDTX4271-5R
MST235-5SPL	1	0.0	LBR	MSZ510-2	1	0.0	LBR	MSL211-3	MSQ440-2
MST306-1	1	6.3	LBR	MSZ512-1	1	0.0	LBR	MSL211-3	MSV477-5
MST359-3	1	38.6	LBS	MSZ537-4	1	0.0	LBR	MSL211-3	Chaposa
MST412-3	1	0.4	LBR	MSZ551-1	1	0.0	LBR	MSM182-1	MSL268-D
MSU016-2	1	0.0	LBR	MSZ562-4	1	0.0	LBR	Muruta	MSL211-3
MSU198-01SPL	1	18.9	LBMS	MSZ570-1	1	0.0	LBR	ND8331cb-3	MSL211-3
MSU245-1	1	13.0	LBMR	MSZ609-1P	1	0.0	LBR	386056.17	Colonial Purple
MSU379-01	1	39.9	LBS	MSZ620-7	1	0.0	LBR	Muziranzara	MSL211-3
MSV114-2	1	6.7	LBR	MSZ705-3	1	0.0	LBR	HS66	BER83
MSV117-1	1	22.3	LBMS	MSZ706-1	1	0.0	LBR	J138K6A22	MSV020-2
MSV165-1	1	31.2	LBS	MSZ706-3	1	0.0	LBR	J138K6A22	MSV020-2
MSV177-1	1	38.8	LBS	MSZ100-3	1	0.1	LBR	Boulder	MSV477-5
MSV186-1	1	0.2	LBR	MSZ610-3	1	0.2	LBR	Chaposa	MSQ176-5
MSV235-2PY	1	0.0	LBR	MSV186-1	1	0.2	LBR	LBR9	Colonial Purple
MSV282-4Y	1	0.0	LBR	MSZ436-2SPL	1	0.2	LBR	MSS576-05SPL	MSQ440-2
MSV284-1	1	0.0	LBR	MSZ578-1Y	1	0.2	LBR	Nicola	Santa Ana
MSV301-02	1	38.9	LBS	MST412-3	1	0.4	LBR	MSN105-1	MSM051-3
MSV394-3	1	27.1	LBS	MSZ199-1	1	0.4	LBR	MSQ070-1	Kalkaska
MSV397-2	1	28.6	LBS	MSZ510-4	1	0.4	LBR	MSL211-3	MSQ440-2
MSV407-2	1	34.6	LBS	MSZ513-2	1	0.4	LBR	MSL268-D	MSL211-3
MSV482-6	1	0.0	LBR	MSZ616-1	1	0.4	LBR	Nicola	MSL211-3
MSV498-1	1	36.2	LBS	MSZ409-1R	1	0.4	LBR	Muruta	MSR217-1R
MSV507-10	1	26.0	LBS	MSZ537-3	1	0.4	LBR	MSL211-3	Chaposa
MSW027-1	1	24.2	LBMS	MSZ702-04	1	0.4	LBR	CIP575045	84SD22
MSW092-1	1	0.0	LBR	MSZ091-3	1	0.4	LBR	B1992-106	MSL211-3
MSW100-1	1	2.9	LBR	MSZ553-1	1	0.5	LBR	MSM182-1	MSQ176-5
MSW111-1	1	22.1	LBMS	MSZ250-1	1	0.6	LBR	MSS070-B	McBride
MSW119-2	1	7.3	LBR	MSZ419-1PY	1	0.6	LBR	MSN230-1RY	MSU200-5PP
MSW140-3	1	28.0	LBS	MSZ620-1	1	0.6	LBR	Muziranzara	MSL211-3
MSW151-5	1	0.0	LBR	MSP497-1	1	1.0	LBR	MSJ456-4	NY120
MSW163-3	1	37.8	LBS	MSZ610-7	1	1.3	LBR	Chaposa	MSQ176-5
MSW164-2	1	40.5	LBS	MSX198-5	1	1.3	LBR	Missaukee	OP
MSW229-1P	1	33.5	LBS	MSZ519-3	1	1.4	LBR	MSQ440-2	MSU320-2Y
MSW237-4Y	1	26.5	LBS	MSY515-1	1	1.7	LBR	Reba	Haig Ind 98
MSW242-5Y	1	5.2	LBR	MSZ210-08	1	1.9	LBR	MSQ131-A	MSL211-3
MSW324-01	1	2.3	LBR	MSZ454-1	1	1.9	LBR	Atlantic	Enfula
MSW326-6	1	35.7	LBS	MSZ702-01	1	2.0	LBR	CIP575045	84SD22
MSW343-2R	1	19.0	LBMS	MSZ157-3	1	2.1	LBR	NDU030-1 (NY121)	Missaukee
MSW437-9	1	27.7	LBS	MSW324-01	1	2.3	LBR	MSQ070-1	Marcy
MSW453-1P	1	8.3	LBMR	MST148-3	1	2.5	LBR	MSI152-A	Yukon Gold
MSW464-3	1	0.0	LBR	2XLB-60	1	2.6	LBR		
MSW474-01	1	23.2	LBMS	MSW100-1	1	2.9	LBR	LBR9	MSP292-7
MSW537-6	1	24.9	LBMS	MSZ547-3	1	3.3	LBR	MSL505-3	MSL211-3
MSW569-2	1	11.4	LBMR	MSY507-2	1	3.5	LBR	Superior	MSL211-3
MSX001-4WP	1	40.5	LBS	MSZ004-1	1	3.8	LBR	Atlantic	MSL211-3
MSX011-4	1	37.3	LBS	MSZ057-5	1	3.8	LBR	MSQ070-1	ND8334Cb-3

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Line Sort:

LINE	N	RAUDPC[1] MEAN	*
MSX148-1WP	1	18.0	LBMS
MSX194-3	1	11.3	LBMR
MSX196-1	1	11.1	LBMR
MSX198-5	1	1.3	LBR
MSX293-1Y	1	0.0	LBR
MSX351-3P	1	32.4	LBS
MSX469-2	1	24.6	LBMS
MSX517-5Y	1	28.8	LBS
MSX526-1	1	32.2	LBS
MSX526-1	1	38.6	LBS
MSY012-2	1	8.3	LBMR
MSY071-1	1	4.6	LBR
MSY089-2	1	35.9	LBS
MSY169-4	1	13.4	LBMR
MSY437-1Y	1	0.0	LBR
MSY452-1	1	4.2	LBR
MSY468-16	1	7.5	LBR
MSY474-08	1	5.1	LBR
MSY491-2Y	1	4.2	LBR
MSY494-6	1	40.5	LBS
MSY507-2	1	3.5	LBR
MSY515-1	1	1.7	LBR
MSY520-1	1	8.3	LBMR
MSY557-2Y	1	23.6	LBMS
MSY569-1RusY	1	20.8	LBMS
MSY713-1	1	40.1	LBS
MSY728-1	1	39.5	LBS
MSZ001-1	1	24.1	LBMS
MSZ004-1	1	3.8	LBR
MSZ007-09	1	37.5	LBS
MSZ007-10	1	37.9	LBS
MSZ037-1Y	1	38.6	LBS
MSZ037-2Y	1	38.3	LBS
MSZ037-5	1	25.6	LBS
MSZ037-6	1	36.5	LBS
MSZ038-1	1	33.3	LBS
MSZ040-1	1	23.6	LBMS
MSZ042-5	1	13.3	LBMR
MSZ049-2	1	25.0	LBS
MSZ051-1	1	24.2	LBMS
MSZ051-5	1	31.5	LBS
MSZ055-3	1	22.1	LBMS
MSZ057-3	1	0.0	LBR
MSZ057-5	1	3.8	LBR
MSZ073-1	1	31.3	LBS
MSZ073-2Y	1	38.4	LBS
MSZ091-3	1	0.4	LBR
MSZ091-4	1	37.5	LBS
MSZ091-6	1	32.9	LBS
MSZ092-2	1	40.5	LBS
MSZ100-1	1	24.1	LBMS
MSZ100-3	1	0.1	LBR
MSZ100-4	1	35.0	LBS
MSZ149-6	1	36.0	LBS
MSZ152-1	1	27.3	LBS
MSZ154-1	1	10.0	LBMR
MSZ157-3	1	2.1	LBR
MSZ159-3	1	22.8	LBMS
MSZ199-1	1	0.4	LBR
MSZ200-3	1	20.2	LBMS
MSZ204-1P	1	9.0	LBMR
MSZ205-1	1	24.8	LBMS
MSZ210-08	1	1.9	LBR
MSZ210-6	1	6.7	LBR
MSZ215-2	1	11.0	LBMR
MSZ215-7	1	6.3	LBR
MSZ216-4	1	15.5	LBMR

RAUDPC Sort:

LINE	N	RAUDPC[1] MEAN	*	Female	Male
MSZ251-1	1	3.8	LBR	MSS070-B	Lamoka
MSZ611-2	1	3.8	LBR	Perkoz	MSL211-3
MSZ706-5	1	3.8	LBR	J138K6A22	MSV020-2
VSB2186F-302-8	1	3.8	LBR		
MSZ613-1	1	3.9	LBR	386056.17	MSL211-3
MSS805-08	1	4.2	LBR	Atlantic	MCR1-150
MSY491-2Y	1	4.2	LBR	MSL183-AY	MSL211-3
VSB16LBR8	1	4.2	LBR		
MSY452-1	1	4.2	LBR	MSQ176-5	MSL211-3
MSY071-1	1	4.6	LBR	MST220-08	MSR102-3
MSY474-08	1	5.1	LBR	MSM182-1	Haig Ind 98
MSW242-5Y	1	5.2	LBR	NY121	Malinche
MSZ552-2P	1	5.3	LBR	MSM182-1	Colonial Purple
MST306-1	1	6.3	LBR	Liberator	Missaukee
MSZ424-1	1	6.3	LBR	NY121	MSR217-1R
MSZ215-7	1	6.3	LBR	MSR058-1	MSQ086-3
Stirling	1	6.3	LBR		
MSZ620-3	1	6.4	LBR	Muziranzara	MSL211-3
MSV114-2	1	6.7	LBR	MSJ316-A	MSQ070-1
MSZ210-6	1	6.7	LBR	MSQ131-A	MSL211-3
Loman	1	6.9	LBR		
MSW119-2	1	7.3	LBR	MSM171-A	MSR036-5
MSZ612-1	1	7.3	LBR	Basadre	MSQ086-3
MSY468-16	1	7.5	LBR	NYL235-4	MSL211-3
NY121	1	7.9	LBR		
MSZ464-3	1	8.1	LBMR	MSQ070-1	Alca Tarma
MSW453-1P	1	8.3	LBMR	Kenya Baraka	Colonial Purple
MSY012-2	1	8.3	LBMR	MSQ070-1	ND8304-2
MSY520-1	1	8.3	LBMR	MSQ440-2	MSN105-1
MSZ204-1P	1	9.0	LBMR	MSQ070-1	MSU200-5PP
MSR058-1	1	9.2	LBMR	W1201	MSJ319-1
MSZ433-3P	1	9.2	LBMR	MSS483-1	MSU200-5PP
MSZ612-3	1	9.4	LBMR	Basadre	MSQ086-3
MSZ154-1	1	10.0	LBMR	NDU022-1	MSQ086-3
MSZ215-2	1	11.0	LBMR	MSR058-1	MSQ086-3
MSX196-1	1	11.1	LBMR	Missaukee	Manistee
MSX194-3	1	11.3	LBMR	Missaukee	C095051-7W
MSW569-2	1	11.4	LBMR	MSI152-A	McBride
MSZ515-1Y	1	12.4	LBMR	MSM288-2Y	MSU320-2Y
MSZ708-6	1	12.7	LBMR	MSL316-EY	84SD22
MSU245-1	1	13.0	LBMR	NY132	MSP542-4
MSZ042-5	1	13.3	LBMR	ND8331Cb-3	MSQ086-3
MSY169-4	1	13.4	LBMR	Boulder	MSR102-3
MSZ218-5	1	14.0	LBMR	MSR061-1	MSQ086-3
MSZ220-01	1	15.3	LBMR	MSR061-1	MSS297-3
MSZ216-4	1	15.5	LBMR	MSR058-1	MSS297-3
MSZ436-1	1	16.0	LBMR	MSS576-05SPL	MSQ440-2
Olalla	1	16.7	LBMR		
MSX148-1WP	1	18.0	LBMS	MSH228-6	ARS10091WP
MSZ407-7	1	18.4	LBMS	Montanosa	Colonial Purple
MSZ453-4	1	18.5	LBMS	McBride	Alca Tarma
MSU198-01SPL	1	18.9	LBMS	MSN111-4PP	MSN105-1
MSW343-2R	1	19.0	LBMS	MSQ440-2	NDTX4271-5R
MSZ407-2	1	19.0	LBMS	Montanosa	Colonial Purple
MSZ300-1	1	19.9	LBMS	W6822-3	MSU205-4
Barbara	1	20.0	LBMS		
MSZ200-3	1	20.2	LBMS	MSQ070-1	Lamoka
MSZ453-1	1	20.6	LBMS	McBride	Alca Tarma
MSY569-1RusY	1	20.8	LBMS	Torridon	CO99053-3RUS
MSZ702-03	1	21.1	LBMS	CIP575045	84SD22
MSBB699-27	1	21.5	LBMS	MSV507-121	MSV507-009 (099)
MSZ748-1	1	21.8	LBMS	MSP091-1	MSQ086-3
MSW111-1	1	22.1	LBMS	MSL505-3	MSR061-1
MSZ055-3	1	22.1	LBMS	MSQ070-1	M5
MSV117-1	1	22.3	LBMS	Missaukee	MSH228-6
MSS428-1	1	22.7	LBMS	Snowden	NY121
MSZ522-5	1	22.7	LBMS	MSS070-B	MSS297-3

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2014 LATE BLIGHT EARLY GENERATION TRIALS
CLARKSVILLE RESEARCH CENTER, MI

Line Sort:				*RAUDPC Sort:*					
LINE	N	RAUDPC[1] MEAN	*	LINE	N	RAUDPC[1] MEAN	*	Female	Male
MSZ218-5	1	14.0	LBMR	MSZ159-3	1	22.8	LBMS	NDU030-1 (NY121)	MSV477-5
MSZ220-01	1	15.3	LBMR	MSZ427-1R	1	22.9	LBMS	MSQ440-2	NDTX4271-5R
MSZ235-4	1	36.0	LBS	MSW474-01	1	23.2	LBMS	MSN190-2	MSP516-A
MSZ235-5	1	38.4	LBS	MSY557-2Y	1	23.6	LBMS	Torridon	Silverton Russet
MSZ235-7	1	26.1	LBS	MSZ040-1	1	23.6	LBMS	NDU045-1	MSR036-5
MSZ250-1	1	0.6	LBR	MSZ001-1	1	24.1	LBMS	1989-86061	Manistee
MSZ251-1	1	3.8	LBR	MSZ100-1	1	24.1	LBMS	Boulder	MSV477-5
MSZ263-1Y	1	36.5	LBS	MSZ452-1	1	24.1	LBMS	Atlantic	Chaposa
MSZ263-4	1	0.0	LBR	MSW027-1	1	24.2	LBMS	Eva	MSQ176-5
MSZ264-1	1	35.1	LBS	MSZ051-1	1	24.2	LBMS	Pike	Chaposa
MSZ267-4	1	29.7	LBS	MSZ610-1	1	24.3	LBMS	Chaposa	MSQ176-5
MSZ268-1	1	31.5	LBS	MSZ456-2	1	24.4	LBMS	McBride	Chaposa
MSZ269-08Y	1	27.3	LBS	Chiloe Ancud	1	24.4	LBMS		
MSZ269-12	1	32.6	LBS	MSX469-2	1	24.6	LBMS	MSQ070-1	OP
MSZ269-13	1	35.6	LBS	MSZ205-1	1	24.8	LBMS	MSQ070-1	MSU383-A
MSZ269-15	1	38.4	LBS	MSS165-2Y	1	24.9	LBMS	MSM188-1	MSL159-AY
MSZ269-17	1	32.6	LBS	MSW537-6	1	24.9	LBMS	MSM070-1	MSP516-A
MSZ269-18	1	36.5	LBS	MSZ049-2	1	25.0	LBS	MSN251-1Y	Lamoka
MSZ269-19	1	35.5	LBS	MSZ037-5	1	25.6	LBS	NDU030-1 (NY121)	McBride
MSZ269-22	1	34.9	LBS	MSV507-10	1	26.0	LBS	Tundra	Kalkaska
MSZ270-1	1	38.6	LBS	MSZ235-7	1	26.1	LBS	MSR157-1Y	MSV477-5
MSZ300-1	1	19.9	LBMS	MSZ509-5	1	26.3	LBS	MSL211-3	MSQ086-3
MSZ405-1PP	1	35.9	LBS	MSW237-4Y	1	26.5	LBS	Montserrat	MSN191-2Y
MSZ407-2	1	19.0	LBMS	MSZ507-2	1	26.9	LBS	MSL211-3	NY121
MSZ407-5P	1	36.5	LBS	MSV394-3	1	27.1	LBS	MSQ070-1	MSH228-6
MSZ407-7	1	18.4	LBMS	MSZ152-1	1	27.3	LBS	ND8307c-3	MSR036-5
MSZ409-1R	1	0.4	LBR	MSZ269-08Y	1	27.3	LBS	MSU278-1Y	MSR127-2
MSZ414-1	1	39.9	LBS	MSW437-9	1	27.7	LBS	Boulder	MSR036-5
MSZ416-8RY	1	39.4	LBS	MSW140-3	1	28.0	LBS	MegaChip	Missaukee
MSZ419-1PY	1	0.6	LBR	MSV397-2	1	28.6	LBS	MSQ070-1	MSJ147-1
MSZ424-1	1	6.3	LBR	MSX517-5Y	1	28.8	LBS	Spartan Splash	MSQ176-5
MSZ427-10R	1	0.0	LBR	MSZ267-4	1	29.7	LBS	MSU278-1Y	Kalkaska
MSZ427-1R	1	22.9	LBMS	MSZ459-5Y	1	29.9	LBS	Lamoka	Alca Tarma
MSZ427-3R	1	39.4	LBS	MSZ615-2	1	30.3	LBS	Sieglinde	MSL211-3
MSZ427-6	1	37.5	LBS	PVYR Red Marker #1	1	30.9	LBS		
MSZ433-3P	1	9.2	LBMR	MSV165-1	1	31.2	LBS	Kufri Jeevan	MSL211-3
MSZ436-1	1	16.0	LBMR	MSZ073-1	1	31.3	LBS	MSU278-1Y	MSR169-8Y
MSZ436-2SPL	1	0.2	LBR	MSZ268-1	1	31.5	LBS	MSU278-1Y	Pike
MSZ452-1	1	24.1	LBMS	MSZ051-5	1	31.5	LBS	Pike	Chaposa
MSZ453-1	1	20.6	LBMS	MSX526-1	1	32.2	LBS	MSR036-5	Lamoka
MSZ453-4	1	18.5	LBMS	MSZ526-1	1	32.2	LBS	Superior	MSL211-3
MSZ454-1	1	1.9	LBR	MSX351-3P	1	32.4	LBS	Colonial Purple	MSL211-3
MSZ456-2	1	24.4	LBMS	MSZ269-12	1	32.6	LBS	MSU278-1Y	MSR127-2
MSZ459-5Y	1	29.9	LBS	MSZ269-17	1	32.6	LBS	MSU278-1Y	MSR127-2
MSZ462-1R	1	39.1	LBS	MSZ091-6	1	32.9	LBS	Elkton	MSL211-3
MSZ464-3	1	8.1	LBMR	MSQ086-3	1	33.2	LBS	Onaway	Missaukee
MSZ502-1Y	1	40.5	LBS	MSZ038-1	1	33.3	LBS	NDU030-1	M5
MSZ507-2	1	26.9	LBS	LT-7	1	33.3	LBS		
MSZ509-5	1	26.3	LBS	MSW229-1P	1	33.5	LBS	MI Purple	MSN105-1
MSZ510-2	1	0.0	LBR	MSZ615-4	1	34.3	LBS	Sieglinde	MSL211-3
MSZ510-4	1	0.4	LBR	MSV407-2	1	34.6	LBS	MSQ070-1	MSP239-1
MSZ512-1	1	0.0	LBR	MSZ269-22	1	34.9	LBS	MSU278-1Y	MSR127-2
MSZ513-2	1	0.4	LBR	MSZ100-4	1	35.0	LBS	Boulder	MSV477-5
MSZ515-1Y	1	12.4	LBMR	MSZ264-1	1	35.1	LBS	MSU128-2	ARS10241-2W
MSZ516-6	1	37.1	LBS	MSZ269-19	1	35.5	LBS	MSU278-1Y	MSR127-2
MSZ518-2	1	39.5	LBS	MSZ539-3	1	35.5	LBS	MSL211-3	MSL268-D
MSZ519-3	1	1.4	LBR	MSZ269-13	1	35.6	LBS	MSU278-1Y	MSR127-2
MSZ522-5	1	22.7	LBMS	MSW326-6	1	35.7	LBS	MSQ070-1	MSN190-2
MSZ526-1	1	32.2	LBS	MSZ405-1PP	1	35.9	LBS	MSM182-1	MSU200-5PP
MSZ526-2	1	39.8	LBS	MSY089-2	1	35.9	LBS	MSS176-1	B2731-2
MSZ533-5	1	39.4	LBS	MSZ149-6	1	36.0	LBS	MSN148-A	MSQ086-3
MSZ533-7	1	38.6	LBS	MSZ235-4	1	36.0	LBS	MSR157-1Y	MSV477-5
MSZ537-3	1	0.4	LBR	MSV498-1	1	36.2	LBS	Snowden	MSQ283-2
MSZ537-4	1	0.0	LBR	MSZ037-6	1	36.5	LBS	NDU030-1 (NY121)	McBride
MSZ539-3	1	35.5	LBS	MSZ263-1Y	1	36.5	LBS	MSU088-1	McBride
MSZ540-2	1	36.5	LBS	MSZ269-18	1	36.5	LBS	MSU278-1Y	MSR127-2
MSZ547-3	1	3.3	LBR	MSZ407-5P	1	36.5	LBS	Montanosa	Colonial Purple

2014 LATE BLIGHT EARLY GENERATION TRIALS
CLARKSVILLE RESEARCH CENTER, MI

Line Sort:				*RAUDPC Sort:*					
		RAUDPC[1]				RAUDPC[1]			
LINE	N	MEAN	*	LINE	N	MEAN	*	Female	Male
MSZ551-1	1	0.0	LBR	MSZ540-2	1	36.5	LBS	MSL211-3	Muziranzara
MSZ552-2P	1	5.3	LBR	MSZ738-2	1	36.5	LBS	MSL316-EY	MSP091-1
MSZ553-1	1	0.5	LBR	MSZ516-6	1	37.1	LBS	Montanosa	MSL211-3
MSZ558-1Y	1	38.6	LBS	MSX011-4	1	37.3	LBS	ARS10241-2	MSN105-1
MSZ562-4	1	0.0	LBR	MSZ007-09	1	37.5	LBS	Atlantic	MSQ086-3
MSZ570-1	1	0.0	LBR	MSZ427-6	1	37.5	LBS	MSQ440-2	NDTX4271-5R
MSZ578-1Y	1	0.2	LBR	MSZ091-4	1	37.5	LBS	Elkton	MSL211-3
MSZ587-1	1	40.5	LBS	MSW163-3	1	37.8	LBS	Atlantic	MSR036-5
MSZ596-2	1	40.3	LBS	MSZ007-10	1	37.9	LBS	Atlantic	MSQ086-3
MSZ609-1P	1	0.0	LBR	MSZ618-1	1	37.9	LBS	Muziranzara	MSQ440-3
MSZ610-1	1	24.3	LBMS	MSZ619-3	1	38.2	LBS	Chaposa	MSL211-3
MSZ610-3	1	0.2	LBR	MSZ037-2Y	1	38.3	LBS	NDU030-1 (NY121)	McBride
MSZ610-7	1	1.3	LBR	MSZ073-2Y	1	38.4	LBS	MSU278-1Y	MSR169-8Y
MSZ611-2	1	3.8	LBR	MSZ235-5	1	38.4	LBS	MSR157-1Y	MSV477-5
MSZ612-1	1	7.3	LBR	MSZ269-15	1	38.4	LBS	MSU278-1Y	MSR127-3
MSZ612-3	1	9.4	LBMR	MST359-3	1	38.6	LBS	MSM185-1	Missaukee
MSZ613-1	1	3.9	LBR	MSX526-1	1	38.6	LBS	MSR036-5	Lamoka
MSZ615-2	1	30.3	LBS	MSZ037-1Y	1	38.6	LBS	NDU030-1 (NY121)	McBride
MSZ615-4	1	34.3	LBS	MSZ270-1	1	38.6	LBS	MSU278-1Y	MSR157-1Y
MSZ616-1	1	0.4	LBR	MSZ533-7	1	38.6	LBS	A00ETB12-2	MSL211-3
MSZ618-1	1	37.9	LBS	MSZ558-1Y	1	38.6	LBS	MSM183-1	MSQ086-3
MSZ619-3	1	38.2	LBS	MSV177-1	1	38.8	LBS	MSL268-D	McBride
MSZ620-1	1	0.6	LBR	MSV301-02	1	38.9	LBS	MSN105-1	MSP197-1
MSZ620-3	1	6.4	LBR	MSZ462-1R	1	39.1	LBS	OG-08-168	MSL211-3
MSZ620-7	1	0.0	LBR	MSZ416-8RY	1	39.4	LBS	MSN230-1RY	NDTX4271-5R
MSZ622-1	1	39.5	LBS	MSZ427-3R	1	39.4	LBS	MSQ440-2	NDTX4271-5R
MSZ702-01	1	2.0	LBR	MSZ533-5	1	39.4	LBS	A00ETB12-2	MSL211-3
MSZ702-03	1	21.1	LBMS	MSY728-1	1	39.5	LBS	523-3-S7	84SD22
MSZ702-04	1	0.4	LBR	MSZ518-2	1	39.5	LBS	MSP091-1	MSQ440-2
MSZ705-3	1	0.0	LBR	MSZ622-1	1	39.5	LBS	Satina	MSL211-3
MSZ706-1	1	0.0	LBR	MSZ526-2	1	39.8	LBS	Superior	MSL211-3
MSZ706-3	1	0.0	LBR	MST075-1R	1	39.9	LBS	Dakota Jewel	MSL211-3
MSZ706-5	1	3.8	LBR	MSU379-01	1	39.9	LBS	MSP238-1	Missaukee
MSZ708-6	1	12.7	LBMR	MSZ414-1	1	39.9	LBS	MSN230-1RY	Colonial Purple
MSZ738-2	1	36.5	LBS	MSY713-1	1	40.1	LBS	MSS703-5	MCR150
MSZ748-1	1	21.8	LBMS	MSZ596-2	1	40.3	LBS	MSS483-1	MSQ440-2
NY121	1	7.9	LBR	MSW164-2	1	40.5	LBS	Atlantic	MSR061-1
Olalla	1	16.7	LBMR	MSX001-4WP	1	40.5	LBS	ARS10091WP	MSL211-3
PVYR Red Marker #1	1	30.9	LBS	MSY494-6	1	40.5	LBS	Dakota Diamond	MSL211-3
Stirling	1	6.3	LBR	MSZ092-2	1	40.5	LBS	Elkton	MSQ086-3
VSB16LBR8	1	4.2	LBR	MSZ502-1Y	1	40.5	LBS	MSI005-20Y	MSQ440-2
VSB2186F-302-8	1	3.8	LBR	MSZ587-1	1	40.5	LBS	MSR241-4RY	MSL211-3

[1] Ratings indicate the average plot RAUDPC (Relative Area Under the Disease Progress Curve).
*LBR = Late Blight Resistant; LBMR = Late Blight Moderately Resistant; LBMS = Late Blight Moderately Susceptible; LBS = Late Blight Susceptible
LB Isolate used: US-23

2014 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									
MSV093-1	1.081	8	11	4	2	0	0	32	1.0
W5955-1	1.094	7	7	5	6	0	0	28	1.4
McBride	1.089	5	6	12	1	1	0	20	1.5
W6609-3	1.095	5	7	7	6	0	0	20	1.6
BNC182-5	1.090	7	2	9	5	1	1	28	1.8
Lamoka	1.096	5	6	4	9	1	0	20	1.8
Manistee	1.092	4	6	6	6	1	2	16	2.0
Sebec (AF0338-17)	1.091	2	8	4	7	3	1	8	2.2
W6822-3	1.101	2	4	8	11	1	0	8	2.2
MSR061-1	1.092	5	1	7	8	3	1	20	2.2
MSL007-B	1.095	2	3	4	11	5	0	8	2.6
MSS428-2	1.090	1	2	10	4	3	5	4	2.8
Atlantic	**1.093**	**0**	**3**	**6**	**7**	**6**	**3**	**0**	**3.0**
FL1879	**1.089**	**2**	**2**	**5**	**5**	**3**	**8**	**8**	**3.2**
MSM246-B	1.097	1	0	6	8	6	4	4	3.2
MSR127-2	1.092	1	1	4	8	6	5	4	3.3
NY152	1.092	0	1	4	8	7	5	0	3.4
Snowden	**1.096**	**0**	**0**	**3**	**7**	**14**	**2**	**0**	**3.6**
Elkton	1.095	0	3	1	5	10	6	0	3.6
NY148	1.099	0	0	0	0	4	21	0	4.8
RUSSET TRIAL									
ATX91137-1Rus	1.079	20	4	1	0	0	0	80	0.2
Russet Norkotah	**1.073**	**18**	**10**	**4**	**0**	**0**	**0**	**56**	**0.6**
MSU285-1Rus(2reps)	1.076	13	8	2	1	0	0	54	0.6
W8152-1Rus	1.091	11	10	4	0	0	0	44	0.7
AF4124-7	1.085	11	8	7	0	0	0	42	0.8
W9133-1Rus	1.073	8	11	4	1	0	0	33	0.9
A06021-T	1.084	7	9	5	3	0	0	29	1.2
Silverton Russet	**1.077**	**6**	**8**	**8**	**2**	**0**	**0**	**25**	**1.3**
AF3362-1Rus	1.088	4	11	8	0	1	0	17	1.3
W9433-1Rus	1.085	4	12	4	4	0	1	16	1.5
A03921-2	1.097	1	12	8	3	0	0	4	1.5
AF4320-7	1.085	3	5	9	5	2	0	13	1.9
ADAPTATION TRIAL, TABLESTOCK LINES									
Red Norland	**1.064**	**21**	**5**	**0**	**0**	**0**	**0**	**81**	**0.2**
MSQ131-A	1.071	17	2	1	0	0	0	85	0.2
Agila	1.069	17	9	0	0	0	0	65	0.3
MSM288-2Y	1.080	19	6	0	1	0	0	73	0.3
CO5228-4R	1.078	18	6	2	0	0	0	69	0.4
MSR186-3P	1.071	16	5	1	1	0	0	70	0.4
W6703-1Y	1.087	14	9	2	1	0	0	54	0.6
ADAPTATION TRIAL, TABLESTOCK LINES (continued)									
Alegria	1.083	12	11	3	0	0	0	46	0.7
Smiley	1.080	11	11	3	0	0	0	44	0.7
MSS576-5SPL	1.082	12	6	6	1	0	0	48	0.8
MSQ086-3	1.087	7	11	7	0	0	0	28	1.0
MST500-1	1.075	7	10	8	0	0	0	28	1.0
MSL211-3	1.081	7	10	6	1	1	0	28	1.2
MSS176-1	1.085	6	8	8	2	1	0	24	1.4
MSS206-2	1.083	4	8	9	2	1	0	17	1.5
Reba	**1.084**	**2**	**7**	**6**	**9**	**2**	**0**	**8**	**2.1**
MSS487-2	1.085	2	6	1	7	4	5	8	2.8

2014 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
PRELIMINARY TRIAL, CHIP-PROCESSING LINES									
MSV344-2	1.077	13	11	0	0	0	0	54	0.5
MST202-5	1.083	14	8	2	0	0	0	58	0.5
MST096-2Y	1.085	11	13	1	0	0	0	44	0.6
MSV434-1Y	1.075	11	8	4	0	0	0	48	0.7
MSV358-3	1.093	8	9	7	1	0	0	32	1.0
MSV307-2	1.085	7	10	5	2	1	0	28	1.2
QSMSU08-04	1.085	10	5	5	5	0	0	40	1.2
MST443-1Y	1.086	6	10	5	3	0	0	25	1.2
MSV440-6	1.076	4	12	8	1	0	0	16	1.2
QSMSU10-02	1.081	5	10	6	4	0	0	20	1.4
MSV507-198	1.089	5	8	7	4	0	0	21	1.4
MSV507-140	1.095	5	10	4	5	1	0	20	1.5
MST178-2	1.074	6	10	5	0	2	2	24	1.5
QSMSU10-15	1.100	3	12	4	5	1	0	12	1.6
MSV394-3	1.091	6	7	6	3	2	1	24	1.6
MSV301-2	1.093	3	8	7	4	1	0	13	1.7
MSV507-121	1.097	6	6	3	7	2	0	25	1.7
MST191-2Y	1.092	4	8	8	1	4	0	16	1.7
QSMSU01-10	1.098	5	6	6	3	1	2	22	1.8
MSS108-1	1.084	8	3	5	5	3	1	32	1.8
Dakota Diamond	1.093	3	4	10	5	2	1	12	2.1
MSS167-6	1.087	3	5	5	11	1	0	12	2.1
MSV507-003	1.103	1	6	10	3	4	0	4	2.1
MSV507-056	1.098	4	3	6	7	4	0	17	2.2
MSV507-040	1.093	2	3	8	9	1	2	8	2.4
Beacon Chipper	1.092	2	5	6	7	5	1	8	2.4
MSV396-4	1.091	3	2	8	5	7	0	12	2.4
MST441-1	1.084	0	1	7	4	0	1	0	2.5
Snowden	**1.099**	**1**	**5**	**5**	**6**	**2**	**3**	**5**	**2.5**
MSV507-052	1.088	2	5	5	7	1	5	8	2.6
MSV030-4	1.099	1	3	8	8	1	4	4	2.7
PRELIMINARY TRIAL, CHIP-PROCESSING LINES (continued)									
NYJ15-7	1.096	3	5	4	3	5	5	12	2.7
MSV498-1	1.089	2	2	8	2	5	4	9	2.8
MSV505-2	1.092	2	0	7	10	4	2	8	2.8
MSV380-1	1.091	0	2	8	9	4	2	0	2.8
MSV507-073	1.101	0	4	8	5	3	5	0	2.9
MSV507-020	1.101	0	5	5	6	5	4	0	2.9
MSV507-001	1.092	3	2	5	3	7	5	12	3.0
MSU358-2	1.096	1	3	5	4	7	5	4	3.1
MST458-4	1.082	0	1	2	4	4	2	0	3.3
MSV033-1	1.090	0	3	4	4	9	5	0	3.4
Pike	**1.097**	**0**	**0**	**6**	**5**	**7**	**7**	**0**	**3.6**
MST424-6	1.084	0	1	3	7	4	9	0	3.7
MSV507-012	1.099	0	0	4	6	7	7	0	3.7
MST184-3	1.093	0	1	1	7	9	6	0	3.8
Atlantic	**1.088**	**0**	**0**	**1**	**4**	**4**	**4**	**0**	**3.8**
NY154 (H15-17)	1.097	0	0	1	3	9	11	0	4.3
MSV507-129	1.106	0	1	0	2	6	16	0	4.4
PRELIMINARY TRIAL, TABLESTOCK LINES									
MSW239-3SPL	1.066	24	1	0	0	0	0	96	0.0
MSV111-1	1.084	22	2	0	0	0	0	92	0.1
Granola	1.074	21	3	1	0	0	0	84	0.2
MSU202-1P	1.075	19	6	0	0	0	0	76	0.2

2014 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
MSS164-1	1.093	15	5	4	1	1	0	58	0.8
Purple Haze	1.089	8	14	3	0	0	0	32	0.8
MST252-1Y	1.076	11	7	6	1	0	0	44	0.9
MSV235-2PY	1.082	8	13	3	1	0	0	32	0.9
MPS 1	1.074	9	11	3	2	0	0	36	0.9
MST145-2	1.085	6	9	10	0	0	0	24	1.2
MST386-1P	1.085	7	10	5	3	0	0	28	1.2
Onaway	**1.074**	**3**	**8**	**5**	**8**	**0**	**0**	**13**	**1.8**
MSU161-1	1.083	4	5	6	9	1	0	16	1.9
MST148-3	1.086	1	9	7	4	1	2	4	2.0
Reba	**1.084**	**0**	**1**	**14**	**6**	**4**	**0**	**0**	**2.5**
USPB/SFA TRIAL CHECK SAMPLES (Not bruised)									
AF4157-6	1.079	15	9	1	0	0	0	60	0.4
W5955-1	1.080	15	7	2	0	0	0	63	0.5
AC01151-5W	1.072	13	10	2	0	0	0	52	0.6
A01143-3C	1.080	12	12	2	0	0	0	46	0.6
A00188-3C	1.084	10	10	5	0	0	0	40	0.8
CO02321-4W	1.077	7	12	5	2	0	0	27	1.1
CO03243-3W	1.076	6	11	5	2	1	0	24	1.2
USPB/SFA TRIAL CHECK SAMPLES (Not bruised, continued)									
W6609-3	1.079	4	12	8	1	1	0	15	1.3
Atlantic	**1.087**	**4**	**10**	**8**	**2**	**1**	**0**	**16**	**1.4**
Snowden	**1.079**	**5**	**7**	**8**	**5**	**0**	**0**	**20**	**1.5**
CO02024-9W	1.077	1	7	12	4	0	1	4	1.9
MSL007-B	1.082	3	5	10	3	3	1	12	2.0
USPB/SFA TRIAL BRUISE SAMPLES									
AF4157-6	1.079	13	7	5	0	0	0	52	0.7
W5955-1	1.080	10	12	3	0	0	0	40	0.7
A01143-3C	1.080	11	10	3	0	1	0	44	0.8
A00188-3C	1.084	9	11	6	0	0	0	35	0.9
CO02321-4W	1.077	7	11	7	0	0	0	28	1.0
AC01151-5W	1.072	8	8	8	1	0	0	32	1.1
CO03243-3W	1.076	9	5	6	2	2	0	38	1.3
Snowden	**1.079**	**4**	**7**	**8**	**6**	**0**	**0**	**16**	**1.6**
W6609-3	1.079	3	10	7	3	2	0	12	1.6
Atlantic	**1.087**	**1**	**7**	**9**	**4**	**4**	**0**	**4**	**2.1**
CO02024-9W	1.077	4	3	10	2	5	1	16	2.2
MSL007-B	1.082	3	4	7	7	1	3	12	2.3

* 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 10/29-30/2014. The table is presented in ascending order of average number of spots per tuber.

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2014 On-Farm Potato Variety Trials

Chris Long, Aaron Yoder, Dr. Dave Douches, and Chris Kapp (Upper Peninsula), James DeDecker, (Presque Isle)

Introduction

On-farm potato variety trials were conducted with 15 growers in 2014 at a total of 25 locations. Ten of the locations evaluated processing entries and twelve 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), 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 Brian Williams Farm (Sanilac), Crawford Farms, Inc. (Montcalm), Elmaple Farms (Kalkaska), Erke Farms (Presque Isle), Kitchen Farms, Inc. (Antrim), Horkey Bros. (Monroe), Lippins Potato Farm (Delta), R&E Farms (Presque Isle), T.J.J. VanDamme Farms (Delta), Walther Farms, Inc. (St. Joseph).

Procedure

There were six types of processing trials conducted this year. The first type contained 16 entries which were compared with the check varieties Snowden, Pike and FL1879. This trial type was conducted at Main Farms, Lennard Ag. Co. and County Line Farms (the last of which was not harvested due to flooding). 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. 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). 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, 16 varieties were compared to the check varieties Snowden, Pike 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 16 varieties compared against the check variety Snowden. Each of the 16 varieties was 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 blocks of two newly commercialized or promising, non-commercialized varieties. Agronomic and production practices for these varieties were based on each individual grower's production system. The growers and varieties were: Sandyland Farms (Montcalm), Manistee (MSL292-A); Andersen Brothers, LLC (Isabella), NY148. 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 2014 annual report published by the United States Potato Board.

Within the fresh market trials, there were 23 primary entries evaluated (this is not including entries from USPB/NFPT trial and Walther Farms yellow trial) of which 15 were russet types and, 8 were non-russet table-stock lines. Trials were conducted in the following counties: Antrim, Delta, Kalkaska, Monroe, Montcalm, Presque Isle, and St. Joseph. The varieties in each trial ranged from mostly round white varieties to mostly 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 variety. The second fresh pack trial type was the Russet Select Trial. The select russet trials were planted at three locations Elmaple Farm (Kalkaska), Montcalm Research Center (Montcalm) 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 11-12" 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 12". This trial was performed twice, once under 'Silverton' management practices and the other with 'Norkotah' management. Only the center row was 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.

Processing Variety Highlights

NY 154; this is a Cornell University developed clone with high yield potential. Trialed in four locations in 2014, this clone had the highest overall yield, with a low incidence of common scab (Table 2). The specific gravity was also excellent, averaging 1.087, above the trial average of 1.084. Internal quality was good overall, with a few tubers exhibiting hollow heart and vascular discoloration. This variety had a vine maturity that was slightly later than Snowden. Tuber type was uniform and round and chip quality was good out-of-the-field.

NY 148; this is another Cornell University clone that had been trialed in Michigan for several years. In 2014 the clone had excellent yields, a good size profile, low incidence of common scab, and above average specific gravity at 1.089. Although agronomic qualities and out-of-the-field chip quality were good, this line proved extremely susceptible to black spot bruising, rendering it unusable for long-term or even short-term storage.

BNC182-5; this clone was crossed in North Carolina and selected in Beltsville, MD. In 2014, it yielded 559 cwt/A US#1. The specific gravity was slightly above the trial average at 1.084. This variety matured mid-season, similar to Lamoka. The apical eyes were moderately deep on the larger tubers. Internal quality was good out of the field, with relatively moderate incidence of hollow heart and vascular discoloration. Sheep nose deformations were reported in multiple locations with this line, and it also expressed moderate common scab tolerance. High accumulation of free simple sugars post-harvest limit this line's storage potential.

Manistee (MSL292-A); this is a Michigan State University developed variety. In 2014, Manistee had a slightly above average yield at 480 cwt/A US#1. This variety had 95 percent marketable yield and a slightly above average specific gravity at 1.084. Raw internal tuber quality was good and tuber type was very uniform, flat and round apical to stem-end. Internal quality as well as chipping quality were excellent. This variety matured slightly earlier than Snowden, with comparable scab tolerance. This variety has chipped well from storage at 48 °F and is being evaluated in the MPIC demonstration storage facility for the 2014-2015 storage season at 46 ^{o}F.

CO03243-3W; this clone was developed by Colorado State University. While limited to only 1 trial location in 2014, it had the highest yield within that trial (SFA) and will be trialed over more locations in 2015.

MSR127-2; this is an MSU selection with a heavy netted skin, uniform tuber type and common scab resistance. In 2014, it yielded slightly below average at 472 cwt/A US#1. Chip quality appears to be good from early storage, and storage quality has held up well in 2014-2015 MRC box bin trials.

W5955-1; this selection has been developed at the University of Wisconsin. This variety appears to chip process well from out-of-the-field and from early to mid-season storage. It's yield potential was average, producing 457 cwt/A US#1 in 2014. The average specific gravity of this line was 1.085 across eight locations. Overall internal quality was good on this line in 2014, with moderate to low levels of hollow heart and vascular discoloration. This line has some common scab tolerance and appears to exhibit a late maturation. Chip quality out of the field was good in 2014 and storage quality has been good so far in 2014-2015 through January.

W6609-3; this is a University of Wisconsin clone with common scab resistance. In the 2014 on-farm trials, this variety had a below average yield of 358 cwt/A US#1 with a 1.086 specific gravity, which is above the trial average of 1.083. The line was evaluated at 6 locations in 2014, and internal qualities appeared to be good, averaged across the trials. This variety had a vine maturity that was similar to Snowden. Tuber type was uniform and round and chip quality was good from mid-season storage in 2013 and so far has held up well in the 2014-2015 MPIC box bin trial.

B. USPB / SFA Chip Trial Results

The Michigan location of the USPB / SFA chip trial was on Sandyland Farms, LLC in Montcalm County in 2014. Table 3 shows the yield, size distribution and specific gravity of the entries when compared with Atlantic 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 12 varieties in the trial.

USPB / SFA Chip Trial Highlights

Two Colorado State University clones, CO03243-3W and CO02024-9W topped the yield table in 2014, followed by a group of lines including (in order of highest to lowest US#1 yields): A01143-3C, Atlantic, and MSL007-B, all of which were above the trial average of 350 cwt/A (Table 3). W5955-1 had the largest percentage of recorded oversize tubers (for the 2nd year in a row) followed closely by Atlantic and MSL007-B (Table 3). AC01151-5W had a very low specific gravity of 1.072, although the trial average was relatively low at 1.079. Additional lines with lower than average specific gravities reported were CO03243-3W, CO02024-9W and CO02321-4W (Table 3). 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 Atlantic (47%) and to a lesser extent in CO03243-3W (17%) and AC01151-5W (7%). AF4157-6 had the highest percentage of vascular discoloration at 37% followed by Snowden (33%) and A00188-3C (30%). AC01151-5W had the highest level of internal brown spotting at 17%. Table 5 shows the post-harvest chip quality based on samples collected on October 9th, 2014 and processed at Herr Foods, Inc. on October 13th. Chip color was generally acceptable across the trial, with A001151-5W having the highest Agtron score of the trial at 66.6. The varieties, listed in ranked order based on quality observations from Herr Foods, Inc. are as follows: W5955-1, CO02321-4W, AF4157-6, A01143-3C, W6609-3, A00188-3C, CO02024-9W, Snowden, MSL007-B, AC01151-5W, CO03243-3W and lastly Atlantic. Atlantic, MSL007-B, W6609-3, Snowden and CO02024-9W showed the greatest susceptibility to blackspot bruise (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 nine russet-type trials located in the following counties: Antrim, Delta, Kalkaska, Monroe, Montcalm, Presque Isle, 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 (AF3362-1Rus), Kitchens Farms (AF3362-1Rus), R&E Farms (Oneida Gold), Lippins Potato Farm (AF3362-1Rus) and Brian Williams Farms (MSS576-5SPL).

Fresh Market Variety Highlights

2014 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

CO05228-4R; this Colorado State University variety has a smooth dark red skin appearance with a small uniform round tuber shape. In the 2014 freshpack variety trials, this clone had a 350 cwt/A US#1 yield, well below the 517 cwt/A average of the check variety 'Red Norland' (Table 10). No hollow heart or any other internal defects were observed in the three locations where this variety was trialed but there were a substantial proportion of B-size tubers. Common scab was more prevalent in this line and it matured slightly later compared with the check variety.

Yellow Flesh

W6703-1Y (Oneida Gold); this University of Wisconsin variety was named 'Oneida Gold' in 2014. It exhibits an average sized, uniform tuber type with nice yellow flesh. It averaged a 517 cwt/A US#1 yield over six locations in 2014, comparing favorably to other fresh market lines. Along with excellent internal quality, this line had good tolerance to common scab. Tuber size distribution was good with 92 percent of the tubers being marketable. The vine maturity is medium-early.

MSM288-2Y; this Michigan State University variety has uniform tuber type with a nice, deep-yellow flesh. In 2014, MSM288-2Y yielded 509 cwt/A US#1 across six locations with a medium vine maturity. Internal defects were low in this line, however at some locations common scab was an issue. The size profile of this line was good with 89 percent of all tubers being classified as marketable.

Round White

MSQ131-A; this Michigan State University variety yielded well in 2014 across six locations, comparable to the round white check variety 'Reba' at 535 cwt/A US#1. While there were a high percentage of over-sized tubers in 2014, there was very low incidence of hollow heart or any other internal defects and a high proportion of the total yield was marketable (97 percent). The variety has mid-season maturation and exhibited low incidence of common scab in 2014 trials.

Splash-type

MSS576-5SPL; this variety was developed at Michigan State University. The tubers have a medium maturity, a large set of US#1 tubers and are white-skinned with pink splashes around the eyes. In 2014, MSS576-5SPL yielded excellent at 619 cwt/A US#1 with minimal internal defects. Additionally, common scab prevalence was quite low in 2014 trials (across four locations) with an average specific gravity of 1.073.

Russet-type

AF3362-1Rus; this University of Maine selection had a 518 cwt./A US#1 yield, placing it at the top for US#1 yields in 2014 (across nine locations). It had an average specific gravity of 1.078 and 2 percent of oversized tubers exhibited hollow heart (Table 9). Thirty-four percent of the marketable yield was oversized, warranting a closer in-row seed spacing than 12 inches. 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. AF3362-1Rus performed well across all geographic latitudes and it also has common scab tolerance.

AF4320-7Rus; this is a variety developed at the University of Maine. It was the second highest US#1 yielding line in 2014 at 507 cwt/A (across 7 locations). As with AF3362-1Rus, there were a high percentage of over-size tubers (31 percent), warranting closer in row spacing than the standard 12 inches. There was no hollow heart detected in the oversize tubers and this line exhibited slight tolerance to common scab. In 2014 it averaged a specific gravity of 1.076, equal to the russet-type trial overall trial average. Tuber type was nice and blocky, and vine maturity was late.

ATX91137-1Rus (Reveille); this variety was crossed in Aberdeen, ID and selected by the Texas A&M breeding program in 1993. In 2014 it was named ‘Reveille’. It had a 502 cwt/A US#1 yield, a specific gravity of 1.066 and low incidence of internal defects (across eight locations). There was very little common scab observed in this line in 2014 and it matured overall slightly later than ‘Silverton’. Fourteen percent of the total yield was classified as pick-outs due largely to misshapen, knobby tubers. The tuber’s appearance was oblong to blocky with a nice russeted skin.

W9433-1Rus; this University of Wisconsin selection had a 479 cwt./A US#1 yield with an average specific gravity of 1.076. This clone was the top yielding russet line in the 2013 trials and the fourth highest in 2014. It averaged 45 percent oversize tubers across nine locations in 2014, although there was no hollow heart detected in any of the tubers (also the case in 2013). The tuber appearance was oblong to blocky with a light russet skin, and had exhibited low incidence of common scab in 2014. Vine maturity was medium. This line appears to have good potential for commercialization.

AF4124-7Rus; this University of Maine variety yielded slightly below average in 2014 at 365 cwt/A US#1 (across six locations). It had a high specific gravity of 1.081 and 13 percent of the total yield were classified as pick-outs, due largely to prominent eyebrows. Internal defects were quite low, and there was no incidence of common scab detected in this line in any of the six locations it was evaluated. It had a medium-late vine maturity.

2014 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
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
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	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
McBride (MSR169-8Y)	Pike X MSJ126-9Y	1.1	Below average yield, medium maturity, yellow flesh, average specific gravity, common scab tolerant
MegaChip (W1201)	WISCHIP X FYF85	1.0*****	High specific gravity, round oval tubers, medium-large size, common scab resistant, deep apical eye
Nicolet (W2133-1)	Snowden X S440	1.8****	Medium yield, similar to Snowden, high specific gravity, mid-season chip quality
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
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
A00188-3C	A91790-13 X Dakota Pearl	1.5***	Medium yield, scaly buff skin, high specific gravity, mid-season chip quality, common scab tolerance

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. *2013 data, **2012 data, ***2010 data, ****2009 data, *****2005 data. Common Scab data provided by MSU Potato Breeding and Genetics Program. † 2014 Long Potato Group data.

Entry	Pedigree	2014 Scab Rating*	Characteristics
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
AF4157-6	Yankee Chipper X Dakota Chipper	1.0†	Medium earl maturity, round to oblong netted tubers, good gravity, good chip color from the field and storage, common scab tolerant
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
CO02321-4W	NY115 X BC0894-2W	2.8	Average yield potential, average specific gravity, medium maturity, common scab susceptible
CO03243-3W	BC894-2W X A91790-13W	1.5†	Large vine size with medium maturity, large yield potential, medium specific gravity
MSL007-B	MSA105-1 X MSG227-2	1.9	Average yield potential, early to mid-season maturity, uniform tuber type, medium specific gravity, scab tolerant, heavy netted skin
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
NYJ15-7	MSK061-4 X Marcy	2.4	High yield, late maturity, medium to high specific gravity, scab susceptible, high incidence of hollow heart

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. * 2013 data, **2012 data, ***2010 data, ****2009 data, *****2005 data. Common Scab data provided by MSU Potato Breeding and Genetics Program. † 2014 Long Potato Group data.

Entry	Pedigree	2014 Scab Rating*	Characteristics
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
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
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
W6822-3	-	1.8	Average yield, medium maturity, high specific gravity, susceptible to internal defects, common scab tolerant

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible. * 2013 data, **2012 data, ***2010 data, ****2009 data, *****2005 data. Common Scab data provided by MSU Potato Breeding and Genetics Program. † 2014 Long Potato Group data.

2014 "Select"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	CHIP SCORE[2]	TUBER QUALITY[3] HH	VD	IBS	BC	VINE VIGOR[4]	VINE MATURITY[5]	COMMENTS
NY154[efgj]	668	703	94	4	81	13	1	1.087	1.1	1.5	2.1	0.5	0.0	3.8	4.0	0.0-1.5 common scab
NYJ15-7[efgj]	657	678	97	3	70	27	1	1.084	1.8	3.3	2.3	0.1	0.6	3.9	4.2	0.0-2.5 common scab
FL1879[efj]	**626**	**639**	**98**	**2**	**63**	**35**	**0**	**1.078**	**1.5**	**1.3**	**1.4**	**1.1**	**0.5**	**4.2**	**2.8**	**0.0-2.0 common scab; misshapened pickouts**
NY152[efghj]	595	666	88	11	84	5	1	1.081	1.2	1.9	0.9	0.4	0.0	3.7	3.6	0.0-2.5 common scab; small round uniform tuber type
NY148[abcdefghj]	574	616	93	7	86	6	0	1.089	1.4	0.0	0.1	0.6	0.1	2.9	3.2	**0.0-2.0 common scab; uniform tuber type**
Sebec (AF0338-17)[aefgj]	568	607	92	5	79	13	1	1.079	1.7	0.9	0.9	0.1	0.0	3.8	3.2	0.0-3.5 common scab
BNC182-5[aefgj]	559	607	91	7	74	17	3	1.084	1.4	2.0	1.1	0.0	0.0	3.4	3.6	**0.0-2.5 common scab; misshapen and sheep nose in pickouts**
Elkton[abcdefghj]	503	546	92	4	78	14	4	1.083	1.5	1.9	0.6	0.0	0.0	2.4	2.8	**0.0-2.5 common scab; heavy netted skin; oval tuber type; misshapened pickouts**
W6822-3[efj]	495	550	89	5	72	17	6	1.091	1.0	1.3	1.3	3.3	1.1	3.6	3.0	0.0-1.5 common scab
A01143-3C[gij]	488	587	82	6	78	4	11	1.079	1.3	0.3	1.9	0.3	0.0	2.5	4.2	0.0-1.5 common scab; severe sheep nose in pickouts
Snowden[aefgij]	**486**	**530**	**90**	**9**	**82**	**9**	**1**	**1.088**	**1.3**	**0.6**	**2.5**	**0.1**	**0.3**	**2.8**	**3.2**	**0.0-3.0 common scab**
Manistee (MSL292-A)[abcdefgj]	480	501	95	4	82	13	1	1.084	1.0	0.4	1.0	0.0	0.0	2.5	2.6	**0.0-3.5 common scab; flat round tuber type**
CO03243-3W[i]	478	535	89	10	82	7	1	1.076	1.5	1.7	0.0	0.0	0.3	0.3	4.0	**1.5 common scab**
MSR127-2[bcdefghj]	472	501	94	5	81	13	1	1.088	1.4	0.1	1.3	0.0	0.0	2.8	3.4	**0.0-1.0 common scab; uniform round tuber type; sl alligator hide; gc in pickouts**
Lamoka[befgj]	468	489	95	5	73	22	1	1.084	1.0	0.0	3.3	0.1	0.1	3.8	3.5	**0.0-1.0 common scab; pear shaped pickouts; alligator hide**
W5955-1[bcdefgij]	457	503	90	6	76	14	4	1.085	1.2	1.4	0.9	0.9	0.4	2.6	3.3	0.0-2.0 common scab; pear shaped in pickouts
CO02024-9W[efgij]	442	516	84	16	83	1	0	1.077	1.3	0.0	0.5	0.3	0.0	3.3	3.4	**0.0-4.0 common scab; small uniform tuber type**
AF4157-6[ij]	439	489	85	13	79	6	2	1.086	1.3	0.2	3.3	0.2	0.0	2.0	2.7	0.0-2.0 common scab; gc and sl pinkeye in pickouts
Atlantic[i]	**432**	**482**	**90**	**6**	**80**	**10**	**4**	**1.087**	**2.0**	**4.7**	**1.0**	**0.0**	**0.3**	**0.3**	**3.0**	**1.5 common scab**
MSS428-1[bcdefg]	423	464	91	6	77	14	3	1.083	1.4	5.2	1.7	0.2	0.2	2.2	2.6	**0.0-4.0 common scab; small uniform tuber type**
Pike[cefj]	**418**	**438**	**95**	**5**	**89**	**6**	**0**	**1.084**	**1.4**	**0.5**	**1.4**	**1.4**	**0.1**	**3.0**	**3.2**	**0.0-2.5 common scab**
MSS934-4[bcdefg]	411	481	85	9	76	9	6	1.077	1.7	0.5	2.2	0.0	0.2	2.6	2.8	**0.0-4.0 common scab; gc in pickouts; bright skin**
MSL007-B[i]	389	412	95	5	85	10	0	1.082	1.5	0.0	2.0	0.0	0.0	0.0	4.0	**0.5 common scab; heavy netted skin; uniform tuber type**
W6609-3[efghij]	358	425	82	15	79	3	3	1.086	1.1	0.6	1.5	0.6	0.8	2.9	3.1	**0.0-1.0 common scab**
A00188-3C[i]	322	440	74	24	73	1	2	1.084	1.0	0.3	3.0	0.0	0.3	0.3	3.5	**0.0 common scab; pear shaped and points in pickouts**
AC01151-5W[i]	321	437	73	25	72	1	2	1.072	1.0	0.7	0.3	1.7	0.7	0.7	4.5	1.5 common scab
CO02321-4W[i]	281	350	80	19	75	5	1	1.077	1.0	0.0	2.0	0.0	0.0	0.0	3.5	**1.5 common scab**
MEAN	**474**	**526**						**1.083**								

tr = trace, sl = slight, N/A = not available

gc=growth crack

2014 Chip Variety Trial Sites

[a] Crooks Farms; Set #1; Montcalm Co.
[b] Crooks Farms; Set#2; Montcalm Co.
[c] Crooks Farms; Set#3; Montcalm Co.
[d] Crooks Farms; Set#4; 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

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

[3]TUBER QUALITY (number of tubers per 10 cut)
HH: Hollow Heart
VD: Vascular Discoloration
IBS: Internal Brown Spot
BC: Brown Center

[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 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
CO03243-3W	478	535	89	10	82	7	1	1.076
CO02024-9W	436	500	87	13	85	2	0	1.077
A01143-3C	433	524	82	10	80	2	8	1.080
Atlantic	**432**	**482**	**90**	**6**	**80**	**10**	**4**	**1.087**
MSL007-B	389	412	95	5	85	10	0	1.082
W5955-1	348	417	84	10	73	11	6	1.080
A00188-3C	322	440	74	24	73	1	2	1.084
AC01151-5W	321	437	73	25	72	1	2	1.072
Snowden	**318**	**388**	**82**	**17**	**77**	**5**	**1**	**1.079**
CO02321-4W	281	350	80	19	75	5	1	1.077
W6609-3	239	320	75	22	73	2	3	1.079
AF4157-6	208	285	73	24	73	0	3	1.079
MEAN	**350**	**424**	**82**	**15**	**77**	**5**	**3**	**1.079**

*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.					
	Internal Defects[1]				
Entry	HH	VD	IBS	BC	Total Cut
CO03243-3W	5	0	0	1	30
CO02024-9W	0	3	2	0	30
A01143-3C	0	6	0	0	30
Atlantic	**14**	**3**	**0**	**1**	**30**
MSL007-B	0	6	0	0	30
W5955-1	0	6	0	3	30
A00188-3C	1	9	0	1	30
AC01151-5W	2	1	5	2	30
Snowden	**0**	**10**	**0**	**0**	**30**
CO02321-4W	0	6	0	0	30
W6609-3	0	8	0	1	30
AF4157-6	0	11	0	0	30

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

Table 5. 2014 Post-Harvest Chip Quality[1]						
	Agtron	SFA[2]	Specific	Percent Chip Defects[3]		
Entry	Color	Color	Gravity	Internal	External	Total
CO03243-3W	62.8	4.0	1.077	22.0	11.0	33.0
CO02024-9W	56.7	4.0	1.077	32.0	2.8	34.8
A01143-3C	56.9	3.0	1.085	14.0	12.0	26.0
Atlantic	**58.2**	**4.0**	**1.090**	**38.0**	**14.0**	**52.0**
MSL007-B	58.7	3.0	1.081	34.0	5.0	39.0
W5955-1	64.9	3.0	1.086	21.0	4.0	25.0
A00188-3C	66.6	4.0	1.083	20.0	8.0	28.0
AC01151-5W	57.6	4.0	1.078	33.0	7.0	40.0
Snowden	**58.1**	**4.0**	**1.084**	**29.0**	**12.0**	**41.0**
CO02321-4W	63.9	3.0	1.082	16.0	9.0	25.0
W6609-3	62.4	3.0	1.087	27.0	9.0	36.0
AF4157-6	65.0	3.0	1.078	9.0	19.0	28.0

[1]Samples collected October 9th and processed by Herr Foods, Inc., Nottingham, PA on October 13, 2014.

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
CO03243-3W	6	11	5	2	1		25	24	1.2	9	5	6	2	2		24	38	1.3
CO02024-9W	1	7	12	4		1	25	4	1.9	4	3	10	2	5	1	25	16	2.2
A01143-3C	12	12	2				26	46	0.6	11	10	3		1		25	44	0.8
Atlantic	**4**	**10**	**8**	**2**	**1**		**25**	**16**	**1.4**	**1**	**7**	**9**	**4**	**4**		**25**	**4**	**2.1**
MSL007-B	3	5	10	3	3	1	25	12	2.0	3	4	7	7	1	3	25	12	2.3
W5955-1	15	7	2				24	63	0.5	10	12	3				25	40	0.7
A00188-3C	10	10	5				25	40	0.8	9	11	6				26	35	0.9
AC01151-5W	13	10	2				25	52	0.6	8	8	8	1			25	32	1.1
Snowden	**5**	**7**	**8**	**5**			**25**	**20**	**1.5**	**4**	**7**	**8**	**6**			**25**	**16**	**1.6**
CO02321-4W	7	12	5	2			26	27	1.1	7	11	7				25	28	1.0
W6609-3	4	12	8	1	1		26	15	1.3	3	10	7	3	2		25	12	1.6
AF4157-6	15	9	1				25	60	0.4	13	7	5				25	52	0.7

[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 7. Pre-Harvest Panel, 9/2/14

Entry	Specific Gravity	Glucose[1] %	Sucrose[2] Rating	Canopy Rating[3]	Canopy Uniform.[4]	Number of Hills	Number of Stems	Average[5] Tuber Weight
CO03243-3W	1.077	0.003	0.428	40	80	3	13	4.23
CO02024-9W	1.078	0.004	0.608	70	90	3	21	2.98
A01143-3C	1.078	0.005	0.942	70	85	3	15	4.78
Atlantic	**1.083**	**0.003**	**0.675**	**50**	**90**	**4**	**18**	**5.77**
MSL007-B	1.081	0.004	0.701	40	70	4	8	4.17
W5955-1	1.076	0.005	0.918	40	90	4	14	4.69
A00188-3C	1.080	0.005	1.249	60	90	3	26	3.16
AC01151-5W	1.075	0.007	0.716	40	70	2	10	3.36
Snowden	**1.081**	**0.004**	**0.886**	**20**	**80**	**3**	**19**	**3.80**
CO02321-4W	1.076	0.003	0.720	30	80	4	16	3.38
W6609-3	1.076	0.003	0.860	40	90	4	16	2.89
AF4157-6	1.073	0.003	0.750	30	90	3	14	3.02

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.

2014 MSU Tablestock Potato Variety Trials

Russet type

Entry	Pedigree	2014 Scab Rating*	Characteristics
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
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
Russet Norkotah LT	Russet Norkotah Line Selection	2.2**	Above average yield, medium to medium-late maturity, long to oblong tubers, heavy russet skin, low specific gravity, better vigor than standard Russet Norkotah
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
Reveille (ATX91137-1Rus)	Bannock Russet X A83343-12	1.1	Common scab tolerant, some incidence of growth defects, high yield potential
A03921-2Rus	-	1.9	High specific gravity, medium yield potential, common incidence of eyebrowing
A06021-1TRus	-	1.0	Medium yield potential, prominent lenticels, common scab tolerance
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
AF4124-7Rus	A8469-5 X SC9512-4	1.8	Below average yield potential, good internal quality
AF4320-7Rus	A99081-8 X A97214-4	2.4	Common scab susceptible, good yielding variety

AF4152-7Rus	-	-	Medium yield potential, misshapen pickouts
W8152-1Rus	A93004-3Rus X CO94035-15Rus	1.6	High yield potential, blocky shape, high specific gravity, long storage potential
W9133-1Rus	ND4093-4Rus X CO82147-4Rus	1.0	High yield, medium to late maturity, common scab tolerant, susceptible to verticillium wilt and early blight
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

2014 MSU Tablestock Potato Variety Trials

Yellow Flesh Type

Entry	Pedigree	2014 Scab Rating*	Characteristics
Agila	-	2.1	Average yield potential, high incidence of growth cracks
Alegria	-	1.8	High yield potential, blocky-oval tuber shape
Allora	-	2.0	Average yield potential, pear-shaped tubers
Autumn Gold	-	-	Below average yield potential, high proportion of small tubers, oblong tuber type
Cascada	-	0.5	Below average yield potential, excellent internal quality, deep yellow colored flesh
Chopin	VDZ87-38 X Casanova	1.5	Common scab resistant, oval tubers, early maturity
Francisca	-	0.5	High yield, oval tubers with smooth yellow skin, early maturity, common scab resistant
Inara	-	0.5	High yield, medium maturity, medium to large oval-oblong tuber shape, medium common scab resistance
Merlot	-	0.5	High yield, small to medium oval tubers, medium to late maturity, red skin yellow flesh
Musica	CMK1993-042-005 X Lady Christl	0.5	High yield, medium to early maturity, large long-oval tubers with smooth skin, yellow flesh, common scab resistance

Novella	-	0.5	Medium to high yield, medium to large uniform long-oval tuber shape, smooth with yellow flesh, common scab susceptible
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
Smiley	-	1.4	Medium yield, medium to large round-oval uniform tuber shape, medium common scab resistance
Solome	-	0.5	Below average yield potential, low specific gravity, oval tuber type
Soraya	-	-	High yield, late maturity, large oval-oblong tubers with yellow skin and yellow flesh
Sundance	-	1.0	Average yield potential, deep yellow colored flesh, excellent internal quality
CO00412-5W/Y	-	-	Below average yield potential, high specific gravity, excellent internal quality, deep yellow colored flesh
CO04099-3W/Y	VC1002-3W X ATC98495-1W	1.0	Medium yield, high specific gravity, medium to early maturity, small oval tubers
MSM288-2Y	MSG145-1 X MSA097-1Y	2.5	A deep yellow flesh selection similar in type to Yukon Gold, common scab susceptible, uniform tuber type, pink eyes on tubers
MSS576-5SPL	MSI005-20Y X MSL211-3	1.6	High yield, below average specific gravity
VC1002-3W/Y	Agria X Wischip	-	High yield, medium to early maturity, small oval tubers with yellow flesh, high specific gravity
VC1009-1W/Y	Agria X MN12823	0.5	High yield, medium maturity, medium specific gravity

2014 MSU Tablestock Potato Variety Trials

Red Skin Type

Entry	Pedigree	2014 Scab Rating*	Characteristics
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
CO05228-4R	CO99256-2R x CO00292-9R	2.9	Early maturity, medium size, good red skin color, common scab susceptible

2014 MSU Tablestock Potato Variety Trials

Round white 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
MSQ086-3	Onaway X Missaukee (MSJ461-1)	1.9	Good yield potential, nice round white tuber type, medium maturity, late blight resistance, good internal quality
MSQ131-A	MSF373-8 X Missaukee	1.9	High yielding, large tuber size, round to oval tuber type
MSS176-1	ND5822C-7 X MSL211-3	1.6	High yield, above average gravity, flat oval shape
MSS206-2	Beacon Chipper X Missaukee	2.5	Medium to high yield, low specific gravity, sticky stolons and bottle-necking

2014 Russet "Select" Freshpack Potato Variety Trial
Overall Average- Ten Locations

LINE	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	TUBER QUALITY[2] HH	VD	IBS	BC	VINE VIGOR[3]	VINE MATURITY[4]	COMMENTS
AF3362-1Rus[abcdefghij]	523	600	87	5	50	37	9	1.077	0.2	1.3	0.1	0.0	2.8	3.6	**0.0-1.5 common scab, knobby and misshapen in pickouts**
AF4320-7Rus[abcdegij]	511	606	85	5	51	34	10	1.075	0.1	1.7	0.0	0.0	2.4	4.6	0.5-2.0 common scab, misshapen pickouts
ATX91137-1Rus[abcdefgij]	509	621	81	6	46	35	12	1.065	0.1	1.5	0.0	0.0	1.5	3.9	0.0-0.5 common scab, knobby, misshapen and gc in pickouts
W9433-1Rus[abcdefghij]	493	560	87	5	44	45	6	1.076	0.1	1.6	0.9	0.1	2.5	3.6	0.0-1.5 common scab, misshapen and knobs in pickouts
Silverton Russet[abcdefghij]	**433**	**524**	**82**	**11**	**54**	**28**	**7**	**1.076**	**0.5**	**1.6**	**0.1**	**0.3**	**2.9**	**3.6**	**0.0-0.5 common scab, gc, knobby and misshapen pickouts, alligator hide**
A03921-2Rus[abcdefgij]	394	488	81	11	56	24	8	1.088	0.4	1.6	1.1	0.2	1.9	3.8	1.0-2.0 common scab, gc, eyebrowing and misshapen pickouts, small uniform tubular tuber type
AF4152-7Rus[c]	393	480	82	9	77	5	9	1.086	0.0	1.0	0.0	0.0	3.0	2.5	misshapen pickouts
A06021-1TRus[abcdefgij]	390	471	83	10	60	23	7	1.077	0.3	1.2	0.2	0.6	1.8	3.3	0.5 common scab,gc, knobs and misshapen in pickouts, prominent lenticels
W8152-1Rus[abcdeghij]	381	475	81	13	62	19	5	1.081	0.9	0.8	0.1	0.3	2.9	3.2	0.5-1.0 common scab, alligator hide, gc and misshapen in pickouts
W9133-1Rus[abcdefghij]	373	472	80	12	55	25	8	1.071	0.5	0.5	0.1	0.0	2.6	2.8	0.0-1.5 common scab, sl alligator hide, misshapen and gc in pickouts
AF4124-7Rus[abdegij]	367	465	80	8	51	29	12	1.081	0.1	1.3	0.0	0.1	2.5	3.7	0.0 common scab, misshapen, prominent eyebrows
Russet Norkotah[abcdeghij]	**360**	**474**	**76**	**17**	**50**	**26**	**7**	**1.072**	**1.8**	**1.5**	**0.1**	**0.0**	**1.7**	**3.8**	**0.0- 1.0 common scab,tr gc, alligator hide, misshapen pickouts**
Goldrush Russet[bd]	**349**	**470**	**75**	**19**	**71**	**4**	**6**	**1.066**	**0.0**	**1.5**	**0.0**	**0.0**	**3.3**	**3.0**	**0.0 common scab, misshapen pickouts**
Russet Norkotah LT[cdefghij]	**340**	**454**	**74**	**22**	**60**	**14**	**4**	**1.070**	**0.6**	**1.1**	**0.2**	**0.0**	**2.7**	**2.4**	**1.0-1.5 common scab, gc and misshapen pickouts**
Mercury[i]	280	419	67	16	61	6	17	1.087	1.0	0.0	0.0	0.0	2.5	2.5	gc in pickouts
MEAN	**415**	**511**						**1.076**							

tr = trace, sl = slight, N/A = not available

gc=growth crack

2014 Russet Variety Trial Sites

[a] Montcalm Research Center (replicated); Montcalm Co.
[b] Elmaple Farm; Kalkaska Co.
[c] Crawford Farms; Montcalm Co.
[d] Kitchen Farms; Antrim Co.
[e] Walther Farms (Norkotah); St. Joseph 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. (Replicated)
[j] NFPT (selected lines replicated); Walther Farms; St. Joseph Co.

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

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

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

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

2014 Tablestock "Select" Freshpack Potato Variety Trial
Overall Average- Seven Locations

		CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				VINE	VINE	
TYPE	LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	VIGOR[3]	MATURITY[4]	COMMENTS
RED SKIN	**Red Norland[cdeg]**	**517**	**578**	**89**	**7**	**86**	**3**	**4**	**1.067**	**0.5**	**0.8**	**0.0**	**0.0**	**3.3**	**2.0**	**0.0-0.5 common scab; misshapened pickouts**
	CO05228-4R[deg]	350	491	74	23	73	1	3	1.073	0.0	0.0	0.0	0.0	2.8	3.0	0.5-2.0 common scab; small uniform tuber; nice dark red skin
ROUND WHITE	**Onaway[a]**	**600**	**632**	**95**	**3**	**82**	**13**	**2**	**1.069**	**0.0**	**9.0**	**0.0**	**0.0**	**4.0**	**2.0**	**0.5 common scab; sheep nosing in pickouts**
	MSS206-2[abcdeg]	594	659	91	2	50	41	7	1.075	2.5	1.7	0.0	0.5	2.7	4.2	0.5-2.5 common scab; sticky stolons and bottle necking; misshapened and gc in pickouts
	MSQ131-A[abcdeg]	535	556	97	1	50	47	2	1.070	0.2	0.2	0.2	0.0	3.3	3.3	0.5-1.5 common scab; gc and misshapen in pickouts
	Reba[acdeg]	**529**	**582**	**91**	**5**	**64**	**27**	**4**	**1.076**	**0.4**	**0.8**	**0.6**	**0.2**	**3.6**	**2.9**	**0.0-1.0 common scab; misshapened pickouts**
	MSS176-1[abcdeg]	513	567	91	3	72	19	6	1.079	0.5	0.5	1.3	1.8	3.8	3.8	0.5 common scab; flat oval shape; gc and misshapen in pickouts
	MSQ086-3[abcdeg]	479	527	92	5	77	15	3	1.075	0.0	1.3	1.0	0.2	3.1	4.0	**0.5-1.0 common scab; gc and misshapen in pickouts**
SPLASH	MSS576-5SPL[cdeg]	619	676	91	4	72	19	5	1.073	0.0	1.0	0.0	0.0	3.8	3.1	0.0-0.5 common scab; gc and misshapened in pickouts; white-fleshed with pink splash around eyes
YELLOW FLESH	Cascada[bf]	524	732	71	22	71	0	7	1.075	0.0	0.0	0.0	0.0	3.5	4.0	0.5-1.0 common scab; points, pear shaped and gc in pickouts
	W6703-1Y (Oneida Gold)[abcdeg]	517	562	92	7	88	4	1	1.077	0.0	0.0	0.8	0.0	3.2	2.8	**0.5 common scab; small uniform tuber type; nice yellow flesh**
	Allora[bf]	516	574	90	8	81	9	2	1.073	0.0	1.5	0.0	0.0	3.0	3.3	**0.5-2.0 common scab; light yellow flesh; bottle necking in pickouts**
	MSM288-2Y[abcdeg]	509	576	89	6	79	10	5	1.075	0.2	0.8	0.0	0.5	3.4	3.0	1.0-3.0 common scab; deep yellow colored flesh; gc and misshapen in pickouts
	MEAN	**523**	**593**						**1.074**							tr = trace, sl = slight, N/A = not available

gc=growth crack

2014 Tablestock Variety Trial Sites

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

[1]SIZE
Bs: < 4.0 oz.
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ENTOMOLOGY RESEARCH REPORT - 2014

Field evaluations of registered and experimental insecticides for managing Colorado potato beetle on potatoes

The Colorado potato beetle (*Leptinotarsa decemlineata*, Say, Coleoptera: Chrysomelidae) is the most widespread and destructive insect pest of potato crops in the eastern United States and Canada. Its ability to develop resistance makes it important to continue testing the efficacy insecticides in the field. Such tests provide data on comparative effectiveness of products and data to help support future registrations and use recommendations.

METHODS

Fifteen insecticide treatments and an untreated control (Table 1) were tested at the MSU Montcalm Research Farm for control of Colorado potato beetle. 'Atlantic' potato seed pieces were planted 12 in. apart, with 34 in. row spacing on 28 May 2014. Treatments were replicated four times in a randomized complete block design. Plots were 50 ft. long and three rows wide with untreated guard rows bordering each plot.

Treatment 1 was applied as a seed treatment, and treatments 2-5 were sprayed in-furrow at planting (Table 1). Two treatments (6 and 7 in Table 1) were a mix of at-planting and foliar sprays. Foliar treatments were first applied at 80% Colorado potato beetle egg hatch on 25 June 2014. Based on the economic threshold of *more than one large larva per plant*, additional first generation foliar sprays were needed for Treatment 7 (10 and 17 July), Treatment 8 (10 July), and Treatments 10-15 (3 July); no subsequent applications were necessary for any of the other foliar treatments. All applications were made using a single-nozzle hand-held boom with a flat tip nozzle (30 gallons/acre and 30 psi).

Post-spray counts of first generation Colorado potato beetle adults, small larvae (1^{st} and 2^{nd} instars), and large larvae (3^{rd} and 4^{th} instars) from five randomly selected plants from the middle row of each plot were made weekly, on 1, 9, 16 July. Plots were visually rated for defoliation weekly by estimating total defoliation per plot.

The numbers of small larvae, large larvae, and adults, were transformed log (x + 0.1) prior to analysis. Analysis of variance was used for data analysis and ad-hoc Tukey means separation was used to compare treatment means ($P < 0.05$).

RESULTS

Except for Treatments 15 and 16, all treatments resulted in significantly fewer large larvae than the untreated control (Figure 1). The neonicotinoid, Platinum, at-planting application continues to perform well, providing excellent first generation beetle control. Similar in performance is the newly registered cyazypyr, Verimark, at the higher rate (13.5 oz/A). The lower rate of Verimark (6.75 oz/A) was somewhat less effective although not statistically significant from the high rate; it performed similarly to the Verimark seed treatment. Among the combined at-planting and foliar applications, Treatment 6 provided excellent first generation beetle control, while Treatment 7 provided less protection, although the difference between the two treatments was not statistically significant. For the two foliar applications (Treatments 8 and 9), Blackhawk provided significantly weaker control, with two applications needed, than the newly registered Exirel, which with only one application was able to suppress larval numbers below threshold in the first generation. *Bacillus thuringiensis* effectively suppressed large larvae below threshold with two foliar applications during the first generation.

The untreated plots had significantly greater defoliation compared to all other treatments except for Treatments 14 and 15. The seasonal defoliation average was 21.6% in the untreated plots, compared to less than 8% for all other treatments. Differences in defoliation among insecticide treated plots ranged from 1 to 10% (except for treatments 14 and 15 which were similar to the control).

In summary, some neonicotinoid insecticides, such as Platinum are still providing sufficient Colorado potato beetle control during the first generation, but new chemistries like cyazypr (Verimark, Exirel) are proving to be effective alternatives to neonicotinoids.

Table 1. Insecticide treatments in the 2014 MSU potato trial, Montcalm Research Farm.

#	**Product name**	**Application rate**	**Mode of application**
1	Verimark (66 lb seed/50’ plot)	0.3 fl oz/plot = 8.87ml/plot	at planting, on seed
2	Platinum	2.66 oz/A	at-plant in furrow
3	Verimark	6.75 oz/A (pH 4-6)	at-plant in furrow
4	Verimark	13.5 oz/A (pH 4-6)	at-plant in furrow
5	Admire Pro	7 oz/A	at-plant in furrow
6	Platinum	2.66 oz/A	at-plant in furrow
	Gladiator + NIS	19 oz/A + 0.25% v/v	foliar broadcast
7	Capture	25.5 oz/A	at-plant in furrow
	Admire Pro	5.22 oz/A	at-plant in furrow
	Gladiator + NIS	19 oz/A + 0.25% v/v/	foliar broadcast
8	Blackhawk	2.5 oz/A	foliar broadcast
9	Exirel	5 oz/A (pH 4-6)	foliar broadcast
10	**Bt* + NIS		foliar broadcast
11	Peptide + *Bt* + NIS	1x	foliar broadcast
12	Peptide + *Bt* + NIS	2x	foliar broadcast
13	Peptide + *Bt* + NIS	4x	foliar broadcast
14	Peptide + NIS	2x	foliar broadcast
15	Peptide + NIS	24x	foliar broadcast
16	untreated control		

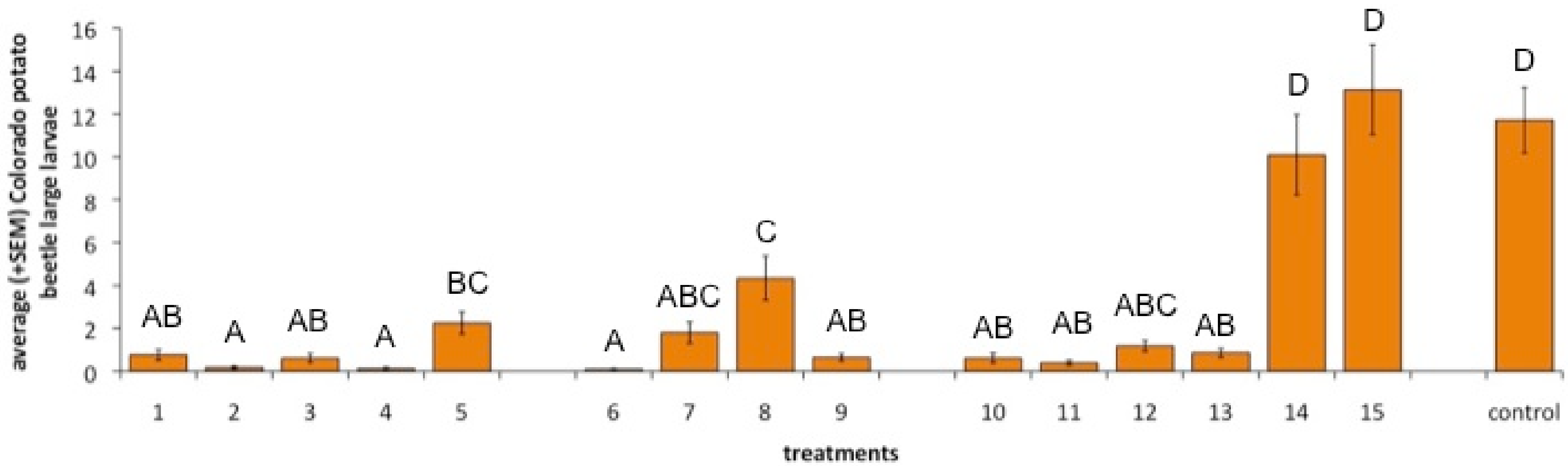

Figure 1. Average number of large larvae across three weekly sampling dates during the first generation of Colorado potato beetles at the Montcalm Research Farm Insecticide trial. Bars that share the same letters are not statistically different from each other. Treatment numbers correspond to numbers in the Table 1.

Nematodes, Cover Crops and Soil Health

George W. Bird
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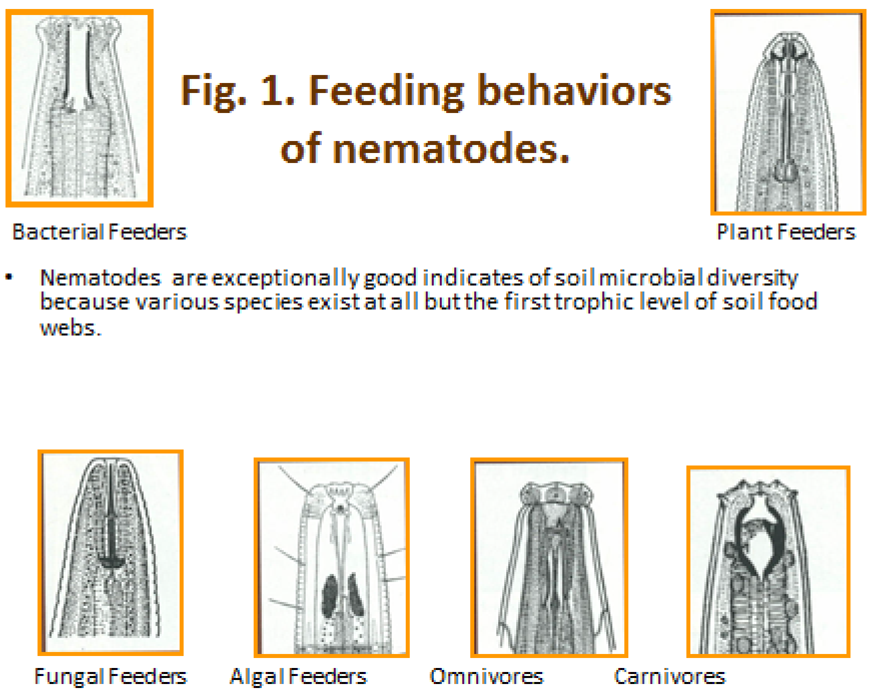
The two current most discussed topics in mid-west agriculture are cover crops and soil health. The MPIC Soil Health White Paper of May 16, 2012, had a significant making these topics of high priority significance. Throughout the years, most Michigan potato growers have had to deal with the Penetrans root-lesion nematode (*Pratylenchus penetrans*) as a predisposition agent for the Potato Early-Die Disease Complex (PED). The Animal Phylum Nematoda, however, is very diverse, containing species with a wide range of feeding behaviors (Figure 1.).



The nematodes that feed on bacteria are critical in the mineralization of nitrogen. The population densities of these species can be impacted significantly by both the cash crops and cover crops in potato rotations. MPIC funded cover crop research in 1988-1991 and again in 2012-2014, to investigate the impact of cover crops on both tuber yield and soil-borne microorganisms. The 1989-1990 research demonstrated that either two years of alfalfa or two years of clover followed by potatoes resulted in significantly greater tuber yields than those associated with eight other cropping systems, including those most commonly used in Michigan

(Table 1). The research did not detect any significant difference in the population densities of either of the organisms involved in PED.

Table 1. Impact of Multi-Year Cropping Regimes on *Solanum tuberosum* tuber yields in the Presence of *Pratylenchus penetrans* and *Verticillium dahliae*. 1995. Chen, Bird and Mather. J. Nematol. 27: 654-660.

Cropping System	Potato Yield (tons/acre	Penetrans Root-lesion nematode	*Verticillium dahliae*
Alfalfa/alfalfa/potato	32.34 a	NS	NS
Clover/clover/potato	33.80 a	NS	NS
Average of the other eight cropping systems	22.91 b	NS	NS

The 2012-2014 trial design involved four cropping systems (Table 2)

Table 2. Cover Crop Experimental Design(MRC)

System	2012	2013	2014
1	Potato-Rye	Rye-Corn	Potato
2	Potato-Wheat	Wheat-Mustard (BF)	Potato
3	Peas-Wheat	Wheat-Oil Seed Radish	Potato
4	Corn-Clover	Clover	Potato

The results of the 2012-2014 trial were similar to those of the 1988-1990 trial, with the highest yields being associated with the corn-clover system (Table 3).

Table 3. 2014 Potato Yield (cwt/A)

System	Crops	A Size	B Size	Jumbo	Culls	Total Yield
1. 2012 2013 2014	Potato-Rye Rye-Corn Potato	14.1	5.5	0.1	0.61	203
2. 2012 2013 2014	Potato-Wheat Wheat-Mustard (BF) Potato	14.1	6.3	0.92	0.54	219
3. 2012 2013 2014	Peas-Wheat Wheat-Oil Seed Radish Potato	15.9	10.2	0.72	0.70	224
4. 2012 2013 2014	Corn-Clover Clover Potato	16.4	8.9	0.76	1.00	270
Yields	P Statistic	0.608	0.109	0.239	0.623	0.280

The period of time, however, was too short for there to be any detectible changes in soil surface hardness, soil subsurface hardness or nematode community structure (Table 4).

The results of 40 years of Michigan potato nematicide research demonstrates circa a 35% tuber yield increase with methan and a 21% tuber yield increase with non-fumigant nematicies (Table 5). While use of nematicides is common in Michigan potato production systems, there is a growing body of evidence that some compounds are resulting in a decline in overall soil health. As a result of this, a major long-term (eight-year) on-farm soil health trial was initiated in 2014. While the results of the 2012 soil health initiative showed that the longer the crop rotation and the greater diversity in the rotation the higher the Soil Health Score (Cornell University System). The new research project, however, will be a two year system with only one year of a cash crop (potato). The alternate year will be devoted solely to soil health improvement. The initiative was started in 2014 as a 54 acre trial planted to peal millet. The nematode data associated with this trial indicated that the pearl millet was either a non-host for the Penetrans root-lesion nematode or a poor host. There were, however, significant plant biomass differences between two different sources of pearl millet.

Table 4. Soil Hardness

System	Crops	Surface (psi)	Subsurface (psi)
1. 2012 2013 2014	Potato-Rye Rye-Corn Potato	**93.1**	**255**
2. 2012 2013 2014	Potato-Wheat Wheat-Mustard (BF) Potato	**94.1**	**244.4**
3. 2012 2013 2014	Peas-Wheat Wheat-Oil Seed Radish Potato	**73.3**	**243.8**
4. 2012 2013 2014	Corn-Clover Clover Potato	**79.7**	**243.4**
Hardness	P Statistic	**0.301**	**0.901**

Table 5. Forty years (1974-2014 of Michigan potato nematicide research data (tuber yield, cwt/acre)

Year	Control	Metam	Temik	Vydate	Mocap
1974	388				
1975	278		314		
1976	176		209		
1977	119		172		
1978	267		371		
1979	160		209		
1980	117		216		
1981	330		370		
1982	185		231	285	272
1983	328		408		
1984	306		405		
1985	300	485	349		
1986	300	418	493		
1987	291	418			
1988					
1989	151		175	228	
1990	203		337		
1991	209			452	
1992	313	459			

Year	No nematicide	Metam	Temik	Vydate	Mocap
1993	273			403	
1994	298	407		347	450
1995					
1996	331		420	390	380
1997	219		257		259
1998	217	370		261	259
1999	266	436	267		
2000	121	348			
2001	252	352			
2002					
2003					
2004					
2005					
2006	126	190		151	
2007					
2008					
2009	404	484		474	
2010					
2011	316	350			
2012	382	429			
2013	269	360		432	242
2014	228			275	
Mean	254	388	306	324	324

(Table 5 continued)

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 23 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 60.7, 67.3, 62.9, 65.5 and 59.1 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 66.1, 71.5, 70.6, 74.4 and 77.1%. 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 2.11, 3.25, 3.58, 1.68, and 2.35. 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 percent K was significantly lower in the back-to-back potato organic treatment (Table 1). Moreover at 30 DAE Cu ppm was significantly lower and Fe ppm was significantly higher in inorganic potato following corn compared to all other treatments (Table 1). Additionally at 60 DAE percent Ca 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 percent S was significantly lower 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).

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). The number of sequences identified to phyla, class, order, family and genus was 28, 81, 140, 300 and 814 respectively (Table 2). The total number of sequences recovered from the data set thus far was 2,672,25 with approximately 14,214 sequences/sample. Currently the remaining DNA isolated from field experiments 2013 and 2014 are in the queue awaiting sequencing and microbial community analysis at the MSU RTSF.

Literature cited

1. Cole, J., Wang, Q., Cardenas, E., Fish, J., Chai, B., Farris, R., Kulam-Syed-Mohideen, A., McGarrell, D., Marsh, T., and Garrity, G. 2009. The Ribosomal Database Project: improved alignments and new tools for rRNA analysis. Nucleic acids research 37:D141–D145.
2. Cole, J. R., Wang, Q., Chai, B., and Tiedje, J. M. 2011. The Ribosomal Database Project: sequences and software for high-throughput rRNA analysis. Wiley-Blackwell, Hoboken, NJ.
3. Kozich, J. J., Westcott, S. L., Baxter, N. T., Highlander, S. K., and Schloss, P. D. 2013. Development of a dual-index sequencing strategy and curation pipeline for analyzing amplicon sequence data on the MiSeq Illumina sequencing platform. Applied and Environmental Microbiology.
4. Kozich, J. J., Westcott, S. L., Baxter, N. T., Highlander, S. K., and Schloss, P. D. 2013. Development of a dual-index sequencing strategy and curation pipeline for analyzing amplicon sequence data on the MiSeq Illumina sequencing platform. Applied and Environmental Microbiology 79:5112-5120.
5. Schloss, P. D., Westcott, S. L., Ryabin, T., Hall, J. R., Hartmann, M., Hollister, E. B., Lesniewski, R. A., Oakley, B. B., Parks, D. H., Robinson, C. J., Sahl, J. W., Stres, B., Thallinger, G. G., Van Horn, D. J., and Weber, C. F. 2009. Introducing mothur: Open Source, Platform-independent, Community-supported Software for Describing and Comparing Microbial Communities Appl. Environ. Microbiol. 75:7537-7754.

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]	Dry Weight (g)	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	40.0 a	2.1 a	0.8213 a	0.4037 a	10.3160 a	0.7940 a	0.3050 a	0.2535 a	35.188 a	207.808 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	42.3 a	2.6 a	0.9237 a	0.4340 a	9.6023 b	0.7956 a	0.3400 a	0.2371 a	35.828 a	154.704 a
Potatoes, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	39.7 a	2.4 a	0.8983 a	0.4437 a	10.7905 a	0.7423 a	0.2913 a	0.2525 a	41.373 a	197.430 a
Potatoes, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	42.1 a	1.9 a	1.1145 a	0.4907 a	10.3473 a	0.7635 a	0.3228 a	0.2573 a	37.905 a	106.823 a
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	-	-	-	-	-	-	-	-	-	-
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-	-	-
ANOVA p-value		0.693	0.802	0.950	0.8616	0.958	0.925	0.912	0.765	0.651	0.755

[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

Treatment[a]	Rate	30 DAE[b, c]					Total Yield CWT	Specific Gravity
		Cu ppm	B ppm	Al ppm	Fe ppm	Na %		
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	7.4940 a	27.750 a	57.0 a	223.10 a	0.0123 a	232.9 a	1.08 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	7.1934 a	27.454 a	48.1 a	166.65 a	0.0097 a	288.4 a	1.09 a
Potatoes, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	13.5070 b	27.955 a	52.5 a	451.88 b	0.0100 a	251.5 a	1.08 a
Potatoes, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	8.2638 a	27.005 a	56.8 a	300.58 b	0.0103 a	291.5 a	1.09 a
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	-	-	-		-	-	-
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-		-	-	-
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	-	-	-		-	-	-
ANOVA p-value		0.972	0.7635	0.756	0.755	0.264	0.473	0.451

[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)

Table 1. Continued

Treatment[a]	Rate	60 DAE[b,c] Dry Weight (g)	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	2.5 a	40.633 a	0.7475 a	0.1640 a	8.9625 a	1.1070 b	0.8884 a	0.3118 ab	62.480 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	2.6 a	41.250 a	0.8475 a	0.1540 a	8.2460 a	1.2053 ab	1.1039 a	0.3175 a	42.160 b
Corn, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	2.7 a	41.095 a	0.9440 a	0.1628 a	8.2168 a	1.2027 ab	0.9963 a	0.2785 c	65.918 a
Corn, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	2.7 a	40.633 a	0.5830 a	0.1663 a	7.5678 a	1.3555 a	1.2877 a	0.2908 bc	41.808 b
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	-	-	-	-	-	-	-	-	-
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-	-
ANOVA p-value		0.866	0.873	0.129	0.871	0.255	0.094	0.348	0.082	0.002

[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

Treatment[a]	Rate	60 DAE[b, c]						122 DAP[d]			
		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	584.74 a	133.725 a	5.3803 a	29.883 a	15.8 a	0.0163 a	97.6 a	66.7a	95.4 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	263.91 b	124.375 a	8.0833 a	30.125 a	5.3 a	0.0155 a	98.3 a	56.1ab	92.5 a	-
Corn, CPCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	544.26 a	103.603 b	16.7903 a	29.908 a	12.0 a	0.0163 a	99.2 a	58.1ab	92.9 a	-
Corn, CPCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	186.90 b	122.250 a	5.4083 a	30.360 a	5.5 a	0.0188 a	89.4 a	43.6b	92.5 a	-
Corn, CCPC Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	-	-	-	-	-	-	-	-	-	202.3 a
Corn, CCPC Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-	-	196.2 a
Corn, CCCP Inorganic Urea 46-0-0 Urea 46-0-0	 75 lb ai/A 120 lb ai/A	-	-	-	-	-	-	-	-	-	202.9 a
Corn, CCCP Organic Herbrucks Urea 46-0-0	 2 ton/A 85 lb ai/A	-	-	-	-	-	-	-	-	-	190.1 a
ANOVA p-value		0.002	0.080	0.529	0.981	0.218	0.224	0.063	0.044	0.954	0.991

[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).

Table 2. Summary of 16S DNA sequencing effort from 2013

No. of samples sequenced	Total no. of sequences	Average no. of sequences/soil sample	Classification[a]				
			Phyla	Classes	Orders	Families	Genera
188	2,672,255	14,214	28	81	140	300	814

[a] Taxonomic classification level was determined based on the Ribosomal Database Project

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

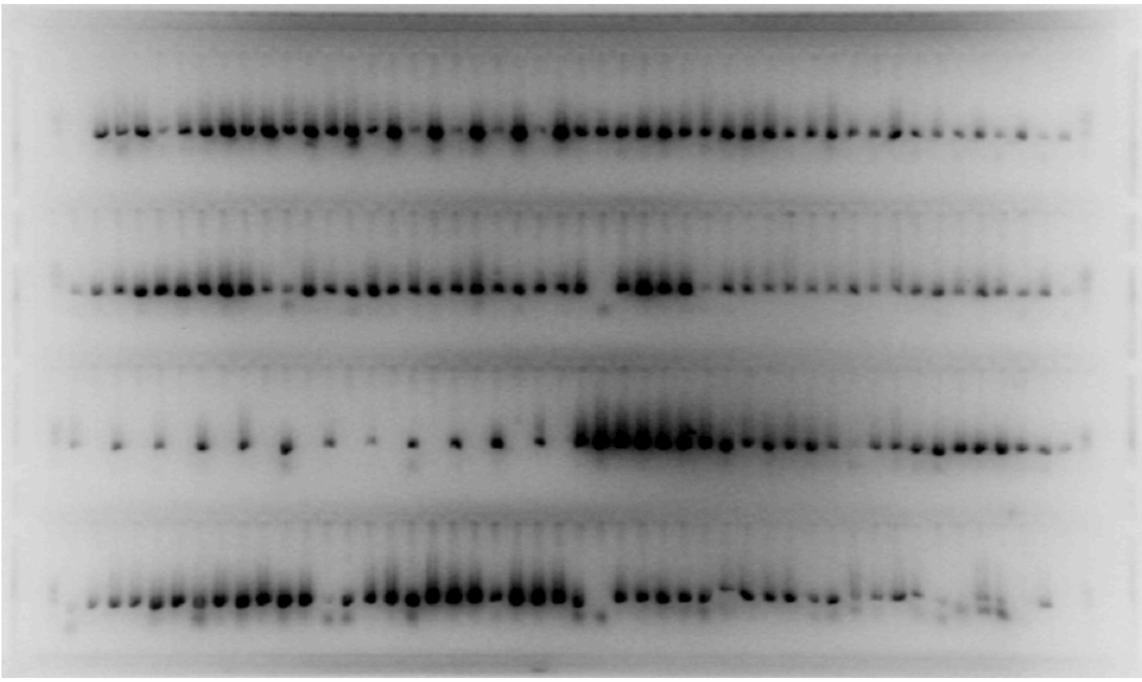

Figure 3. PCR amplification of soil genomic DNA from 2014 field trials. Resulting products are used for soil microbial community DNA sequence analyses.

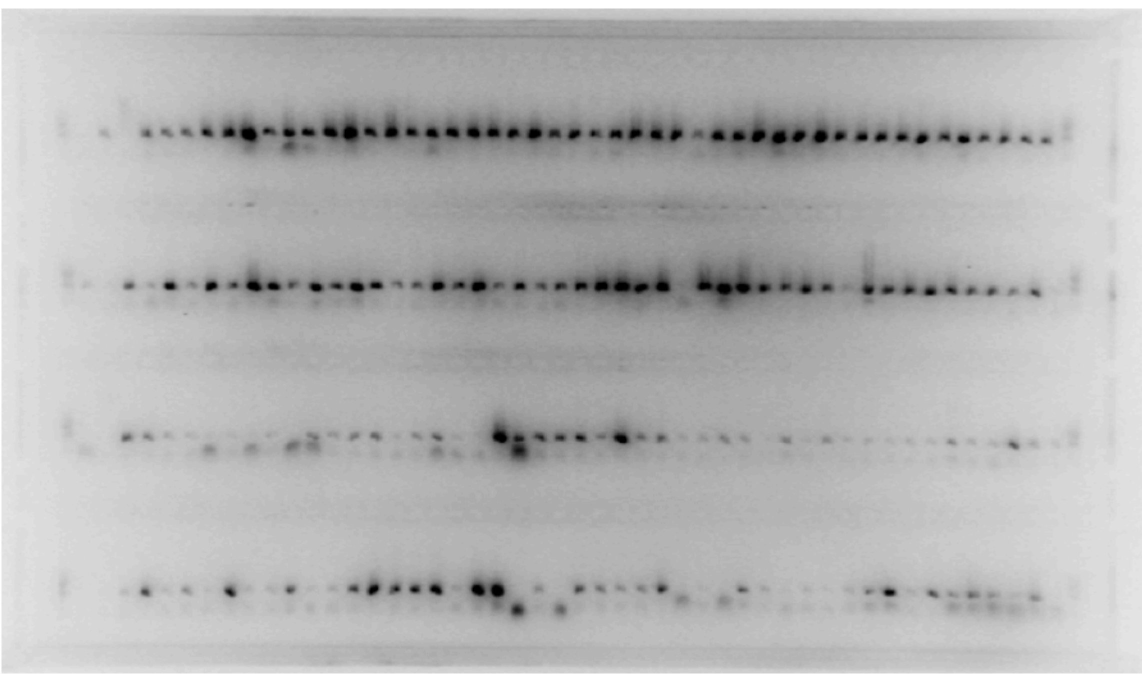

Figure 4. PCR amplification of soil genomic DNA from 2014 field trials. Resulting products are used for soil microbial community DNA sequence analyses.

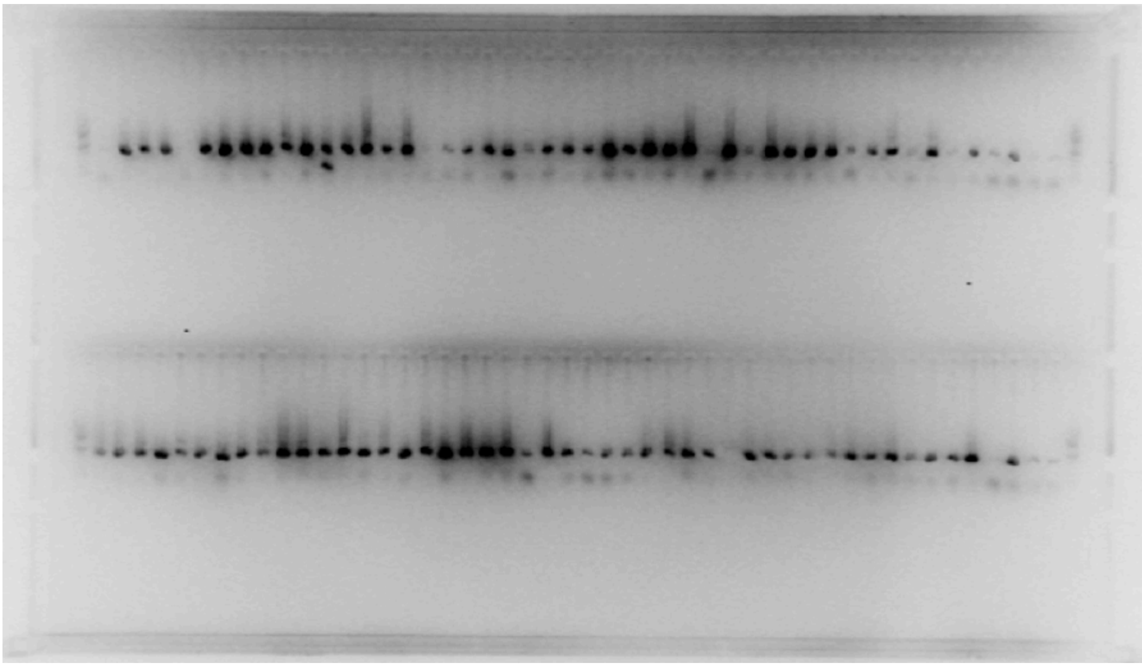

Figure 5. PCR amplification of soil genomic DNA from 2014 field trials. Resulting products are used for soil microbial community DNA sequence analyses.

Potato diseases update for Michigan State University

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Several disease issues impacted Michigan potato production during 2014 but the most serious was late blight. In this short update the highlights of the season will be covered. Dry rot is one of the most important establishment and postharvest diseases and can be caused by several *Fusarium* species. In the United States (US), yield losses attributed to dry rot in storage is estimated at $69 million to $228 million (unpublished data from USDA, Schisler). Currently there are at least 13 known *Fusarium* species responsible for potato dry rot in the US, and 11 of these species have been recently reported in MI. Seed treatments are effective but in situations where seed is extensively infected efficacy could be impaired. There is no curative action for Fusarium seed piece decay. The bulletins E-2995 (Seed Piece Health Management) and E-2992 (Fusarium Dry Rot) cover these issues extensively. The report on Fusarium dry management with fungicides in this volume covers some options for control.

Potato Late Blight was confirmed in a potato crop in Indiana in early July then followed by several fields in Montcalm County in mid-July. The genotype of the *Phytophthora infestans* isolate was the US-23 genotype confirmed by GPI allozyme analysis and DNA fingerprinting. Although this genotype was Ridomil sensitive the recommendations for treatment remain the same as those developed over several years of trials and include treating with one of the translaminar fungicides listed on http://www.lateblight.org/fungrate.html. The weather conditions and moderately mild winter favored this destructive pathogen in MI particularly in the west-central production area. Late blight is caused by the water mold *Phytophthora infestans*. The pathogen favors wet weather with moderate temperatures (60 – 80 °F), high humidity and frequent rainfall. Under such conditions, the disease can spread extremely rapidly and has the potential to completely defoliate fields within three weeks of the first visible infections if no control measures are taken. In addition to attacking foliage, *P. infestans* can infect tubers at any stage of development before or after harvest and soft rot of tubers often occurs in storage following tuber infections. Over the growing season there were multiple confirmed reports of late blight in potatoes and tomatoes throughout the southern half of Michigan and in the eastern counties also. Growers should beware of reducing their rates on contact fungicides as it is difficult to predict more than a few days in advance that weather conditions will be conducive or that late blight has appeared in a neighbor's field. The genotype in all cases in 2014 was US-23. The reports on late blight management with fungicides applied as traditional foliar applications and as seed treatments in this volume cover some options for control.

Other diseases were extensively reported in MI such as common scab and potato early die and some of the research trials on theses diseases are reported on in this volume.

Seed treatments, in furrow and early foliar treatments for control of seed-borne *Phytophthora infestans* (US-23), 2014.

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INTRODUCTION:

Potato (*Solanum tuberosum* L.) late blight caused by the oomycete *Phytophthora infestans* (Mont. de Bary), is a major constraint in potato production worldwide (Fry *et al*., 1997). The disease can cause significant losses in the field and storage. Economic losses due to late blight from yield loss and cost of disease management is estimated to exceed $6.7 billion annually (USAblight.org). Infected seed tubers, tubers in cull piles, volunteer tubers and rarely oospores (located in the soil); have been reported as primary sources of inoculum for initiation of epidemics (Zwankhuizen et al., 1998; Kirk et al., 2003; Fernandez-Pavia et al., 2004). Infected tubers may rot in field or later in storage, affecting both tubers intended for seed and consumption (Johnson and Cummings, 2009; Kirk et al., 2009; Olanya et al., 2009) or after planting, but can initiate a late blight epidemic if the pathogen survives in seed tubers and is transmitted to the developing shoot and then to foliage (Kirk et al., 1999; Johnson, 2010). However the rotting of tuber in storage is dependent on the aggressiveness of the *P.infestans* genotype and storage temperature. Storage temperatures of potato tubers vary depending on the intended use. Potato tubers intended for seed stored at 38°F have been reported to have no or minimal tuber tissue infection even in the tubers infected with the aggressive US-8 genotype (Kirk et al., 2001b). *Phytophthora infestans* can latently infect potato seed tubers during long-term cold storage (Johnson and Cummings, 2009). Although tubers can be infected in the field during the growing season, transmission of pathogen can occur during harvest, seed cutting and seed handling operations (Lambert et al. 1998). Therefore, it is important to treat seed tubers with effective fungicides prior to or at planting. The advent of the more aggressive, A2 mating type and metalaxyl insensitive genotypes of *P. infestans* such as US-8 (Lambert and Currier, 1997; Fry 2008, Kirk et al., 2001) increased the potential of late blight epidemic. However, genotypes of *P. infestans* that have recently appeared in North America are more sensitive to the phenylamide fungicide metalaxyl, than the insensitive biotypes common up to 2009 (Hu et al., 2012). Despites the huge effort by plant breeders, and advent of different new fungicides and technologies to monitor and control the disease, numerous challenges still remain for the management of tuber blight (Olanya *et al*., 2009). Although integrated disease management is the most reliable method for controlling late blight, growers rely heavily on fungicides to combat the disease. The right timing and rate of application of fungicides is of great importance to control late blight. The performance of fungicides against *P. infestans* during handling operations of potato seed piece may be more beneficial than used curative applications (Inglis et al., 1999). The objectives of this study therefore were to evaluate the different fungicides available in the market for the successful management of seed-borne late blight. The specific objectives of this study were to determine (i) effectiveness of different fungicides to control seed borne *P. infestans* applied as seed treatments or applied in-furrow during planting and after emergence and ii) to determine the impact of fungicides applied alone or in combinations.

MATERIALS AND METHODS:

Inoculum Preparation: Multiple isolates of *P. infestans* US-23 genotype (A1 mating type, sensitive to metalaxyl) from potato and tomato were used in this study. Isolates were sub-cultured on Pea agar media amended with ampicillin; incubated at 18°C in the dark for two weeks and exposed to light for two days to encourage sporulation. Culture plates (9 cm diameter x 15 mm depth Petri plates) were flooded with 50 ml sterile distilled water and gently scraped with an L-shaped glass rod to dislodge mycelium and sporangia. The final concentration of inoculum was adjusted to 10^6 sporangia ml^{-1} using a Makler counting chamber. The suspension was placed at 4°C for 2 hours to release the zoospores.

Inoculation and Seed Treatment: Potato tubers (cv. Snowden) susceptible to late blight (Kirk et al., 2009) were used in the experiment. Tubers free from disease symptoms were selected for the experiment. Potato tubers were first cut into two or three sections (based on the size of potato) longitudinally ensuring the presence of viable sprouts on each seed-piece. The cut seed pieces were immersed in the mixture of mycelium and zoospores of *P. infestans* for 30 minutes then dried at 70ºF for 1 h prior to treating with fungicidal seed treatments. Tubers were stored for a further 24 h prior to planting. 15 different fungicides with different concentrations (some treated alone and some in combination) were used in the study (Tables 1 - 2). Treatments applied to seed pieces were (i) not-inoculated, (ii) inoculated, (iii) inoculated and treated with fungicides either after inoculation (described above) or left not-treated for the in-furrow application. The samples for each treatment consisted of 320 seed pieces that were split into groups of 50 for 6 replications for the field experiment and 20 tubers were sampled for determination of inoculation efficiency in controlled environment chambers. Dust formulations were measured and added to inoculated seed pieces in paper bags and shaken for 2 min to ensure uniform spread of the fungicide until the fungicides were coated on the seed. Fungicides applied as pre-planting potato seed liquid treatments were applied in water suspension at a rate of 0.2 pt H_2O/cwt onto the exposed seed tuber surfaces, with the entire seed surface being coated. In-furrow at-planting applications were delivered at 8 pt water/A in a 7 in. band using a single XR11003VS nozzle at 30 p.s.i.

Experimental set up:

Laboratory experiment: A total of 20 potato seed pieces from each treatment were separated and collected in 5 lb mesh bags and replicated four times consisting of 5 tubers in each replication. The tubers were incubated in plastic boxes lined with wet paper towels at 60°F in environmental control chambers for 30 days. After 30 days of incubation, disease incidence was evaluated by counting the number of seed pieces with symptoms of late blight.

Field experiment: To evaluate the effects on emergence and plant stand, treated seed tubers were planted at the Clarksville Research Center, MSU, MI (Capac loam soil); 42.8733, -85.2604 deg; elevation 895 ft. on 28 May 2014 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 six times in a randomized complete block design. The two-row beds were separated by a 5-ft unplanted 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 (days after planting). Weeds were controlled by hilling and with Dual 8E at 2 pt/A 10 DAP and Poast at 1.5 pt/A 58 DAP. Insects were controlled with Admire Pro 2F at 1.25 pt/A at planting (unless an insecticide was included in the seed treatment formulation) 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.

Data Collection and Analysis: The number of emerged plants was recorded over a 41-day period after planting and 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. Data were analyzed using the statistical analysis software package JMP (SAS Institute, Cary, NC) by analysis of variance, and mean separation tests conducted with Least Square Means Tukey HSD at $P \leq 0.05$. Meteorological variables were measured with a Campbell weather station located at the farm from 1 June to 31 September. Average daily air temperature (°F) from 1 June was 67.6, 64.9, 67.5 and 59.7 and the number of days with maximum temperature >90°F was 0 (Jun, Jul, Aug and Sep, respectively). Average daily relative humidity (%) over the same period was 71.1, 71.5, 75.8 and 74.0 (Jun, Jul, Aug and Sep, respectively). Average daily soil temperature at 4" depth (°F) over the same period was 68.3,72.5, 72.4, and 66.0 and the number of days with maximum soil temperature >90°F was 0 from June to Sept. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 37.1, 39.6, 40.1 and 39.7 (Jun, Jul, Aug and Sep, respectively). Average precipitation was 0.41, 0.30, 0.59 and in (Jun, Jul, Aug and Sep, respectively). Plots were irrigated to supplement precipitation to about 0.1 in. /A/4 day period with overhead sprinkle irrigation.

RESULT AND DISCUSSION

Lab experiment: Late blight developed successfully in all the replications of the inoculated check seed pieces. Late blight and other diseases did not develop in non-inoculated non-treated check seed pieces. Seed pieces treated with different fungicides developed late blight in some tubers in all treatments (Table 1). Treatment with disease incidence lower than 65% were significantly different from inoculated check (80%). This study was done to check the efficacy of the inoculation.

Field experiment: Late blight developed in the seed pieces and affected plant stand in all treatments in that no treatments achieved 100% plant stand, including the not-inoculated not-treated check. Responses of some treatments considered relative to the not-inoculated non-treated check indicated that some treatments enhanced emergence rate. At the final plant stand evaluation, all treatments except Cruiser Maxx Potato, Serenade Soil, Tenet and Moncoat MZ had significantly greater plant stand in comparison to the inoculated check treatment. Treatments with greater than 63.3; 60.0 to 83.7; 49.7 to 74.7; 48.7 to 73.7; 48.0 to 73.0; 46.3 to 71.3 and 30.0 to 49.7% plant stand were not significantly different from each other. Emergence taken over a 41 day period (RAUEPC) indicated that treatments with RAUEPC values from 15.3 to 30.6 were not significantly different from the inoculated check (RAUEPC = 16.0). Treatments with RAUEPC values from 33.6 to 47.6; 30.6 to 45.3; 25.1 to 40.4; 24.5 to 39.8; 23.6 to 38.9 and 15.3 to 30.6 were not significantly different. The treatments Reason + Nubark Mancozeb and Revus + Nubark mancozeb had significantly greater plant stand than not-inoculated non-treated check but were not significantly different from each other. Late blight symptoms appeared on stems of two plants; 1 in the inoculated check and another in a Tenet treatment. Except these two treatments, late blight did not appear on stems or foliage in any treatments. Seed treatments and in-furrow applications of fungicides were not phytotoxic.

Table 1. **Effect of seed and in-furrow treatments for control of seed-borne *Phytophthora infestans* (US-23) on disease incidence in inoculated tubers (%).**

Treatment and rate/1000 ft row and rate/cwt potato seed	Disease Incidence %[a]	
Not-inoculated Not-treated Check…………………....	0	f[c]
Cruiser Maxx Potato 28EC 0.215 fl oz (A)[b]…………	65	ab
Cruiser Maxx Potato 28EC 0.215 fl oz + Revus 250SC 0.307 fl oz (A)…………………………	50	bc
Cruiser Maxx Potato 28EC 0.215 fl oz + Revus 250SC 0.614 fl oz (A)…………………………	30	cde
Curzate 60DF 1 oz (<u>A</u>) + Nubark Mancozeb 6DS 1 lb (<u>A</u>)……………………...	20	def
Maxim 4FS 0.08 fl oz (A) + Quadris 2.08FL 0.6 fl oz (B)…………………………	45	bcd
Maxim MZ 6.2DP 0.5 lb (<u>A</u>)…………………………	40	bcd
Moncoat MZ 7.5DP 12 oz (<u>A</u>)………………………	45	bcd
Nubark mancozeb 6DS 1lb (<u>A</u>)………………………	30	cde
Reason 500SC 0.15 fl oz (A)………………………...	25	c-f
Reason 500SC 0.15 fl oz (A) + Nubark Mancozeb 6DS 1lb (<u>A</u>)………………………	10	ef
Revus 250SC 0.307 fl oz (A) + Nubark Mancozeb 6DS 1lb (<u>A</u>)………………………	35	cde
Revus 250SC 0.614 fl oz (A) + Nubark Mancozeb 6DS 1lb (<u>A</u>)………………………	30	cde
Revus 250SC 0.307 fl oz (A)…………………………	30	cde
Revus 250SC 0.614 fl oz (A)…………………………	35	cde
Inoculated Not-treated Check…………………..........	80	a

[a] Disease incidence (%) is calculated as the ratio of tubers developing late blight symptoms. 20 potato seed pieces were incubated in plastic boxes lined with wet paper towels at 15°C in a controlled environmental chamber for 30 d.

[b]Application dates: A= 28 May (liquid formulations for seed piece application at 0.2 pt. H_2O/cwt); <u>A</u>= 28 May (dry formulation); B= 28 May (in-furrow).

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

Table 2: Effect of seed and in-furrow treatments for control of seed-borne *Phytophthora infestans* (US-23) on plant stand (%) and emergence (relative area under emergence progressive curve; RAUEPC (0-100).

Treatment and rate/1000 ft row and rate/cwt potato seed	Final Plant Stand % June 11 14 DAP[a]		June 13 16 DAP		June 15 18 DAP		June 18 21 DAP		June 26 29 DAP		July 1 34 DAP		July 8 41 DAP		RAUEPC[b]	
Non-inoculated Not-treated Check………………..	5.0	a[d]	14.7	a	39.7	ab	57.7	a-e	63.3	a-f	78.0	ab	83.0	ab	40.4	abc
6% Mancozeb Fir Bark 6DS 1lb (A[c])……………..	1.0	a	5.7	a	25.7	ab	57.3	a-e	70.3	a-d	74.3	ab	74.7	abc	38.1	a-e
Cruiser Maxx Potato 28EC 0.215 fl oz (A)………..	1.7	a	7.3	a	20.3	ab	37.3	b-g	49.3	d-h	49.0	c-f	49.7	c-g	26.2	c-f
Cruiser Maxx Potato 28EC 0.215 fl oz + Revus 250SC 0.307 fl oz (A)……………………..	2.7	a	10.7	a	28.3	ab	53.0	a-f	64.7	a-f	71.7	a-d	71.7	a-e	36.7	a-e
Cruiser Maxx Potato 28EC 0.215 fl oz + Revus 250SC 0.614 fl oz (A)……………………..	0.7	a	6.3	a	22.0	ab	54.0	a-e	67.0	a-f	70.3	a-e	71.0	a-f	36.0	a-e
Curzate 60DF 1 oz (A) + Nubark Mancozeb 6DS 1 lb (A)…………………..	3.3	a	13.3	a	40.7	ab	67.0	ab	83.7	ab	81.3	ab	81.3	ab	44.9	ab
Emesto Silver Red Pigmented 118FS 0.31 fl oz (A) + Nubark Mancozeb 6DS 1 lb (A)………………	4.3	a	13.3	a	37.3	ab	66.7	ab	78.7	abc	81.3	ab	81.3	ab	44.0	ab
Emesto Silver Red Pigmented 118FS 0.31 fl oz (A) + Reason 500SC 0.15 fl oz (A) + Nubark Mancozeb 6DS 1 lb (A)…………………	3.0	a	8.3	a	26.3	ab	54.0	a-e	68.0	a-f	73.7	abc	73.7	a-d	37.7	a-e
Emesto Silver Red Pigmented 118FS 0.31 fl oz (A) + Nubark Mancozeb 6DS 1 lb (A) + Serenade Soil 1.34SC 19.3 fl oz (B)………………	5.7	a	15.3	a	26.7	ab	44.3	a-g	60.3	b-f	62.7	b-e	63.3	a-f	33.6	a-e
Maxim 4FS 0.08 fl oz (A) + Quadris 2.08FL 0.6 fl oz (B)………………………	3.0	a	10.7	a	30.3	ab	50.3	a-f	63.3	a-f	71.3	a-d	71.3	a-f	36.3	a-e
Maxim MZ 6.2DP 0.5 lb (A)……………………....	2.7	a	9.7	a	28.0	ab	52.3	a-f	70.3	a-d	78.0	ab	78.0	ab	38.9	a-e
Moncoat MZ 7.5DP 12 oz (A)……………………	3.0	a	9.3	a	20.0	ab	35.3	c-g	43.0	e-h	46.0	ef	46.3	fg	24.5	def
Nubark Gold 6DS 1 lb (A)………………………..	6.3	a	14.3	a	39.7	ab	64.3	abc	75.3	a-d	78.0	ab	78.0	ab	43.0	ab
Nubark mancozeb 6DS 1lb (A)……………………	5.3	a	15.7	a	37.0	ab	59.0	a-e	67.7	a-f	69.3	a-e	69.3	a-f	38.8	a-e
Quadris 2.08FL 0.6 fl oz (B)………………………	0.0	a	5.3	a	22.3	ab	47.7	a-g	55.3	c-g	59.7	b-e	60.0	b-f	30.6	b-f
Reason 500SC 0.15 fl oz (A)……………………..	5.0	a	13.0	a	36.0	ab	63.7	abc	69.3	a-e	72.7	a-d	73.0	a-e	40.2	abc
Reason 500SC 0.15 fl oz (A) + Nubark Mancozeb 6DS 1lb (A)…………………..	3.0	a	11.0	a	37.7	ab	74.7	a	87.0	a	88.0	a	88.3	a	47.6	a
Revus 250SC 0.307 fl oz (A) + Nubark Mancozeb 6DS 1lb (A)…………………..	2.7	a	12.3	a	37.0	ab	63.7	abc	76.0	abc	82.0	ab	82.0	ab	43.0	ab
Revus 250SC 0.614 fl oz (A) + Nubark Mancozeb 6DS 1lb (A)…………………..	4.0	a	13.7	a	42.0	a	71.3	a	78.0	abc	83.3	a-d	83.7	ab	45.3	ab
Revus 250SC 0.307 fl oz (A)……………………..	3.0	a	11.0	a	36.3	ab	62.7	a-d	71.3	a-d	72.3	a-d	72.3	a-e	39.8	a-d
Revus 250SC 0.614 fl oz (A)……………………..	2.3	a	9.3	a	30.0	ab	58.0	a-e	70.0	a-d	72.7	a-d	73.3	a-d	38.5	a-e
Ridomil Gold 4SL 0.42 fl oz (B)…………………	0.7	a	6.7	a	27.0	ab	49.3	a-g	56.7	c-f	62.0	b-e	62.0	b-f	32.1	b-e
Serenade Soil 1.34SC 8.8 fl oz (B)……………….	0.3	a	5.0	a	12.7	b	19.3	g	26.0	h	32.3	f	32.3	g	15.3	f
Tenet 4WP 1.5 fl oz (B)…………………………..	0.7	a	4.3	a	15.7	ab	33.0	d-g	42.7	fgh	48.0	def	48.0	efg	23.6	ef
Tenet 4WP 2.25 fl oz (B)………………………….	3.7	a	11.7	a	20.0	ab	30.3	efg	42.7	fgh	48.3	def	48.7	d-g	24.6	def
Tenet 4WP 3 fl oz (B)…………………………….	2.3	a	8.0	a	20.7	ab	35.3	c-g	43.3	e-h	49.0	c-f	49.0	d-g	25.1	c-f
Inoculated Not-treated Check…………………......	1.0	a	6.0	a	12.7	b	23.3	fg	29.3	gh	30.0	f	30.0	g	16.0	f

[a]DAP= days after planting
[b]RAUEPC = Relative area under the emergence progress curve measured from planting to days after planting
[c]Application dates: A= 28 May (liquid formulations for seed piece application at 0.2 pt H_2O/cwt; A = 28 May (dry formulation) and B= 28 May (in-furrow application)
[d] Values followed by the same letters are not significantly different p= 0.05 (Least Square Means Tukey HSD)

References:

Fernandez-Pavia, S.P. Grunwald, N.J. Diaz-Valasis, M., Cadena-Hinojosa, M., and Fry, W.E. 2004. Soilborne oospores of *Phytophthora infestans* in Central Mexico survive winter fallow and infect potato plants in the field. Plant Dis. 88:29-33.

Fry, W. 2008. Phytophthora infestans: the plant (and R gene) destroyer. Mol. Plant Pathol. 9:385-402.

Fry, W.E. and Goodwin, S.B. 1997. Re-emergence of potato and tomato late blight in the United States. Plant Dis. 81: 1349-1357.

Hirst, J. M., and Stedman, O. J. 1960. The epidemiology of *Phytophthora infestans*. II. The source of inoculum. Ann. Appl. Biol. 48:489-517.

Hu, C.-H., Perez, F. G., Donahoo, R., McLeod, A., Myers, K., Ivors, K., Secor, G., Roberts, P. D., Deahl, K. L., Fry, W. E., and Ristaino, J. B. 2012. Recent genotypes of *Phytophthora infestans* in eastern United States reveal clonal populations and reappearance of mefenoxam sensitivity. Plant Dis. 96:1323-1330.

Inglis, D. A., Powelson, M. L., and Dorrance, A. E. 1999. Effect of registered potato seed piece fungicides on tuber-borne *Phytophthora infestans*. Plant Dis. 83:229-234.

Johnson, D. A. 2010. Transmission of *Phytophthora infestans* from infected potato seed tubers to emerged shoots. Plant Dis. 94:18-23.

Johnson, D.A. and Cummings, T.F. 2009. Latent infection of potato seed tubers by *Phytophthora infestans* during long-term cold storage. Plant Dis. 93:940-946.

Kirk, W. W. 2003. Thermal properties of overwintered piles of cull potatoes. Am. J. Potato Res. 80: 145-149.

Kirk, W. W., Abu-El, Samen, F., Wharton, P., Douches, D., Tumbalam, P., Thill, C. and Thompson, A. 2009. Impact of different US genotypes of *Phytophthora infestans* on potato seed tuber rot and plant emergence in a range of cultivars and advanced breeding lines. Potato Res 51: 121-140.

Kirk, W., Felcher, K., Douches, D., Niemira, B. and Hammerschmidt, R. 2001a. Susceptibility of potato (*Solanum tuberosum* L.) foliage and tubers to the US-8 genotype of *Phytophthora infestans*. Am J Potato Res. 78:319-322

Kirk, W.W., Niemira, B. A. Stein J. M., and Hammerschmidt R. 1999. Late blight (*Phytophthora infestans* (Mont) De Bary) development from potato seed-pieces treated with fungicides. Pestic Sci. 55:1151-1158.

Kirk, W.W., Niemira, B.A. and Stein, J.M. 2001b. Influence of storage temperature on rate of potato tuber tissue infection caused by different biotypes of *Phytophthora infestans* (Mont.) de Bary estimated by digital image analysis. Potato Res. 44:86-96.

Lambert, D. H. Currier, A. I., and Olanya, M. O. 1998. Transmission of *Phytophthora infestans* in cut potato seed. Am. J. Potato Res. 75:257-263.

Lambert, D.H. and Currier, A.I. 1997. Differences in tuber rot development for North American clones of *Phytophthora infestans*. Am Potato J. 74:39-43.

Olanya, O.M., Ojiambo, P.S., Nyankanga, R.O., Honeycutt, C.W., Kirk, W.W. 2009. Recent developments in managing tuber blight of potato (*Solanum tuberosum*) caused by *Phytophthora infestans*. Can. J. Plant Pathol. 31:280-289.

Zwankhuizen, M. J., Govers, F., and Zakoks, J. C. 1998. Development of potato late blight epidemics: Disease foci, disease gradients,and infection sources. Phytopathology. 88:754-763.

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Seed treatments and seed plus in furrow treatments for control of seed-borne *Fusarium sambucinum*, 2014.

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Potato seed (Snowden) was prepared for planting by cutting and treating with fungicidal seed treatments two days prior to planting. The seed were first inoculated by spraying about 7 fl oz of conidial suspension (30 conidia/fl oz) of a mixture of 10 virulent single spore isolates of *Fusarium sambucinum* over the entire cut surface to give a final dosage of about 0.03 fl oz per seed piece. 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 22 May 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. 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/cwt 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. Foliar applications were applied with a 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 (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 or if a formulation included an insecticide the Admire was not applied, 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 15 Sep). Plant stand was rated 17, 22 and 32 days after planting (DAP) and relative rate of emergence was calculated as the Relative Area Under the Emergence Progress Curve [RAUEPC from 0 – 32 DAP, maximum value = 100]. Plots were harvested on 3 Oct and individual treatments were weighed and graded. 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 30 May was 60.1, 65.8, 67.5, 66.1, and 60.7 and the number of days with maximum temperature >90^{o}F was 0, 0, 1, 0 and 0 (May, Jun, Jul, Aug, Sep, respectively). Average daily relative humidity (%) over the same period was 64.8, 71.4, 72.1, 72.7 and 74.7%. Average daily soil temperature at 4” depth (^{o}F) over the same period was 60.2, 68.3, 73.1, 67.7, 62.0 and 61.6. Average daily soil moisture at 4” depth (% of field capacity) over the same period was 37.4, 39.2, 37.8, 36.6 and 36.3. Precipitation (in.) over the same period was 4.22, 4.21, 3.31, 3.2, and 2.73. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

Treatments with final plant stand greater than 98.1% were significantly higher in comparison to the not-treated control (84.6%) and treatments with final plant stand less than 98.1% were significantly different from the not-treated not-inoculated control (45.9). Treatments with a relative rate of emergence (RAUEPC) greater than 39.5 were significantly higher in comparison to the untreated control (29.9) and treatments with RAUEPC values less than 36.7 were significantly different from the not-treated not-inoculated control (45.9). No treatments had an effect on either US-1 or total yield and ranged from 268 (not-treated) to 447 and 296 (not-treated) to 486 cwt/A, respectively.

Funding: MPIC and Industry

Treatment and rate/cwt potato seed (A); rate/1000 row feet (B)	Emergence (%) 17 DAP		22 DAP	33 DAP		RAUEPC[a] Max = 100 (0 – 33 DAP)		Yield (cwt/A) US-1	Total
Nubark mancozeb DS 16 oz (A[b])………	41.5	bcd[c]	83.0	98.7	ab	42.8	b-e	378	410
Nubark mancozeb DS 16 oz A); Quadris FL 0.6 fl oz (B)………………..	36.0	de	81.0	100	a	41.3	b-e	410	436
Nubark mancozeb DS 16 oz (A); Inspire SC 0.48 fl oz (B)……………….	44.5	bcd	76.6	98.5	ab	42.4	b-e	406	438
Nubark mancozeb DS 16 oz (A); Medallion WP 0.48 oz (B)……………..	30.5	de	69.7	99.4	ab	36.7	def	374	397
Nubark mancozeb DS 16 oz/cwt (A); Luna Tranquility SC 0.55 fl oz (B)…….	34.5	de	88.8	98.1	ab	39.5	b-f	399	443
Serenade Soil SC 8.8 fl oz (B)…………	33.0	de	71.6	100.0	a	38.3	c-f	368	397
Maxim 4FS FS 0.08 fl oz (A)…………	43.5	bcd	74.5	98.9	ab	42.1	b-e	368	390
Tenet WP 1.5 oz (B)……………………	56.5	abc	67.7	98.8	ab	45.5	a-d	378	423
Tenet WP 2.25 oz (B)…………………..	36.5	cde	71.4	99.1	ab	39.1	b-f	378	403
Tenet WP 3 oz (B)……………………....	58.0	ab	77.8	100.0	a	48.3	abc	447	486
Maxim 4FS FS 0.08 fl oz (A); Tenet WP 3 oz (B)……………………....	32.0	de	59.7	94.2	bc	34.3	ef	392	418
Vertisan EC 1.1 fl oz (B)……………….	69.5	a	86.7	100.0	a	54.7	a	425	463
Maxim 4FS FS 0.08 fl oz (A); Quadris FL 0.6 fl oz (B)………………..	60.0	ab	77.8	99.6	ab	49.1	ab	382	441
Inspire SC 0.3 fl oz (B)………………...	48.0	bcd	84.5	100.0	a	46.3	a-d	414	456
Check (inoculated)………….…………	18.5	e	65.7	84.6	c	29.9	f	268	296
Check (not-inoculated)…………………	48.5	bcd	82.0	100	a	45.9	a-d	381	412

[a] RAUEPC = Relative area under the emergence progress curve measured from planting to 31 days after planting.
[b] Application dates: A= 20 May (liquid formulations for seed piece application at 0.2 pt/cwt); B= 22 May (in-furrow).
[c] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD).

Funding: MPIC and Industry

Evaluation of fungicide programs for potato early blight, brown leaf spot control, Botrytis tan spot and white mold, 2014.

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Potatoes ('Russet Norkotah', cut seed, treated with Maxim FS at 0.16 fl oz/cwt) were planted at Clarksville Research Center, Michigan State University, Clarksville, MI (Capac loam soil); 42.8733, -85.2604 deg; elevation 895 ft. on 26 May 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 15 Jul to 3 Sep (8 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 from adjacent plots inoculated with *Phytophthora infestans* with bi-weekly applications of Previcur N 6SC at 1.2 pt from early canopy closure on 15 Jul to 3 Sep. Weeds were controlled by hilling and with Dual 8E (2 pt on 3 Jun), Poast 1.5EC (1.5 pt on 13 Jul). Insects were controlled with Admire 2F (20 fl oz at planting), Sevin 80S (1.25 lb on 13 and 29 Jul), Thiodan 3EC (2.33 pt on13 Aug) and Pounce 3.2EC (8 oz on 22 Jul). Plots were rated visually for combined percentage foliar area affected by early blight and brown leaf spot and Botrytis tan spot on 30 Aug and 5, and 11 Sep [8 days after final application (DAFA). The evaluations for early blight and brown leaf spot were combined into a single assessment. The relative area under the disease progress curve (RAUDPC; max = 100) was calculated for each disease and for each treatment from the date of appearance of symptoms (30 Aug) to 11 Sep, a period of 12 days. Vines were killed with Reglone 2EC (1 pt on 12 Sep). Plots were harvested on 10 Oct and tubers from individual treatments were weighed and graded. Meteorological variables were measured with a Campbell weather station located at the farm from 1 May to the final evaluation (30 Aug). Average daily air temperature (^{o}F) from 1 Jun was 67.6, 65.1, and 67.5 and the number of days with maximum temperature >90^{o}F was 0, 0 and 0 (Jun, Jul, Aug, respectively). Average daily relative humidity (%) over the same period was 71.1, 71.5, and 75.6. Average daily soil temperature at 4" depth (^{o}F) over the same period was 68.3, 72.5, and 72.4. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 37.1, 39.6, and 40.1. Precipitation was 5.78, 3.58, and 6.70 in. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation. Early blight severity values accumulated from emergence on 5 Jun to 29 Sep (evaluation date) were 917 P-days.

Weather conditions were 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 steadily during Aug and untreated controls reached about 47.0% foliar infection by 19 Aug after which the vines started to senesce making disease assessment difficult as several diseases were interacting and late blight moved into the plots. Most treatments had significantly less combined early blight, brown leaf spot and Botrytis tan spot than the untreated control except those with greater than 27.4% affected foliage. White mold developed slowly during Aug and untreated controls reached 6.8 and 9.5% foliar infection by 4 and 25, respectively. Fungicide programs with less than 4.4% and 8.5% white mold were significantly different to the untreated control up to 19 Jul and 2 Aug, respectively. Fungicide programs with greater than 26.3% and 48.8% bacterial stem rot were significantly different to the untreated control up to 19 Jul and 2 Aug, respectively. Programs with bacterial stem rot less than 2.7 and 1.9% were not significantly different to the untreated control (2.7 and 3.9%) up to 19 Jul and 2 Aug, respectively. Treatments with greater than US-1 yield of 216 cwt and total yield of 306 cwt were significantly different from the untreated control. Phytotoxicity was not noted in any of the treatments.

Treatment and rate	Early Blight		Brown Leaf Spot		Alternaria combined[b]		Botrytis tan spot		Alternaria + Botrytis[c]	
	Final foliar severity 81 DAP[a] (%)									
Echo ZN 38.5SC 32 fl oz (ABDFH[d]); Luna Tranquility 45.1SC 8 fl oz (CEG)……	2.5	ghi[e]	2.2	d-g	5.4	h-k	7.9	d-g	13.1	g-k
Echo ZN 38.5SC 32 fl oz (ABDFH); Luna Tranquility 45.1SC 11.2 fl oz (CEG)...	1.6	ij	1.1	g	3.2	k	5.0	gh	8.3	k
Bravo WS 6SC 6SC 24 fl oz (A-H)………	3.6	fgh	3.8	b-f	7.6	f-i	14.6	ab	22.0	b-f
Bravo WS 6SC 6SC 24 fl oz (ACEG)….….	4.3	d-g	7.3	b	12.2	c-f	15.7	a	27.4	bc
Bravo WS 6SC 6SC 24 fl oz (ADEFGH); Vangard 75WG 7 oz (BC)…………………	6.0	c-f	2.2	d-g	8.6	e-h	6.0	fgh	14.5	f-j
Bravo WS 6SC 6SC 24 fl oz (ADEFGH); Inspire Super 2,82EW 2.82EC 20 fl oz (BC)	1.9	hij	2.2	d-g	4.3	h-k	7.1	efg	11.1	ijk
Bravo WS 6SC 6SC 24 fl oz (ADEFGH); Switch 62.5WG 20 oz (BC)………………..	2.2	g-j	4.7	b-e	7.3	f-j	9.5	b-f	16.5	e-i
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Meteor 4F 1.5 pt (BD)……………………..	2.5	ghi	7.3	b	10.5	d-g	8.5	c-f	19.2	c-g
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 1.5 pt (BDF)…………………….	8.5	abc	6.1	bc	14.8	cd	10.2	a-e	25.5	b-e
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 1.5 pt (BDF)…………………….	8.5	abc	2.7	d-g	11.4	def	13.2	abc	24.7	b-e
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Meteor 4F 2 pt (BD)………………………..	1.0	j	5.0	bcd	6.0	g-k	12.3	a-d	18.3	c-h
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 2 pt (BDF)………………………	3.9	e-h	3.8	c-f	7.8	f-i	10.0	a-e	17.8	c-h
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 2 pt (BDF)………………………	3.9	e-h	2.0	efg	6.2	g-k	8.5	c-f	14.8	f-j
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Luna Tranquility 45.1SC 11.2 fl oz (BD)….	2.5	ghi	1.2	g	4.0	ijk	6.0	fgh	9.9	jk
CX-10250 100WG 0.9 oz (ACEG); Bravo WS 6SC 6SC 24 fl oz (BDFH)……..	7.9	bcd	4.7	b-e	13.5	cde	12.3	a-d	25.7	bcd
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Omega 500F 8 fl oz (BD)………………….	7.1	b-e	2.7	d-g	10.3	d-g	8.5	c-f	18.9	c-g
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Omega Top 40F 7 fl oz (BD)………………	3.6	fgh	3.8	c-f	7.9	f-i	13.6	ab	21.4	b-f
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Endura 70WG 8 oz (BD)…………………...	4.3	d-g	3.3	c-g	8.0	e-i	9.4	b-f	17.6	d-h
Quash 50WG 2.5 oz (A-H)…………………	5.0	c-f	7.3	b	12.4	c-f	13.2	abc	25.7	bcd
Quash 50WG 3.5 oz (A-H)…………………	1.4	ij	1.8	fg	3.3	jk	7.1	efg	10.2	jk
Echo ZN 38.5SC 32 fl oz (ABDFH); Priaxor 4.17SC 6 fl oz (CEG)……………...	6.0	c-f	1.8	fg	8.1	e-i	3.6	h	11.7	h-k
OxiDate 2.0 27L 80 fl oz + Silwett ECO 100SL 3.2 fl oz (A-H)………..	12.6	ab	5.0	bcd	18.3	bc	7.1	efg	25.2	b-e
OxiDate 2.0 27L 32 fl oz + Silwett ECO 100SL 3.2 fl oz (A-H)………..	14.7	a	7.3	b	22.9	b	9.4	b-f	31.6	ab
Untreated Check……………………………	12.6	ab	18.5	a	32.0	a	14.6	ab	47.0	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 19 Aug, 11 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 tab spot (*Botrytis cinerea*) on 19 Aug.
[d] 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
[e] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD)

Funding: MPIC and Industry

Treatment and rate	White mold severity (%) 8/4 66 DAP[a]		White mold severity (%) 8/25 87 DAP		Bacterial vine rot severity (%) 7/19 66 DAP		Bacterial vine rot severity (%) 8/2 87DAP		Yield (cwt/A) US-1		Yield (cwt/A) Total	
Echo ZN 38.5SC 32 fl oz (ABDFH[b]); Luna Tranquility 45.1SC 8 fl oz (CEG)……	0.2	i[c]	2.2	fgh	0.0	f	0.4	fg	241	a-d	299	b-g
Echo ZN 38.5SC 32 fl oz (ABDFH); Luna Tranquility 45.1SC 11.2 fl oz (CEG)...	0.4	hi	2.7	fg	0.0	f	1.2	de	260	ab	325	abc
Bravo WS 6SC 6SC 24 fl oz (A-H)………	4.4	abc	10.6	a	2.2	b	2.7	ab	257	ab	324	abc
Bravo WS 6SC 6SC 24 fl oz (ACEG)……..	5.6	ab	9.7	a	2.7	a	2.5	abc	242	a-d	286	c-g
Bravo WS 6SC 6SC 24 fl oz (ADEFGH); Vangard 75WG 7 oz (BC)…………………	2.2	de	3.5	ef	0.0	f	1.0	def	232	b-f	305	b-f
Bravo WS 6SC 6SC 24 fl oz (ADEFGH); Inspire Super 2,82EW 2.82EC 20 fl oz (BC)	1.7	ef	6.9	bc	0.0	f	1.4	cde	238	a-e	293	b-g
Bravo WS 6SC 6SC 24 fl oz (ADEFGH); Switch 62.5WG 20 oz (BC)………………..	2.2	de	5.8	cd	0.0	f	1.7	b-e	243	a-d	324	abc
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Meteor 4F 1.5 pt (BD)……………………..	0.9	fgh	2.1	fgh	0.0	f	0.4	fg	187	g	271	d-g
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 1.5 pt (BDF)…………………….	1.1	fgh	3.3	ef	0.0	f	0.9	ef	249	abc	314	abc
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 1.5 pt (BDF)…………………….	0.7	ghi	2.7	fg	0.0	f	1.2	de	246	abc	303	b-f
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Meteor 4F 2 pt (BD)………………………..	0.9	fgh	3.2	ef	0.0	f	0.9	ef	251	ab	334	ab
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 2 pt (BDF)………………………	0.9	fgh	2.2	fgh	0.0	f	0.4	fg	201	fg	264	fg
Bravo WS 6SC 6SC 24 fl oz (ACEGH); Meteor 4F 2 pt (BDF)………………………	1.2	efg	2.5	fg	0.0	f	1.0	def	245	abc	302	b-f
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Luna Tranquility 45.1SC 11.2 fl oz (BD)….	0.2	i	1.2	h	0.0	f	0.4	fg	240	a-d	299	b-g
CX-10250 100WG 0.9 oz (ACEG); Bravo WS 6SC 6SC 24 fl oz (BDFH)……..	3.9	bc	9.5	a	1.0	d	3.9	a	207	efg	260	g
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Omega 500F 8 fl oz (BD)………………….	0.4	hi	1.7	gh	0.0	f	0.2	g	274	a	355	a
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Omega Top 40F 7 fl oz (BD)………………	0.2	i	2.5	fg	0.0	f	1.0	def	257	ab	306	b-e
Bravo WS 6SC 6SC 24 fl oz (ACEFGH); Endura 70WG 8 oz (BD)…………………..	3.1	cd	4.6	de	0.2	f	1.9	bcd	244	a-d	312	a-d
Quash 50WG 2.5 oz (A-H)…………………	6.3	a	6.6	bc	1.7	c	1.6	b-e	233	b-e	306	b-e
Quash 50WG 3.5 oz (A-H)…………………	5.0	abc	8.5	ab	1.5	c	1.8	bcd	212	d-g	284	c-g
Echo ZN 38.5SC 32 fl oz (ABDFH); Priaxor 4.17SC 6 fl oz (CEG)……………...	0.7	ghi	2.5	fg	0.0	f	1.0	def	242	a-d	301	b-f
OxiDate 2.0 27L 80 fl oz + Silwett ECO 100SL 3.2 fl oz (A-H)………..	1.4	efg	3.2	ef	0.6	e	1.6	b-e	206	efg	271	d-g
OxiDate 2.0 27L 32 fl oz + Silwett ECO 100SL 3.2 fl oz (A-H)………..	5.0	abc	8.5	ab	1.0	d	1.0	def	216	c-g	282	c-g
Untreated Check……………………………	6.7	a	9.5	a	1.0	d	1.7	b-e	194	g	266	efg

[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: Industry and MPIC

Evaluation of fungicide programs for potato late blight control: 2014.

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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 26 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 31 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 25 Aug (8 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 8, 12, 19 and 27 Aug, [9, 13, 20, and 28 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 27 Aug, a period of 28 days. Vines were killed with Reglone 2EC (1 pt on 11 Sep). Plots (2 x 25-ft row) were harvested on 20 Oct and tubers from individual treatments were weighed and graded. A sample of 50 tubers was collected from each plot at harvest and stored at 50°F and 95% RH in the dark for 56 days 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 Jun to the final evaluation (27 Aug). Average daily air temperature (°F) from 1 Jun was 67.6, 65.1, and 67.5 and the number of days with maximum temperature >90°F was 0, 0 and 0 (Jun, Jul, Aug, respectively). Average daily relative humidity (%) over the same period was 71.1, 71.5, and 75.6. Average daily soil temperature at 4" depth (°F) over the same period was 68.3, 72.5, and 72.4. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 37.1, 39.6, and 40.1. Precipitation was 5.78, 3.58, and 6.70 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 31 Jul (inoculation date) to 27 Aug was 45 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 27 Aug. Up to 19 Aug, all fungicide programs had significantly less foliar late blight than the untreated control (58.9%). By 27 Aug, all programs had with less than 73.9% foliar late blight significantly better foliar late blight than the untreated control (100 %). All fungicide programs had significantly lower RAUDPC values in comparison to the untreated control (30.9). On 15 Dec (56 days after harvest) the percent incidence of infected tubers from untreated plots was 14.3% and treatments with less tan 3.4% tuber blight incidence were significantly different in comparison to the untreated control. Treatments with greater than US1 yield of 171 and total yield of 242 cwt/A, respectively were significantly different from the untreated control (US1 = 171 and total yield = 242 cwt/A). Phytotoxicity was not noted in any of the treatments.

Treatment and rate	Foliar potato late blight (%) 19 Aug 20 DAI[a]		Foliar potato late blight (%) 27Aug 28 DAI		RAUDPC[b] 28 DAI		Yield (cwt) US1		Yield (cwt) Total		Tuber blight (%)[c] 203 DAP[d]	
Bravo WS 6SC 6SC 1.5 pt (ACEF); Zampro 4.38SL 14 fl oz (BD)……………...	3.5	efg	13.9	hi	3.8	k-n	357	f-l	455	g-m	4.1	d-k
Bravo WS 6SC 6SC 1.5 pt (ACEF); A20941 100OD 2.05 fl oz + Revus 2.09SC 8.2 fl oz (BD)………………	0.7	hi	7.3	ij	1.2	mn	342	h-l	454	h-m	25.4	ab
Bravo WS 6SC 6SC 1.5 pt (ACEF); A20941 100OD 2.05 fl oz (BD)…………...	3.6	efg	29.1	fg	5.3	j-n	430	a-f	555	a-f	4.0	e-k

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Bravo WS 6SC 6SC 1.5 pt (ACEF); A20942 406SC 2.5 fl oz (BD)……………..	2.5	fgh	11.5	ij	2.5	lmn	471	abc	574	a-e	27.2	a
Bravo WS 6SC 6SC 1.5 pt (ABCE); A20941 100OD 2.05 fl oz + Revus 2.09SC 8.2 fl oz (DF)………………	0.3	i	3.9	j	0.8	n	469	a-d	581	a-d	0.9	jk
CX-10250 100WG 1 oz (ACEF); Bravo WS 6SC 6SC 1.5 pt (BDGH)………	3.6	efg	46.5	de	7.8	ijk	367	e-j	452	h-m	6.9	c-j
CX-10470 100L 1.5 pt (A-H)……………...	16.2	bc	93.4	a	18.8	bcd	361	e-l	480	e-l	1.4	ijk
CX-10470 100L 1.75 pt (A-H)…………….	8.5	cde	78.7	abc	13.3	e-h	384	e-i	492	c-k	1.4	ijk
CX-10470 100L 1.75 pt (ACEF); Bravo WS 6SC 6SC 1.5 pt (BDGH)……….	7.1	cde	85.9	a	13.8	e-h	427	a-f	517	b-j	16.3	a-d
Bravo WS 6SC 6SC 1.5 pt (ACEF)………..	10.1	bcd	34.2	efg	7.7	ijk	387	e-i	519	b-j	10.3	b-i
Bravo WS 6SC 6SC 1.5 pt (A-H)………….	7.9	cde	75.2	abc	12.8	fgh	301	jkl	392	lm	6.2	c-k
Ranman 400SC 2.75 fl oz + Silwett L-77 100SL 2 fl oz (A-H)………….	2.5	fgh	33.3	efg	5.8	j-m	390	d-i	528	b-i	7.7	c-j
Mildicut 275SC 40 fl oz (A-H)…………….	1.2	ghi	14.9	hi	2.7	lmn	483	ab	599	ab	5.4	c-k
Mildicut 275SC 30 fl oz (A-H)…………….	1.5	f-i	43.0	def	6.6	jkl	435	a-e	549	a-g	13.8	a-f
Zing 100F 34 fl oz (A-H)…………………..	1.7	f-i	28.1	fg	4.9	j-n	361	e-l	464	f-m	12.6	a-g
GWN-9790 100F 6.4 fl oz (A-H)………….	1.9	f-i	41.4	def	6.8	jkl	343	h-l	433	j-m	11.5	a-h
GWN-10236 100F 6.4 fl oz (A-H)………...	2.1	fgh	60.1	bcd	9.6	hij	296	l	407	klm	18.7	abc
GWN-10237 100F 25 fl oz (A-H)…………	10.9	bcd	97.5	a	18.0	b-e	391	c-h	494	c-k	3.4	e-k
GWN-10243 100F 25 fl oz (A-H)…………	10.9	bcd	73.9	abc	15.3	c-g	331	h-l	429	j-m	6.0	c-k
KPhite 7L 3 pt (A-H)………………………	7.9	cde	85.9	a	14.2	d-h	366	e-k	502	b-j	3.6	e-k
Ariston 3.83SC 2 pt + R11 100XL 6.84 fl oz (A-H)……………….	1.2	ghi	23.4	gh	4.4	k-n	379	e-i	507	b-j	6.6	c-k
Ariston 3.83SC 32 fl oz (A-H)……………..	2.4	fgh	48.3	de	8.1	ijk	348	g-l	481	e-k	10.8	a-h
Ariston 3.83SC 32 fl oz + Perfectose 100SC 56 fl oz (A-H)…………..	1.3	ghi	13.1	hi	2.4	lmn	418	b-g	543	a-h	8.7	c-j
Ariston 3.83SC 32 fl oz + Blackroot 100SC 56 fl oz (A-H)…………...	1.3	ghi	11.5	ij	2.2	lmn	369	e-j	489	c-k	2.9	f-k
SA-0350102 100SC 20 fl oz (A-H)………..	1.5	f-i	33.1	efg	5.9	j-m	363	e-l	454	h-m	4.0	e-k
SA-0011404 100SG 1.25 lb (A-H)………...	23.8	b	85.9	a	19.0	bc	297	kl	380	m	6.2	c-k
Ariston 3.83SC 32 fl oz (AD); Reason 44.4SC 5.5 fl oz (BE); Echo 6SC 16 fl oz (BCEF); Previcur Flex 6SC 11.2 fl oz (CF)…………	0.7	hi	7.7	ij	1.4	mn	494	ab	587	abc	2.6	g-k
Echo 6SC 16 fl oz (A-H)…………………..	4.3	def	57.1	cd	11.7	ghi	378	e-i	502	b-j	8.3	c-j
Bravo WS 6SC 6SC 1.5 pt (ACEGH); Ridomil Gold Bravo 3.67SC 2.5 pt (BDF)...	0.7	hi	29.0	fg	4.3	k-n	393	c-h	487	d-k	4.2	d-k
Ridomil Gold Bravo 3.67SC 2.5 pt (DEF)...	1.1	ghi	23.4	gh	3.7	k-n	509	a	639	a	0.0	k
Inoculated Check…………………………..	59.9	a	100	a	30.9	a	171	m	242	n	14.3	a-e

[a] Days after inoculation of *Phytophthora infestans* (US-23, A1 mating type, mefenoxam sensitive) on 31 Jul.
[b] RAUDPC, relative area under the disease progress curve calculated from day of appearance of initial symptoms to 27 Aug (28 days).
[c] Incidence of tuber late blight after storage for 28 days at 50°F (178 DAP).
[d] Days after planting.
[e] Application dates: A= 8 Jul; B= 15 Jul; C= 23 Jul; D= 29 Jul; E= 6 Aug F= 12 Aug; G= 19 Aug; H= 25 Aug
[f] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD).

Funding: MPIC and Industry

In-furrow fungicide treatments for control of Verticillium wilt of potatoes, 2014.

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In-furrow fungicides were applied at the Michigan State University Clarksville Research Center (CRC), Clarksville, MI (Capac loam soil); 42.8733, -85.2604 deg; elevation 895 ft and at the Michigan State University Potato Research Farm (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 19 May (MRC) and 30 May (CHES) 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. In-furrow fungicides included in the trial were Inspire 2.08SC (7 fl oz/A), Maxim 4.0SC (24.5 fl oz/A), Quadris 2.08SC (11.6 fl oz/A), Moncut 50%WP (1.07 fl oz/A), Headline 2.08SC (12 fl oz/A), Luna Tranquility 4.16SC (11.2 fl oz/A), and Blocker 4F 4.0SC (160 fl oz/A). Vydate 3.77SC was applied with each treatment in-furrow (at planting; 34 oz/A), to foliage at hilling (17 oz/A) and 3 weeks after hilling (17 oz/A). In-furrow, at-planting applications of fungicide were delivered in 8 pt water/A in a 7 in. band using a single XR11003VS nozzle at 30 psi. Foliar applications of 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 (days after planting). 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 20 Aug at MRC and 1 Sep at CRC). Plots (1 x 20-ft row) were harvested on 11 Sep (MRC) (120 DAP) and 30 Sep (CRC) (121 DAP) and individual treatments were weighed and graded.

MRC Sampling

Five plants per plot were harvested on 20 Aug [98 days after planting (DAP); 56 days after the final Vydate application] and each plot was given a value from 0 to 11 using the Horsfall-Barratt rating scale (0=0%; 1=0.1-3%; 2=3.1-6%; 3=6.1-12%; 4=12.1-25%; 5=25.1-50%; 6=50.1-75%; 7=75.1-87%; 8=87.1-94%; 9=94.1-97%; 10=97.1-99.9%; 11=100%) based on the percent of stems which showed symptoms of Verticillium wilt. Following visual assessment, 0.5 mL of stem sap was extracted using a hydraulic plant sap press (Spectrum, Inc.). The sap was plated on selective *Verticillium dahliae* media and incubated for 21 days. Colony forming units were then counted on each plate. Randomly selected samples of 10 tubers per plot were washed and assessed for stem end vascular beading incidence (%) on 11 Oct 2014, 30 days after harvest (152 DAP).

MRC 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 19 May was 60.0, 60.7, 67.3, 62.9, and 59.1 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 70.7, 71.5, 74.5, 72.0 and 74.1%. Average daily soil temperature at 4" depth (^{o}F) over the same period was 61.7, 69.6, 78.0, 75.8, and 67.6. Precipitation (in.) over the same period was 2.11, 3.25, 3.58, 1.68, and 2.35. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

MRC Results (Table 1.)

No treatments were significantly different in percent of emergence. Inspire, Quadris, Moncut, Headline, Luna Tranquility, and Vydate alone were all significantly different from the not-treated control for CFU from stem sap with Quadris and Luna Tranquility giving the lowest CFU counts overall. Though this is not a complete indication of prevention against Verticillium wilt it is important to note the differences in CFU inside the plant stem. There were no significant differences in tuber stem end discoloration but the not-treated control had a higher percentage of tuber stem end discoloration than any other treatment. Treatments of Quadris, Moncut, Luna Tranquility, and Blocker 4F had a significantly higher yield compared to the non-treated control. Soil treatments were not phytotoxic in terms of plant stand, rate of emergence, or marketable yield.

CHES Sampling

Five plants per plot were harvested on 28 Aug [90 days after planting (DAP); 41 days after the final Vydate application] and each plot was given a value from 0 to 11 using the Horsfall-Barratt rating scale as described above. Following visual assessment, 0.5 mL of stem sap was extracted using a hydraulic plant sap press (Spectrum, Inc.). The sap was plated on selective *Verticillium dahliae* media and incubated for 21 days. Colony forming units where then counted on each plate. Randomly selected samples of 10 tubers per plot were washed and assessed for stem end vascular beading incidence (%) on 30 Oct 2014, 30 days after harvest (153 DAP).

CHES 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 30 May was 60.1, 65.8, 67.5, 66.1, and 60.7 and the number of days with maximum temperature >90^{o}F was 0, 0, 1, 0 and 0 (May, Jun, Jul, Aug, Sep, respectively). Average daily relative humidity (%) over the same period was 64.8, 71.4, 72.1, 72.7 and 74.7%. Average daily soil temperature at 4" depth (^{o}F) over the same period was 60.2, 68.3, 73.1, 67.7, 62.0 and 61.6. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 37.4, 39.2, 37.8, 36.6 and 36.3. Precipitation (in.) over the same period was 4.22, 4.21, 3.31, 3.2, and 2.73. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

CHES Results (Table 2.)

No treatments were significantly different in percent of emergence. Inspire, Maxim, Quadris, and Vydate alone had significantly lower amounts of colony forming units from extracted stem sap compared to the not-treated control. Though this is not a complete indication of prevention against Verticillium wilt it is important to note the differences in CFU inside the plant stem. Maxim, Moncut, and Luna Tranquility had significantly higher percentage of tuber stem end discoloration compared with the not-treated control. Luna Tranquility and Blocker 4F had marketable yields that were significantly higher than 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 as was seen in the amount of colony forming units found within plant stems, at both locations. Quadris and Inspire had significantly lower levels of CFU within the stem at both trial locations. Tuber stem end vascular beading levels remain inconclusive and therefore cannot be solely contributed to *Verticillium dahliae* infection within the potato stem. Many treatments at both MRC and CRC had significantly higher yield levels compared with the not-treated control. This is not entirely contributed to control of *V. dahliae* due to the wide pathogen range of sensitivity for many of the chemistries. Management of Verticillium wilt requires an integrated approach that combines the use of host resistance, cultural control methods, and chemical control. Further research is needed to identify what cultural and chemical control strategies may be effective against the disease.

Table 1. Effects of in-furrow, at planting fungicide treatments on emergence percent, *Verticillium dahliae* colony forming units (CFU) as number of CFU in 0.5 mL of stem sap, vascular beading, and yield in hundred-weight per acre at MRC.

Treatments and Rate/A[a]	Emergence %	Average CFU/0.5 mL of Stem Sap 20 Aug[b,c]	Average % of vascular beading in tuber 11 Oct	Average Yield in Hundred Weight per Acre 11 Sept
Not-treated Control	69.6	90.8 a[d]	42.5	160.8 a
Inspire 7 oz/A + Vydate 34 oz/A	76.3	48.8 cd	5.00	190.5 ab
Maxim 24.5 oz/A + Vydate 34 oz/A	80.0	79.3 ab	12.5	191.4 ab
Quadris 11.6 oz/A + Vydate 34 oz/A	77.5	19.8 e	22.5	300.1 e
Moncut 1.07 lb/A + Vydate 34 oz/A	67.1	51.0 cd	25.0	194.8 b
Headline 12 oz/A + Vydate 34 oz/A	64.6	51.8 bcd	7.50	181.2 ab
Luna Tranquility 11.2 oz/A + Vydate 34 oz/A	75.9	29.3 de	22.5	233.1 cd
Blocker 4F 160 oz/A + Vydate 34 oz/A	75.4	64.5 abc	20.0	208.5 bc
Vydate 34oz/A Only	80.8	52.5 bcd	12.5	184.4 ab
ANOVA p-value	0.667	0.005	0.319	<0.0001

[a] In-furrow at planting application in 8 gal H_2O/A 19 May, 2014
[b] Sap extracted from stems using hydraulic plant sap press (Spectrum, Inc.). Plated on *Verticillium dahliae* selective media and incubated for 21 days.
[c] CFU=colony forming units seen on selective *Verticillium dahliae* media
[d] Means followed by same letter do not significantly differ (α=0.10, LSD)

Table 2. Effects of in-furrow, at planting fungicide treatments on emergence percent, *Verticillium dahliae* colony forming units (CFU) as number of CFU in 0.5 mL of stem sap, vascular beading, and yield in hundred-weight per acre at CRC.

Treatments and Rate/A[a]	Emergence %	Average CFU/0.5 mL of Stem Sap 28 Aug[b,c]	Average % of vascular beading in tuber 30 Oct	Average Yield in Hundred Weight per Acre 30 Sept
Not-treated Control	62.1	48.8 a[d]	0.00 a	180.0 a
Inspire 7 oz/A + Vydate 34 oz/A	58.3	26.8 b	0.00 a	203.7 ab
Maxim 24.5 oz/A + Vydate 34 oz/A	54.6	31.0 b	22.5 b	199.1 ab
Quadris 11.6 oz/A + Vydate 34 oz/A	60.4	28.5 b	17.5 ab	234.9 abc
Moncut 1.07 lb/A + Vydate 34 oz/A	57.6	35.5 ab	20.0 b	183.7 a
Headline 12 oz/A + Vydate 34 oz/A	62.1	38.8 ab	12.5 ab	229.1 abc
Luna Tranquility 11.2 oz/A + Vydate 34 oz/A	55.8	33.3 ab	22.5 b	249.9 bc
Blocker 4F 160 oz/A + Vydate 34 oz/A	61.3	43.3 a	15.0 ab	274.0 c
Vydate 34oz/A Only	59.6	27.8 b	7.5 ab	195.6 ab
ANOVA p-value	0.932	0.095	0.009	0.009

[a] In-furrow at planting application in 8 gal H_2O/A 19 May, 2014
[b] Sap extracted from stems using hydraulic plant sap press (Spectrum, Inc.). Plated on *Verticillium dahliae* selective media and incubated for 21 days.
[c] CFU=colony forming units seen on selective *Verticillium dahliae* media
[d] Means followed by same letter do not significantly differ (α=0.10, LSD)

Funding: MPIC and Industry

In-furrow and foliar fluopyram treatments for control of Verticillium wilt of potatoes, 2014.

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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 deg; elevation 895 ft and at the Michigan State University Potato Research Farm (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 19 May (MRC) and 30 May (CRC) 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 20 Aug at MRC and 1 Sep at CRC). Plots (1 x 20-ft row) were harvested on 11 Sep (MRC) (120 DAP) and 30 Sep (CRC) (121 DAP) and individual treatments were weighed and graded.

MRC Sampling

Five plants per plot were harvested on 20 Aug [98 days after planting (DAP); 56 days after the final fluopyram application] and each plot was given a value from 0 to 11 using the Horsfall-Barratt rating scale (0=0%; 1=0.1-3%; 2=3.1-6%; 3=6.1-12%; 4=12.1-25%; 5=25.1-50%; 6=50.1-75%; 7=75.1-87%; 8=87.1-94%; 9=94.1-97%; 10=97.1-99.9%; 11=100%) based on the percent of stems which showed symptoms of Verticillium wilt. Following visual assessment, 0.1mL of stem sap was extracted using a hydraulic plant sap press (Spectrum, Inc.). The sap was plated on selective *Verticillium dahliae* media and incubated for 21 days. Colony forming units were then counted on each plate. Randomly selected samples of 10 tubers per plot were washed and assessed for stem end vascular beading incidence (%) on 11 Oct 2014, 30 days after harvest (152 DAP).

MRC 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 (^oF) from 19 May was 60.0, 60.7, 67.3, 62.9, and 59.1 and the number of days with maximum temperature >90^oF was 0, 0, 0, 0 and 0 (May, Jun, Jul, Aug, Sep, respectively). Average daily relative humidity (%) over the same period was 70.7, 71.5, 74.5, 72.0 and 74.1%. Average daily soil temperature at 4" depth (^oF) over the same period was 61.7, 69.6, 78.0, 75.8, and 67.6. Precipitation (in.) over the same period was 2.11, 3.25, 3.58, 1.68, and 2.35. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

MRC Results (Table 1.)

No timing treatments were significantly different in percent of emergence. Timing treatment A, Timing treatment C, and Timing treatments A & C all had significantly higher levels of stem sap CFU compared to the not-treated control. Timing treatments B & C and Timing treatments A, B & C had significantly lower stem sap CFU compared to the not-treated control. Though this is not a complete indication of prevention against Verticillium wilt it is important to note the differences in CFU inside the plant stem. All timings except for Timing treatment C had significantly lower percentages of tuber stem end vascular beading when compared to the not-treated control. Timing treatment B, Timing treatment C, Timing treatments A & B, Timing treatments A & C, Timing treatments B & C, and Timing treatments A, B & C all had a significantly higher yield compared to the non-treated control. Soil treatments were not phytotoxic in terms of plant stand, rate of emergence, or marketable yield.

CHES Sampling

Five plants per plot were harvested on 28 Aug [90 days after planting (DAP); 41 days after the final fluopyram application] and each plot was given a value from 0 to 11 using the Horsfall-Barratt rating scale as described above. Following visual assessment, 0.1mL of stem sap was extracted using a hydraulic plant sap press (Spectrum, Inc.). The sap was plated on selective *Verticillium dahliae* media and incubated for 21 days. Colony forming units where then counted on each plate. Randomly selected samples of 10 tubers per plot were washed and assessed for stem end vascular beading incidence (%) on 30 Oct 2014, 30 days after harvest (153 DAP).

CHES 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 (^oF) from 30 May was 60.1, 65.8, 67.5, 66.1, and 60.7 and the number of days with maximum temperature >90^oF was 0, 0, 1, 0 and 0 (May, Jun, Jul, Aug, Sep, respectively). Average daily relative humidity (%) over the same period was 64.8, 71.4, 72.1, 72.7 and 74.7%. Average daily soil temperature at 4" depth (^oF) over the same period was 60.2, 68.3, 73.1, 67.7, 62.0 and 61.6. Average daily soil moisture at 4" depth (% of field capacity) over the same period was 37.4, 39.2, 37.8, 36.6 and 36.3. Precipitation (in.) over the same period was 4.22, 4.21, 3.31, 3.2, and 2.73. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

Funding: MPIC and Industry

CHES Results (Table 2.)

No timings treatments were significantly different in percent of emergence. Timing treatment C had significantly higher amounts of CFU from extracted stem sap when compared with the not-treated control. Timing treatment A, Timing treatment B, Timing treatments A & B, Timing treatments B & C, and Timing treatments A, B & C had significantly lower amounts of colony forming units from extracted stem sap when compared with the not-treated control. Though this is not a complete indication of prevention against Verticillium wilt it is important to note the differences in CFU inside the plant stem. Timing treatment B, Timing treatment C, Timing treatments A & B, Timing treatments A & C, Timing treatments B & C, and Timing treatments A, B & C had significantly higher percentage of tuber stem end discoloration compared with the not-treated control. Timing treatment B, Timing treatments B & C, and Timing treatments A, B & C had marketable yields that were significantly higher than 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 as was seen in the amount of colony forming units found within the plant stem, at both locations. Timing treatments B & C and Timing treatment A, B & C had significantly lower levels of CFU within the stem at both trial locations. Timing treatment B, Timing treatments A & B, Timing treatments A & C, Timing treatments B & C, and Timing treatments A, B & C had a significantly lower percentage of tuber stem end vascular at both locations when compared with the not-treated control. Timing treatment B, Timing treatments B & C, and Timing treatments A, B & C at both MRC and CRC had significantly higher yield levels compared with the non-treated control. The results of this trial indicated that the timing of application significantly affected *V. dahliae* CFU and that multiple applications of fluopyram throughout the growing season had a significant effect on disease symptoms associated with *V. dahliae* and yield. It is important to note that the manufacturers of fluopyram have reason to believe that this chemistry has a significant nematicidal property. Without investigating this chemistry's effect on nematodes, it is hard to determine whether these results are due to control of *Verticillium dahliae* by fluopyram or whether they are due to control of root-lesion nematodes by fluopyram or a combination of these effects with Vydate. 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 these trials.

Table 1. Effects of in-furrow, at planting fluopyram treatments on emergence percent, *Verticillium dahliae* colony forming units (CFU) as number of CFU in 0.1 mL of stem sap, vascular beading, and yield in hundred-weight per acre at MRC.

Timing of Fluopyram Application[a]	Emergence %	Average CFU/0.1 mL of Stem Sap 20 Aug[b,c]	Average % of vascular beading in tuber 11 Oct	Average Yield in Hundred Weight per Acre 11 Sept
Not-treated Control	80.0	15.0 b[d]	73.0 a	191.0 a
Timing A	72.6	27.0 a	31.0 bc	183.6 a
Timing B	55.8	14.0 b	13.0 cd	242.2 bc
Timing C	80.7	34.0 a	70.0 a	232.2 bc
Timing A & B	63.4	14.0 b	30.0 bc	225.0 b
Timing A & C	71.6	34.0 a	45.0 b	253.8 c
Timing B & C	74.0	7.50 c	30.0 bc	297.2 d
Timing A, B & C	80.8	5.00 c	7.00 d	354.8 e
ANOVA p-value	>0.10	<0.0001	<.0001	<0.0001

[a] In-furrow at planting (Timing A), 21 DAP (Timing B), 42 DAP (Timing C)
[b] Sap extracted from stems using hydraulic plant sap press (Spectrum, Inc.). Plated on *Verticillium dahliae* selective media and incubated for 21 days.
[c] CFU=colony forming units seen on selective *Verticillium dahliae* media
[d] Means followed by same letter do not significantly differ (α=0.10, LSD)

Table 2. Effects of in-furrow, at planting fluopyram treatments on emergence percent, *Verticillium dahliae* colony forming units (CFU) as number of CFU in 0.1 mL of stem sap, vascular beading, and yield in hundred-weight per acre at CRC.

Timing of Fluopyram Application[a]	Emergence %	Average CFU/0.1 mL of Stem Sap 28 Aug[b,c]	Average % of vascular beading in tuber 30 Oct	Average Yield in Hundred Weight per Acre 30 Sept
Not-treated Control	60.0	23.0 b[d]	60.0 a	178.0 a
Timing A	58.3	13.0 c	50.0 ab	186.0 a
Timing B	66.1	4.00 d	10.0 d	320.0 b
Timing C	59.4	25.0 a	40.0 bc	169.0 a
Timing A & B	58.8	3.00 d	20.0 cd	213.0 a
Timing A & C	64.2	22.0 b	40.0 bc	189.0 a
Timing B & C	59.6	13.0 c	10.0 d	338.0 b
Timing A, B & C	60.1	1.00 e	10.0 d	358.0 b
ANOVA p-value	>0.10	<0.0001	<0.0001	<0.0001

[a] In-furrow at planting (Timing A), 21 DAP foliar application (Timing B), 42 DAP foliar application (Timing C)
[b] Sap extracted from stems using hydraulic plant sap press (Spectrum, Inc.). Plated on *Verticillium dahliae* selective media and incubated for 21 days.
[c] CFU=colony forming units seen on selective *Verticillium dahliae* media
[d] Means followed by same letter do not significantly differ (α=0.10, LSD)

Evaluation and comparison of fungicides for the control of post harvest potato tuber diseases (2014/15).

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Summary

Potatoes are susceptible to a variety of storage pathogens, including late blight (*Phytophthora infestans*), Pink rot (*Phytophthora erythroseptica*), (Fusarium dry rot (*Fusarium sambucinum*), Pythium leak (*Pythium ultimum*), black dot (*Colletotrichum coccodes*) and silver scurf (*Helminthosporium solani*). Current recommendations for potato storage diseases include sanitation and exclusion as the primary controls for these pathogens in storage facilities.

The objective of these trials was to continue the evaluation of fungicides and against the most common storage disease encountered in Michigan potato production.

Materials and Methods

Late Blight, Pink rot and Pythium experiments

Experiments were carried out from Oct 2014 to Jan 2015 with the potato cultivar “FL2137”. All tests were carried out at 10°C (49°F) for the chip processing cultivar. Potatoes free from visible diseases were selected for the trials from tubers harvested in October 2014. Tubers were prepared for inoculation with *Phytophthora infestans* (*Pi;* genotype US-23, A1 mating type, sensitive to metalaxyl), *P. erythroseptica* (*Pe*), and *Pythium ultimum* (*Py*) by grazing with a single light stroke with a wire brush, sufficient to abrade the skin of the tubers to a depth of 0.01 mm. Solutions (1 x 10^3/ml) of sporangia/zoosporangia of *Pi*, oospores/sporangia of *Pe*, and oospores of *Py*, were prepared from cultures of the pathogens previously isolated from potato tubers in Michigan. All pathogens were grown in Potato Dextrose Nutrient Broth for 20 days prior to preparation of inoculum solutions. Two non-treated controls, either inoculated with one of the pathogens or non-inoculated were included in the trials.

Inoculated and damaged/inoculated tubers, (50/replicate/treatment; total 200 tubers/treatment) were sprayed with 10 ml of pathogen suspension, for a final dosage of about 0.25 ml per tuber. Tubers were stored for 2-h after inoculation at 20°C before treatment. Fungicides were applied as liquid treatments in a water suspension with a single R&D XR11003VS spray nozzle at a rate of 1L/ton (0.26 gal/ton) at 50 psi onto the tuber surfaces, with the entire tuber surface being coated. After inoculation, tubers were incubated in the dark in plastic boxes at the temperatures described for different periods depending on the test (details were noted in report tables). The oomycete diseases were evaluated as the percent incidence of tubers with any signs or symptoms of the pathogen. Tubers with surface sporulation, discoloration of the skin or blackened/dead sprouts were considered infected. The remaining tubers were cut open and the number of tubers with symptoms or signs of the individual pathogens were counted to determine incidence of disease. Data were analyzed by two-way ANOVA using ARM software (Version 8, Gylling Data Management) and mean separation calculated using Fisher’s protected least significant difference (LSD) test at $P= 0.05$.

Culturing of *Pectobacterium carotovora* and tuber inoculations

Isolates of ***Pectobacterium carotovora*** were from the collection of W. Kirk (Michigan State University). These isolates were acquired from field infections in 2011, from tubers of potatoes of commonly grown in Michigan, USA. Isolates were obtained by streaking on water agar then colonies with typical characteristics of Pectobacteria spp. (grey colonies) were further purified by growing on solid semi-selective PT medium). A single isolate was selected for this study, MSUPc2011-01.

The isolates were grown on solid semi-selective PT medium for 14 days in the dark at 25°C. To check bacterium cell concentration, cells were harvested by flooding plates with sterile water (18°C) and gentle scraping of the surface of the culture using a rubber policeman. The bacterial suspension was stirred with a magnetic stirrer for 1 h. The suspension concentration was measured with a hemacytometer and adjusted to about 1 x 10^{10} total cells ml^{-1}.

Whole tuber inoculation with Pectobacterium carotovora

Tuber soft rot development was evaluated at the chipping post-harvest potato storage temperatures (10^{o}C) using whole tuber sub–peridermal inoculation. All tubers were washed in distilled H_2O to remove soil. The tubers were then surface sterilized by soaking in 0.6% sodium hypochlorite solution for 4 h. Tubers were dried in a controlled environment with forced air ventilation at 5950 l min^{-1} at 15^{o}C in dry air (30% relative humidity) for four hours prior to inoculation.

Tuber tissue inoculation; The washed, surface-sterilized tubers were inoculated by a sub-peridermal injection of a bacterial suspension of $1x10^{10}$ ml (delivering about 1000 bacterial cells $inoculation^{-l}$) with a hypodermic syringe and needle at the apical end of the tuber about 1 cm from the dominant sprout to a maximum depth of 1 cm. The control tubers were inoculated with cold sterile distilled H_2O. The wound was sealed with paraffin wax. After inoculation, tubers were placed in the dark in sterilized covered plastic crates and returned to controlled environment chambers [Percival Incubator (Model I-36LLVL, Geneva Scientific, LLC, PO Box 408, Fontana, WI)]. The chambers were set at 10^{o}C and 95% humidity and the sample tubers were incubated for 40 days until evaluation.

Evaluation of soft rot

Tubers (n = 200 per treatment) were weighed prior to inoculation and the weight recorded on a spreadsheet and written on the tuber surface. The tubers were subdivided into 4 replications. After incubation, the site of the inoculation was cut longitudinally and the rotted area removed with a stream of water. The remaining tubers tissue was weighed and the percentage tissue lost calculated.

Data Analysis

Data for soft rot were analyzed by analysis of variance (least squares method) using the JMP program version 10.0 (SAS Institute Inc., SAS Campus Drive, Cary, North Carolina 27513, USA). Treatment effects were determined by ANOVA and comparisons were made.

Semi selective PT Medium (PT) pH 7.0***, (Perombelom)***

Polygalacturonic acid (Sigma, P 1879) 5.0 g
Tryptone (Oxoid, L42) 0.5 g
NaNO3 1.0 g
K2HPO4 4.0 g
MgSO4 .6H2O 0.2 g
Agar (BDH Agar Powder) 8.0 g
Tween 20 (Sigma, P 9416) 0.1 ml
1 mmol ml-1 NaOH 17.0 ml
Distilled water to 700 ml

Trials conducted in 2014/15; 1) Efficacy of storage products against soft rot; 2014/15. and 2) Effect of storage products for control of Pink rot, Pythium Leak and Potato Late Blight, 2014/15.

Trial 1) Efficacy of storage products against soft rot

FL2137 were treated as described in Table 1. Samples were stored at 10^{o}C (FL2137) in the dark for 53 days after application (DAA). Tubers were inoculated prior to treatment for each disease. On 6 Jan 2014, 53 DAA tubers were rated for percentage weight loss due to Pectobacterium.

2) Effect of storage products for control of Pink rot, Pythium Leak and Potato Late Blight, 2014/15.

FL2137 were treated as described in Table 1. Samples were stored at 10^{o}C [FL2137 (for Pink rot, Pythium leak and late blight)] in the dark for 53 days after application (DAA). Tubers were inoculated prior to treatment for each disease. On 6 Jan 2014, 53 DAA tubers were rated for incidence only of Pink rot, Pythium Leak and Potato Late Blight.

Results and Conclusions

Trial 1 Efficacy of storage products against soft rot *(Table 1)*

In the soft rot test, disease developed in all treatments and the inoculated check had 47.0% weight loss (Table 1). No soft rot developed in the non-inoculated check. Treatments with less than 29.6% weight loss due to soft rot were significantly different from the inoculated check. All treatments had significantly more weight loss due to the soft rot in comparison to the not-inoculated check.

Trial 2 Effect of storage products for control of Pink rot, Pythium Leak and Potato Late Blight *(Table 2)*

In the pink rot test, disease developed in all treatments and the inoculated check had 85.4% incidence (Table 2). No pink rot developed in the not-inoculated check. Treatments with less than 72.1% incidence of pink rot were significantly different from the inoculated check. Treatments with greater than 0.6% incidence of pink rot were significantly different from the not-inoculated check.

In the Pythium leak test, disease developed in most treatments and the inoculated check had 36.5% incidence (Table 2). No Pythium leak developed in the not-inoculated check. All treatments had significantly lower incidence of tubers with Pythium leak in comparison to the inoculated check. Treatments with greater than 1.3% incidence of Pythium leak were significantly different from the not-inoculated check.

In the potato late blight test, disease developed in all treatments and the inoculated check had 100% incidence (Table 2). No potato late blight developed in the not-inoculated check. All treatments had significantly lower incidence of tubers with potato late blight in comparison to the inoculated check. All treatments had significantly higher incidence of tubers with potato late blight in comparison to the not-inoculated check. Treatments with incidence of potato late blight from 21.9 to 31.1, 31.1 to 45.8, 45.8 to 60.2, 54.7 to 70.9, 60.2 to 72.5 and 65.5 to 79.3 % incidence were not significantly different.

Table 1.Efficacy of storage products against soft rot; 2014/15.

Treatments and rate of application per ton of tubers	Soft rot Tuber Weight Loss (%)	
OxiPhos 41.1L 12.8 fl oz/ton	29.6	a
StorOx 29.1L 2.56 fl oz/ton	8.1	b
Phostrol 53.6SC 12.8 fl oz/ton	12.1	b
Inoculated Check	47.0	a
Non-inoculated Check	0.0	c

[a] Tubers (n = 200 per treatment) were weighed prior to inoculation and the weight recorded on a spreadsheet and written on the tuber surface. The tubers were subdivided into 4 replications of 50 tubers and placed in a boxes. After incubation, the site of the inoculation was cut longitudinally and the rotted area removed with a stream of water. The remaining tubers tissue was weighed and the percentage tissue lost calculated.
[b] Values followed by the same letter are not significantly different at $P = 0.05$ level according to Fisher's protected least significant difference (LSD) test.
[d] NA= not assessed as treatment was not made.

Funding: MPIC and Industry

Table 2. Effect of storage products for control of Pink rot, Pythium Leak and Potato Late Blight, 2014/15.

Treatments and rate of application per cwt or ton of tubers	Pink rot Incidence (%)		Pythium Incidence (%)		Late Blight Incidence (%)	
Stadium 3.33SC 0.05 fl oz/cwt	24.1	c[a]	12.3	b	72.5	bc
Ranman 3.33SC 0.1 fl oz/cwt	12.7	d	3.9	de	60.2	cde
Ranman 3.33SC 0.2 fl oz/cwt	4.8	e	10.0	bc	67.6	bcd
Mildicut 2.5SC 0.5 fl oz/cwt	39.6	b	4.5	cd	78.4	b
Mildicut 2.5SC 1 fl oz/cwt	36.7	b	2.1	de	71.0	bcd
Mildicut 2.5SC 1.5 fl oz/cwt	0.6	fgh	1.3	def	45.8	ef
Mildicut 2.5SC 3 fl oz/cwt	0.3	gh	0.0	f	21.9	g
Phostrol 53.6SC 1.28 fl oz/cwt	0.4	gh	0.0	f	54.7	de
KPhite 7L 1.28 fl oz/cwt	2.8	efg	3.0	de	77.7	b
OxiPhos 41.1L 12.8 fl oz/ton	3.2	ef	0.9	ef	79.3	b
OxiPhos 41.1L 6.4 fl oz/ton	NA[b]		0.0	f	65.5	bcd
Phostrol 53.6SC 12.8 fl oz/ton	72.1	a	16.4	b	31.1	fg
Inoculated Check	85.4	a	36.6	a	100.0	a
Non-inoculated Check	0.0	h	0.0	f	0.0	h

[a] Values followed by the same letter are not significantly different at $P = 0.05$ level according to Fisher's protected least significant difference (LSD) test.
[b] NA= not assessed as treatment was not made.

2013-2014 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 twelfth annual Demonstration Storage Report contains the results of the storage work conducted in the facility during the 2013-2014 storage season. Section I, "2013-2014 New Chip Processing Variety Box Bin Report", contains the results and highlights from our 10 cwt. box bin study. Section II, "2013-2014 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: Bruce Sackett, Steve Crooks, Todd Forbush, Chris Long, Troy Sackett, Dennis Iott, Keith Tinsey, Mike Wenkel, Duane Anderson, Stephanie Anderson, Loren Wernette, Tim Wilkes, Larry Jensen, Chase Young and Tim 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. Steve, Norm and John Crooks, Crooks Farms, Inc.; Brian, Jeff and Alan Sackett, Sackett Potatoes; 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 2013 production season *

The overall 6-month average maximum temperature during the 2013 growing season was four degrees cooler than the 6-month average maximum temperature for the 2012 season and was identical to the 15-year average (Table 1). The 6-month average minimum temperature for 2013 was one degree lower than the 15-year average. There were 3 days with recorded temperature readings of 90F or above in 2013. There were 140 hours of 70 °F temperatures between the hours of 10 PM and 8 AM which occurred over 28 different days, April to September (Data not shown). The level of night time temperature stress experienced during the 2013 growing season was below the 5 year average. There was one day in May that the air temperature was below 32 F. The average maximum temperatures for July through September 2013 were similar to the 15-year average (Table 1). For the period from September 15th to October 20th, there were fourteen days that the air temperature was below 32 F.

Rainfall for April through September was 21.50 inches, which was 2.69 inches above the 15-year average (Table 2). In October 2013 4.65 inches of rain was recorded. Irrigation at MRC was applied 13 times from June 20th to September 7th, averaging 0.79 inches for each application. The total amount of irrigation water applied during this time period was 10.2 inches.

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

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.
1999	59	37	71	48	77	55	84	62	76	56	73	48	73	51
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**
15-Year Average	58	35	68	46	78	55	82	59	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
1999	5.49	5.07	5.82	4.29	5.46	4.03	30.16
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**
15-Year Average	2.95	3.84	2.87	2.94	3.66	2.55	18.81

I. 2013-2014 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

Sixteen new varieties were evaluated and compared to the check variety Snowden in 2013. The 17 varieties were chosen by the MPIC Storage and Handling Committee. Once the varieties were chosen, 1 cwt. of each variety was planted in a single 34 inch wide row, on May 6th at the MSU, Montcalm Research Center, Entrican, MI. The varieties were all planted at a 10" in-row seed spacing. All varieties received a rate of fertilizer recommended to achieve a 375 to 425 cwt./A yield (311 lb. N/Acre). The varieties were vine killed after 127 days and allowed to set skins for 22 days before harvest on October 2nd, 2013 (149) 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 2013-2014 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 16 varieties were graded to remove all "B" size tubers and pickouts, thus entering storage in good physical condition.

The storage season began October 2nd, 2013, and ended June 2nd, 2014. Bin 7 was gassed with CIPC on November 11th, 2013, and January 15th, 2014. Variety evaluation began October 7th, 2013, 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 2-5 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.

Table 1. 2013-2014 MPIC Demonstration Box Bin Variety Descriptions

Entry	Pedigree	2013 Scab Rating*	Characteristics
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
Snowden (W855)	B5141-6 X Wischip	3.1	High yield, late maturity, mid-season storage, reconditions well in storage, medium to high specific gravity
Manistee (MSL292-A)	Snowden X MSH098-2	3.3	Above average yield, late blight susceptible, medium specific gravity, long storage potential, uniform tuber type, heavy netted skin, excellent late season chip quality
A00188-3C	A91790-13 X Dakota Pearl	0.5	High U.S. No. 1 yield, scaly buff skin, high specific gravity, mid-season chip quality, common scab tolerance
AC01151-5W	COA96142-7 X NDA2031-2	1.2	Medium maturity, medium vine size, oblong shape with white flesh
CO02321-4W	NY115 X BC0894-2W	2.5	Average yield potential, average specific gravity, medium maturity, common scab susceptibility
MSL007-B	MSA105-1 X MSG227-2	1.5	Average yield potential , early to mid-season maturity, uniform tuber type, medium specific gravity, scab tolerant, heavy netted skin
MSM246-B	MSE274-A X NY115	3.3	Round-white with a good sugar profile, good specific gravity, excellent chip quality, common scab susceptible
MSN190-2	MSI234-6Y X MSG227-2	2.0	High specific gravity, early maturity, blackspot bruise resistant, average yield
MSR169-8Y	Pike X MSJ126-9Y	1.4	Below average yield, medium maturity, yellow flesh, average specific gravity, common scab resistant

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible.
Common scab data provided by MSU Potato Breeding and Genetics Program.

Table 1. continued

Entry	Pedigree	2013 Scab Rating*	Characteristics
MSR127-2	MSJ167-1 X MSG227-2	1.0	Scab resistant, high specific gravity, good chip quality from storage, above average yield potential, medium-late maturity
MSS165-2Y	MSM188-1 X MSL159-AY	1.9	High yield, above average specific gravity, late maturity, uniform round tuber type, heavy netted skin, yellow flesh, good internal tuber quality
MSS934-4	ND6095-1 X ND7377Cb-1	2.9	High yield, oval to oblong tuber type, common scab susceptible
NY148	NY128 X Marcy	2.1	Full season maturity, high gravity, scab-resistant chip stock, good yield potential, medium to late season storage quality, black spot bruise susceptible
NY153	Waneta X Pike	2.1	Full season maturity, medium tuber size profile, good chip quality
W5955-1	Pike X C31-5-120	1.5	High yield, high specific gravity, size profile similar to Atlantic, long storage potential
W6609-3	Pike X Dakota Pearl	0.5	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 provided by MSU Potato Breeding and Genetics Program.

Table 2. 2013 Michigan Potato Industry Commssion Box Bin Processing Potato Variety Trial

2013 MPIC Box Bin Processing Potato Variety Trial
MSU Montcalm Research Center, Montcalm County, MI

Harvest 2-Oct-13 149 Days

DD, Base 40[6] 3320

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL	VINE	VINE		CHIP
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	VIGOR[4]	MATURITY[5]	COMMENTS	COMMENTS
MSS934-4	550	583	94	6	74	20	0	1.083	1.0	0	1	0	0	10	3.0	3.5	2.0 common scab, rhizoctonia	tr SED
MSR127-2	385	446	86	14	84	2	0	1.088	1.0	0	0	0	0	10	3.0	2.5	0.5 common scab, rhizoctonia	
MSL007-B	344	404	85	14	85	0	1	1.083	1.0	0	0	0	0	10	2.0	3.5	1.0 common scab, trace of pitted scab	
Lamoka	332	390	85	14	81	4	1	1.088	1.5	0	1	0	0	10	3.5	3.0	1.0 common scab	
NY148	315	419	75	24	74	1	1	1.097	1.0	0	0	0	0	10	3.0	3.0	1.5 common scab, trace of pitted scab, rhizoctonia	sl SED
AC01151-5W	312	433	72	26	72	0	2	1.082	1.0	0	0	2	0	10	2.5	2.0	2.0 common scab, rhizoctonia	
W5955-1	308	389	79	18	79	0	3	1.090	1.0	0	1	0	0	10	3.5	2.5	2.0 common scab, rhizoctonia	
MSM246-B	305	351	87	13	84	3	0	1.092	1.0	0	1	0	0	10	3.0	2.0	2.5 common scab, rhizoctonia	
MSL292-A	274	334	82	18	82	0	0	1.085	1.0	0	1	0	0	10	2.5	3.5	0.5 common scab	
MSN190-2	253	390	65	35	64	1	0	1.100	1.0	0	0	0	0	10	2.5	3.0	0.5 common scab, heavy netted skin	
MSS165-2Y	212	395	53	47	52	1	0	1.093	1.0	0	0	0	0	10	3.5	3.5	1.5 common scab	tr SED
Snowden	**202**	**296**	**68**	**30**	**68**	**0**	**2**	**1.089**	**1.0**	**0**	**2**	**0**	**0**	**10**	**3.0**	**2.0**	**3.0 common scab**	
NY153	171	272	63	36	63	0	1	1.084	1.0	0	1	0	0	10	3.5	3.5	0.5 common scab, uniform small tubers	
CO02321-4W	165	295	56	43	56	0	1	1.087	1.0	0	1	0	0	10	3.0	2.5	2.0 common scab, rhizoctonia	
MSR169-8Y	135	234	58	42	58	0	0	1.087	1.5	0	2	0	0	10	2.0	3.0	0.5 common scab	sl SED
W6609-3	133	251	53	47	53	0	0	1.088	1.0	0	2	0	0	10	3.0	2.5	0.5 common scab	
A00188-3C	114	313	36	64	36	0	0	1.080	1.0	0	1	0	0	10	4.0	2.0	1.0 common scab, rhizoctonia, small tuber type	
MEAN	**265**	**364**						**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: 11-Jun-13
Ratings: 1 - 5
1: Slow Emergence
5: Early Emergence (vigorous vine, some flowering)

[5]VINE MATURITY RATING
Date Taken: 20-Aug-13
Ratings: 1 - 5
1: Early (vines completely dead)
5: Late (vigorous vine, some flowering)

Planted: 6-May-13
Vines Killed: 10-Sep-13
Days from Planting to Vine Kill: 127
Seed Spacing: 10"
No Fumigation

[6]MAWN STATION: Entrican
Planting to Vine Kill

Results: 2013-2014 New Chip Processing Box Bin Highlights

MSR127-2

This Michigan State University (MSU) chip processing variety has common scab tolerance and a uniform round tuber type. The specific gravity for this variety was 1.088. The recorded US#1 yield for this variety was above the trial average in the 2013 Box Bin Trial at 385 cwt./A (Table 2), a trend repeated from 2012. 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. Slight stem end defect (SED) was reported in the out-of-the-field chip sample. 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 2013-2014 storage season, MSR127-2 was placed into storage on October 2nd, 2013 and evaluated a week later for sugar stability.   On October 7th, 2013, MSR127-2 had a percent (X10) sucrose value of 0.525 and a glucose value of 0.002 percent. The sucrose percent (X10) values remained somewhat flat, ranging from 0.458 in late October to a peak of 0.632 in mid-May. The percent glucose remained low all season until mid-April, 2014 at which time it rose quickly. A chip picture is included from April 9th, 2014, to show the chip quality during this period. The sucrose and glucose values on this day were 0.471 percent (X10) and 0.004 percent, respectively. MSR127-2 appears to have good mid-season chip processing quality and better late-season chip quality than observed the previous storage year. The percent weight loss recorded for this variety at the time of bin unloading was 4.4, with 27.6 percent of the tubers evaluated expressing bruise with discoloration under the surface of the skin. These numbers are similar to the majority of the varieties evaluated this season. Overall, this variety performed well, attaining the second highest US#1 yield in the 2013 trial for the 2nd year in a row. This variety is on track for larger scale testing in 2016.

NY148 (NYE106-4)

This Cornell University developed variety exhibited an above average specific gravity in the 2013 Box Bin Trial. The specific gravity was the highest in the trial at 1.097 for the 2nd year in a row. The recorded yield for NY148 was above average at 315 cwt./A US#1 (Table 2). This variety exhibited mid-season maturity in 2013. The out-of-the-field chip sample scored a 1.0 SFA score with slight presence of stem end defect. On October 7th, 2013, the percent sucrose (X10) was 0.785 and percent glucose was 0.003. Sucrose and glucose levels came down to their lowest points in mid-February at 0.630 percent (X10) and 0.002, respectively. At this point in storage, the sucrose values began to rise to 1.361 percent (X10) in late May 2014. From the beginning of storage in October through the end of the storage season in late May, glucose levels hovered close to 0.003 percent. Total defects recorded for this variety in early May 2014 were 6.7 percent. The picture above captured NY148 at its latest acceptable chip quality point from storage on May 5th, 2014. The percent sucrose (X10) and glucose were 0.752 and 0.004 on this date. The percent weight loss recorded at the time of bin unloading for this variety was 7.19, with 27.1 percent of the tubers evaluated expressing bruise with discoloration under the surface, comparable to the other varieties evaluated in the 2013 Box Bin Trial. While this variety has excellent yield potential and moderate common scab tolerance, chip quality appears to be questionable out of storage due to the accumulation of physical defects, particularly black-spot bruising early in storage. Further storage and chip quality testing from commercially harvested, bulk-stored tubers is required before this clone can be considered for commercialization.

W5955-1

This variety was developed at the University of Wisconsin. 2013 was the first 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 303 cwt/A US#1 (Table 2). The variety exhibited mid-season maturity in 2013. It had excellent out-of-the-field chip quality, with a 1.0 chip score. Internal quality was also good, with only one tuber with vascular discoloration recorded. At the onset of storage on October 7th, 2013 tuber samples tested at 0.675 (X10) percent sucrose and 0.002 percent glucose. Glucose levels remained at 0.002 throughout the winter months and started to rise to 0.003 on April 9th, and 0.008 the following sample date, April 21st, 2014. At the same date, sucrose levels had nearly doubled from 0.866 to 1.527 (X10) percent. The picture above captures W5955-1 at the latest acceptable chip quality sample from storage on March 24th, 2014. Total defects were at 1.9 percent at this time, rising to 23.3 percent on the final sampling date of April 21st. These defects were primarily due to internal discoloration. The percent weight loss recorded at the time of bin unloading for this variety was 4.42 percent, with only 0.4 percent of tubers expressing pressure bruise with discoloration, a substantially lower proportion than other varieties evaluated in the Box Bin Trial for this year. Based on the above average yields, desirable tuber shape, high specific gravity, excellent chip quality and apparent low susceptibility to pressure bruising, W5955-1 is considered one of the top lines coming out of the 2013-2014 storage season. Because the 2013-2014 storage season was the first year of evaluation for this line, additional data is needed prior to moving forward with testing this line at the commercial scale. With a continued high-performance in 2014-2015, evaluation of this line at lower temperatures would be worth consideration to potentially extend late-season chipping quality. This variety has expressed common scab tolerance better than Snowden making it a potential variety to plant in fields with common scab pressure. In addition, W5955-1 appears to chip well directly out-of-storage and does not lose chip quality at the time of bin loading.

Snowden

This variety was included as a commercial standard for the 2013 Box Bin Trial. The recorded yield for the Snowden variety was below average for the 2nd year in a row at 202 cwt./A US#1 with a slightly above average specific gravity at 1.089 (Table 2). On October 2nd, 2013, this variety was put into storage and a week later was analyzed for sucrose and glucose concentration. On October 7th, 2013, a 0.806 percent sucrose (X10) and a 0.002 percent glucose value was recorded. Sucrose and glucose levels came down to their lowest points in mid-February at 0.426 percent (X10) and 0.001, respectively. From this point in storage, the sucrose values began to rise to 1.157 percent (X10) in early-April 2014. The percent glucose level was at 0.010 on this date. The chip picture above depicts Snowden during its last acceptable chip quality period taken on March 10th, 2014. Total defects recorded for this variety on March 10th, 2014, were 0.0 percent with a percent sucrose (X10) of 0.673 and a percent glucose of 0.002. The percent weight loss recorded at the time of bin unloading for this variety was slightly high at 15.51, with a more modest 14.7 percent of the tubers evaluated expressing bruise with discoloration under the surface.

II. 2013 - 2014 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 2013-2014 bulk bin storage season was to explore a temperature ramp down protocol for Lamoka that would preserve chip quality, but slow or eliminate pathogen development in early storage. The second goal was to develop storage profiles on two promising advanced clones MSL292-A (Manistee) and MSL007-B (Goal 1 and 2 are reviewed in Section A. of this report). The third goal was to continue our evaluation of Ozone gas injection into bulk piled potatoes as a means of stopping or slowing the development of storage pathogens (Section B. of this report). A major fungal pathogen that is commonly implicated in potato storage breakdown is Pythium Leak (*P. ultimum*). This pathogen was inoculated into a bulk pile, of the chipping variety "Pike", and was challenged with Ozone gas. The severity of tuber rot was subsequently evaluated. The Storage and Handling Committee has made these two areas, variety commercialization (Goals 1 and 2) and storage pathology (Goal 3, the focal points of the 2013-2014 storage research season.

Section A. Introduction to Variety Commercialization

The first variety tested for storage profiling in the 2013-2014 storage season was Lamoka (NY139), a clone from the potato breeding program at Cornell University, Ithaca, NY. This variety has a strong yield potential, specific gravity, great late-season chip quality and good common scab tolerance. As the tubers become larger, they tend to be more pear to oval shaped. More stem end defects are present in the larger tubers, so managing tuber size profile is important in this variety. Lamoka has a generally thin, smooth skin. The second variety tested was MSL292-A (Manistee), a new long-term storage, chip processing variety from the Potato Breeding and Genetics Program at Michigan State University. This clone has an above average overall yield of US#1 size tubers, with a uniformly netted skin. The specific gravity is average. Tuber type can be compressed, apical to stem end, but in general this occurs only in a small percentage of the total tuber number. The variety has a common scab susceptibility similar to Snowden. The final variety tested was MSL007-B. This variety has an average US#1 yield potential, very uniform round tuber type, heavy netted skin and good common scab tolerance. Tuber maturity and sugar stability has raised some concerns, but agronomic performance continues to propel this variety toward further commercial testing.

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 clearer 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.

In the 2013-2014 storage season; bins 1 and 2 were filled with Lamoka (NY139); bin 3 was filled with MSL292-A (Manistee); lastly, bin 4 was filled with MSL007-B. The Lamoka crop in bulk bins 1-2 was grown by Sacket Potatoes. Sandyland Farms produced the Manistee crop in bulk bins 3-4 as well as the MSL007-B crop in bulk bin 5.

Bin 1 was filled on October 2nd, 2013. The seed was planted May 17th, 2013 and vine killed on September 4th, 2013 (110 DAP, 2963 GDD_{40}). The variety was harvested October 1st, 2013; 137 days after planting. The pulp temperature for bulk bin 1 tubers at the time of bin loading was 62.0 ^{o}F. The planting, vine kill, harvest dates and tuber condition for bin 2 are identical to that reported for bin 1. The pulp temperature for bin 2 tubers was 64.5 ^{o}F at the time of loading.

Bin 3 was filled on October 11th, 2013. The Manistee crop was planted June 5th, 2013, and vine killed on September 4th, 2013 (97 DAP, 2722 GDD_{40}). The variety was harvested October 11th, 2013; 118

days after planting. The pulp temperature for bulk bin 3 tubers at the time of bin loading was 62.4 ºF. The planting, vine kill and harvest dates for bin 4 are identical to that reported for bin 3. The pulp temperature for bulk bin 4 tubers at the time of bin loading was 61.3 ºF.

Bin 5 was filled on October 15th, 2013. The crop was planted June 5th, 2013, and vine killed on September 10th, 2013 (97 DAP, 2722 GDD_{40}). The variety was harvested October 14th, 2013; 131 days after planting. The pulp temperature for bulk bin 5 (containing MSL007-B) at the time of bin loading was 56.3 ºF.

Bins 1 and 2 were gassed with CIPC on October 29th, 2013. Bins 4 and 5 were gassed with CIPC November 11th, 2013. On January 27th, 2013, bin 1 was gassed for a second time with CIPC, while bin 2 was gassed again on February 24th. Bins 3, 4 and 5 were all gassed for a second time on March 6th, 2014. Bin sugar monitoring began the day the 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 testing the Lamoka in bulk bins 1-2 was to: a.) determine the effect of cooling rate on simple sugar accumulation and b.) to determine the impact of storage temperature on pathogen development in Lamoka. For bulk bins 3 and 4, the objective was to determine the optimal storage temperature for Manistee (MSL292-A) that produce the best chip quality at the latest possible point in the storage season. The objective for bin 5 was to evaluate chip quality, pressure bruise susceptibility, and storage length of MSL007-B when stored in a commercially relevant environment.

Bulk Bin 1, Lamoka (NY139); 52 ºF

Figure 1. Techmark-Inc. chip picture, bulk bin 1 Lamoka, 4.9.14

Lamoka is a common scab tolerant, round to oval shaped chip processing variety from Cornell University. The variety has produced good chip quality late in the season from 48 ºF storage. In the 2013 on-farm variety trials, this line yielded 404 cwt/A US#1, above the trial average (359). The specific gravity of this variety averaged 1.079 in 2013, slightly above the average (1.078). Potential drawbacks of this variety could be Black Leg, Pythium Leak, Pink Rot and Black Heart susceptibility. These defects need to be evaluated more extensively over different environments and years.

For the 2013-2014 storage season, this variety was grown by Sackett Potatoes, Mecosta, Michigan, which is located in Montcalm County. The tuber pulp temperature upon arrival at the storage was 62.0 ºF. The variety was tested and found to be 65 percent black spot bruise free after bin loading. The tuber quality was generally good at bin loading with a substantial number of large tubers. The larger tubers were oval to oblong in appearance with loose skins. The potatoes in bulk bin 1 were planted with a 10.5 inch in-row seed spacing. This bin was held for a period of suberization (54-56 °F) before cooling. Some internal sugar color and sugar related defects were present from the time of bin loading until mid-November, 2013. Consequently, the pile temperature was maintained around 56.0 °F until sugar related defects decreased in November. Starting in early December, 2013, sugar levels were monitored as the pile was cooled by a rate of 0.2 ºF per day to a target storage temperature of 52.0 °F.

At the time of bin loading on October 2nd, 2013, the tuber sucrose and glucose concentrations were 0.643 percent (X10) and 0.004 percent, respectively. Sucrose levels peaked at 0.952 (X10) on November 18th then declined to 0.570 on January 27th, 2014 where it was maintained until unloading in mid-April. Glucose levels remained below 0.004 percent for the duration of the storage season. While chip quality was maintained late into the spring with low reported defects and good chip color (see Figure 1), in mid-March, bin odor and leakage in the plenums indicated the presence of tuber disease in the pile. Bin 1 was chip processed on April 15th, 2014 due to the presence of wet breakdown in the bulk pile related to what was thought to be tuber Black Leg or bacterial rot. The pile ending pulp temperature was 52.0 °F when shipped to Utz Quality Foods, Hanover, PA. At the time of bin unloading, tuber weight loss was 4.57 percent, with 23.0 percent of the tubers sampled having pressure bruise with discoloration under the skin, slightly higher than some of the other varieties evaluated for pressure bruise in 2013-2014. When processed at Utz Quality Foods, the tubers were reported to have a 1.096 specific gravity. Utz Quality Foods scored the finished chips with 2 percent total defects, 1 percent external and 1 percent internal.

Figure 2. Finished bag sample processed at UTZ Quality Foods on 4.16.2014. Lamoka tubers from Bulk Bin number 1

Lamoka continues to exhibit good agronomic quality, such as high yield potential, common scab tolerance and good chip quality in small test plots. Encouraging this variety to set good skins before harvest and storage will be important for its commercialization. Managing diseases such as Soft Rot, Dry Rot and Pythium Leak in the field and in storage bins will be important for the successful adoption of this variety as well. Adjusting nitrogen application rates may help to ensure better skin set at harvest to improve physical storability. Lamoka has shown to be a 130 day potato, slightly later than the standard chipping variety Snowden. In some fields, Lamoka has appeared to exhibit some tolerance to late blight during the growing season. Overall, this variety has many great qualities and needs to be evaluated in more large acreage trials for a number of years to better understand its physical and chemical storability.

Bulk Bin 2, Lamoka (NY139); 48 ^{o}F

Lamoka in bulk bin 2 was grown under identical conditions as the tubers in bulk bin 1, both bulk bins being produced by Sackett Potatoes, Mecosta, MI. The tuber pulp temperature of the Lamoka tubers in bin 2 upon arrival on October 2nd, 2013 was 64.5 ^{o}F. The sucrose and glucose levels at the time of bin loading were 0.742 percent (X10) and 0.002 percent, respectively. The tubers were tested and found to be 60 percent black spot bruise free after bin filling. The tuber quality was acceptable, but moderate skin feathering was observed at the time of bin loading. Similar to bulk bin 1, bin 2 was held at around 55.0 ^{o}F for wound healing until mid-November. There were significant amounts of internal and external chip related defects early in the storage season resulting in the bin's holding temperature remaining around 55.0-56.0 °F until mid-November 2013. From mid-November, the pile was cooled rapidly (0.4 ^{o}F per day) until reaching the desired holding temperature of 48.0 °F in mid-December 2013. Sugar levels were monitored as the pile was cooled. Sucrose levels peaked in mid-December and slowly dropped to 0.572 percent (X10) in early April where they remained flat until shipping. Glucose levels remained very low all season long, remaining at 0.002 or 0.001 for nearly the entire storage season up through early June. The sucrose and glucose values just prior to processing were 0.624 percent (X10) and 0.001 percent, respectively. See the Techmark Inc. June 2nd generated photo which correlates to these sugar numbers (Figure 3). Some hollow heart defect was observed at the time of processing. Unlike bin 1, there was no indication of tuber disease from foul odors or leakage in bin 2 where the storage temperature had been maintained 4 ^{o}F cooler. This factor, along with ideal sugar levels, allowed this bin to be held until June, 2014 at which point they were processed.

Figure 3. Techmark-Inc. chip picture, bulk bin 2 Lamoka, 6.2.14

Bin 2 was chip processed at Utz Quality Foods, Hanover, PA on June 4th, 2013 (see Figure 4). The specific gravity was reported at 1.095, with a total of 4% chip defects (2% internal, 2% external). At the time of bin unloading, tuber weight loss was 4.55 percent, with 26.7 percent of the tubers expressing pressure bruise and discoloration under the skin. This variety appears to pressure bruise similarly to other varieties and comparisons with bin 1 data indicate that bin temperature did not substantially impact pressure bruising. The slightly higher number of pressure bruises with discoloration under the skin (compared with bin 1) may have been elevated due to the duration of the tubers in storage, although this difference was small.

Figure 4. Finished bag sample processed at UTZ Quality Foods on 6.4.2014. Lamoka tubers from Bulk Bin number 2

Lamoka has exhibited great agronomic quality as previously mentioned. Encouraging good skin set will be very important prior to harvest and before storage to ensure physical storability. 2013-2014 storage data indicates that Lamoka can be held at 48 ^{o}F and maintain long season chip quality. Encouragingly, at this lower temperature, physical storability was improved (no appreciable incidence of wet-breakdown or storage rots were observed). This observation can provide insight into management of the storage pathogens that this variety has been shown to be susceptible to. Managing in-field bacterial diseases such as aerial vine rot will be important to reduce inoculum load brought into storage. Seed spacing will be a good tool to use to manage overall tuber size, thus reducing internal tuber defects such as stem end. In southern Michigan counties, this variety would best be planted at an 8-9 inch in-row seed spacing. In Central Michigan, the in-row seed spacing can be widened to a 9-10 inch in-row seed spacing.

Bulk Bin 3, Manistee (MSL292-B); 50 ºF

Figure 5. Techmark-Inc. chip picture, bulk bin 3 Manistee, 6.2.14

MSL292-A is a Michigan State University developed variety. In the 2013 on-farm trials, this variety yielded 426 cwt./A US#1 when averaged over nine locations, above the average yield of 359 cwt/A. The average specific gravity was 1.077, close to the overall average of 1.078. A small percentage of tubers may be compressed, apical to stem end and a skin with a uniform, heavy-netted appearance. Manistee exhibits moderate common scab suceptibility, similar to Snowden. An in-row seed spacing of 10 to 12 inches is recommended.

For the 2013-2014 storage season, the potatoes in bin 3 were grown by Sandyland Farms, Howard City, Michigan. The tuber pulp temperature upon arrival at the storage was 62.4 ºF. The variety was tested and found to be 88 percent black spot bruise free after bin loading. The tuber quality was good with a medium tuber size profile and slightly flattened shape from apical to stem-end. The potatoes in bulk bin 3 were planted with a 10 inch in-row seed spacing. This bin was held for a two week period of suberization (55-58 °F) before cooling. The pile temperature was cooled slowly to 50.0 °F as not to impede reparation of the free sugar present, although early storage samples had sucrose and glucose levels suitable for chipping with no reported defects. Upon reaching 50.0 °F in early December and seeing that defect levels remained low, the pile temperature was maintained at 50.0 °F for the duration of the season.

At the time of bin loading on October 11th, 2013, the tuber sucrose and glucose concentrations were 0.606 percent (X10) and 0.002 percent, respectively. In early December, 2013, the sucrose value had remained stable at 0.669 percent (X10). Sucrose and glucose levels remained low for the entirety of the storage season, not exceeding 0.742 (X10) and 0.003 percent respectively. Chip quality remained good throughout the storage season as well; at the time of shipping on June 2nd, 2014 there were no reported defects or undesirable color (see Figure 5). The pile ending pulp temperature was 50.0 °F when shipped on June 2nd, 2014, to Better Made Snack Foods, Detroit, Michigan. At the time of bin unloading, tuber weight loss was 4.51 percent, with 14.7 percent of the tubers that expressed pressure bruise having discoloration under the skin. This variety appears to pressure bruise similarly to other varieties. When processed at Better Made Snack Foods, the tubers were reported to have an Agtron score of 66.6 and with 6.24% total defects. Figure 6 represents a chip quality grade sample conducted on finished product from the Better Made Snack Foods processing run based on MSU evaluation criteria. Our color defects and internal defects scores were similar to Better Made data.

Figure 6. MSU grade sample from bin 3 processed at Better Made Snack Foods on 6.3.14

Manistee appears to have very good late season chip quality as confirmed by this processing run at Better Made on June 3rd, 2013. This is a quality that has been observed with this variety in previous storage years as well. The physical tuber quality of this variety held-up season long with no rot observed at the time of bin unloading. Overall, the general agronomic qualities of Manistee appear to be good, though some common scab susceptibility has been observed.

Bulk Bin 4, Manistee (MSL292-B); 48 °F

Figure 7. Techmark-Inc. chip picture, bulk bin 4 Manistee, 6.2.14

Tubers in bin 4 were grown filled with the same variety, from the same farm (Sandyland Farms, Howard City, Michigan) and on the same date as in bin 3. The tuber pulp temperature upon arrival at the storage was 61.3 °F. The tubers were tested and found to be 77 percent black spot bruise free with some mechanical damage observed following bin loading. This bin was held for a two week period of suberization (57-58 °F) before cooling. Sucrose and glucose levels were low at the time of bin loading, and remained relatively stable throughout the storage season. Following suberization, bin 4 was cooled 0.4 °F/day to a final storage temperature of 48 °F. After sucrose levels dropped to 0.525 (X10) percent in early December, they began to rise up to 0.798 (X10) in mid-January. Glucose levels rose slightly up to 0.005 percent in mid-January, at which time total defects rose as well to 18.3 percent. Following a brief drop in sugar concentration and defects, levels rose again in late February with 0.009 percent glucose and 18.6 percent total defects. Sucrose/glucose and chip defects dropped from late March through the rest of the storage season until shipment on June 2^{nd}, 2014.

The pile ending pulp temperature was 49.6 °F when shipped on June 2^{nd}, 2014 to Shearer's Foods, Brewster, OH. At the time of bin unloading, tuber weight loss was 4.86 percent, with 8.4 percent of the tubers with bruising and discoloration under the skin, over 6 percent less than the Manistee tubers from bin 3. Tuber quality at the time bin unloading was comparable to bin 3, which is reflected in the Techmark chip quality data and pictures (see Figure 6). At the last sampling date (June 2^{nd}, 2014), tubers from bin 4 had 0.645 (X10) percent sucrose, 0.002 percent glucose and 3.8 percent total defects.

Figure 7 represents a chip quality sample conducted at Sackett Potatoes chip quality lab in Mecosta, Michigan from June 2nd, 2014.

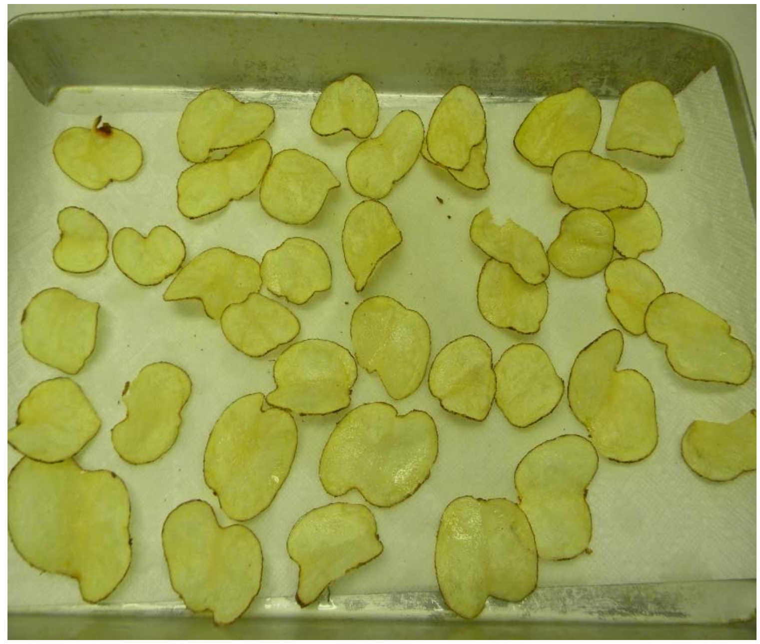

Figure 7. Chip quality lab picture from Sackett Potatoes, bulk bin 4, Manistee, 6.2.14

In evaluating chip quality data from the two storage environments used for Manistee tubers in 2013-2014, at both 50 °F (bin 3) and 48 °F (bin 4), chip quality was excellent. Sucrose and glucose levels were slightly more variable in bin 4 than in bin 3, where they remained flat throughout the storage season, although these spikes were not severe or prolonged. The superior storability of Manistee at these temperatures is encouraging for this variety, and future evaluations of this line at even lower temperatures should be considered.

Bulk Bin 5, MSL007-B; 54 °F

MSL007-B is a Michigan State University developed variety. In the 2013 on-farm trials, this variety yielded 407 cwt/A US#1 when averaged over six locations. The specific gravity averaged 1.074, slightly lower than the trial average of 1.078. This variety has a nice, uniform-round tuber type. The skin has a uniform heavy netted appearance, and it exhibits some common scab tolerance.

Figure 8. Techmark Inc. chip picture of MSL007-B just prior to processing, 4.9.14

The MSL007-B potatoes in bin 5 were grown by Sandyland Farms in Montcalm County, Michigan and were harvested and loaded into storage on October 15th with a pulp temperature of 56.3 ºF. The overall size profile of the tubers was good. The potatoes were determined to be 72% bruise free after bin loading. The tubers were kept at 55.0 °F after arrival and allowed to remain at this temperature to suberize for four weeks. After suberization, bin 5 was cooled gradually to a final storage temperature of 54 ºF. At loading, the percent sucrose was 0.744 (X10) and dropped in subsequent weeks to a low of 0.303 (X10) in early December. Although sucrose levels remained low throughout the storage season, glucose levels did not fall below 0.005 percent, and began to rise in early March, reaching 0.009 percent at the last sampling date of April 9, 2014. Chip defects were substantial throughout the storage season, ranging from 27.1 % early in the storage, to 67.6 % in early January, to 49.9% just prior to shipping. MSL007-B was shipped to be dehydrated for starch on April 15th 2014. The sucrose and glucose readings at the time of shipping were 0.576 percent (X10) and 0.009 percent respectively. The pile temperature was 57.4 ºF on the date of shipping. Figure 8 depicts the chip quality of the MSL007-B tubers on the day of bin unloading. Pressure bruise data from this bin at the time of bin unloading indicated that there was 6.34 weight loss from tubers, and 28.9 percent of the tubers evaluated had pressure bruising with color, only 17.8 percent were bruise free, indicating the likelihood of pressure bruise susceptibility with this variety.

The persistently high number of chip defects, high glucose content and pressure bruise susceptibility limit the utility of this variety for chip processing. Glucose levels early in the storage season did not drop below 0.005 percent and likely led to some of the chip defects that were observed with this line. Pressure bruising was significant, as evaluated after bin unloading. Although tubers at loading had a good general appearance (uniform, round shape), the absence of storability in this line will limit its use in Michigan.

Section B. Introduction to Storage Pathology and Ozone Utilization

The Storage and Handling Committee has been working with Guardian Integrated Technologies Co. and Techmark Inc. during the 2012-2013 and the 2013-2014 storage season to evaluate the effectiveness of ozone application to bulk potato piles to reduce the impact of post-harvest storage losses caused by pathogens. Ozone can be generated relatively easily on-site, and plumbed directly into the potato storage bins. The gas is highly reactive with organic molecules non-discriminately oxidizing those compounds that it comes in contact with.

Figure 9. Pressure bruise-like injury observed in bulk bin 9 (ozone treated- 2013).

Figure 10. Pressure bruise lesions apparent of time of bin unloading (ozone treated-2014).

Methods

Bins 8 and 9 were both filled with the variety Pike (both years) and inoculated with four common rot pathogens, Dry Rot, Pink Rot, Pythium Leak and Soft Rot. Potatoes were produced by Crooks Farms, Stanton, Michigan. Bins were loaded on September 26th, in 2012 and 2013. In the 2012-2013 storage season, both bins were inoculated with 4 x 30 pound bags of tubers with the previously mentioned pathogens, and were placed in a column at 4,8,12 and 16 feet above the storage floor. Ozone application was made at a measured rate to bin 9 beginning at bin loading (bin 8 served as the negative control). This process was modified in 2013-2014 in an attempt to achieve a more accurate evaluation of ozone application based on inoculum loads typically encountered in commercial bulk storage facilities. In an attempt to address this, a smaller number of tubers were inoculated in 2013-2014, where 4 bags of three A-sized tubers were placed at 4 different levels within the bin (4, 8, 12 and 16 feet) and inoculated solely with the Pythium Leak pathogen. Bins and bin plenums were monitored throughout the storage season for pile collapse, rotting, and wet break-down. Pile temperatures were maintained at 54-56 ^{o}F, with relative humidity between 94-96 percent.

Results

In 2012-2013 no reduction in pathogen spread was evident between the ozone-treated and control bins. Both bins 8 and 9 displayed pile collapse (in soft and dry rot columns). Active pathogen growth was also observed in Pythium and Pink Rot columns. Wet break down was observed in both piles, ultimately rendering the crops unmarketable.

Tubers in bin 9 were observed to have a white, bleached appearance (Figure 9) and prominent pressure bruise lesions located where tubers were making contact with each other in the pile. The tubers with the bleached appearance and pressure bruise lesions were observed in the lower third of the pile. The ozone concentration was regulated based on 1-1.5 ppm ozone present in the return air on the top of the bulk pile of potatoes. It was theorized that allowing the total ozone concentration in bulk bin 9 to be established based on sampling from the top of the pile would result in a much higher rate of ozone being injected into the bottom of the pile. It is this elevated rate of ozone that was believed to have caused the oxidation of the potato tubers at the bottom of the potato pile, potentially increasing tuber dehydration and tuber pressure bruising. The ozone was also implicated in tuber periderm cracking, which may have resulted in an increased tuber infection. Methods were adopted in 2013-2014 to address this issue.

Figure 11. Bin 8 (Control Bin) tuber quality at date of shipment 2/17/2014.

Figure 12. Bin 9 (Ozone treatment) tuber quality at date of shipment 2/17/2014.

The results of the demonstration in 2013-2014 were similar to that of the 2012-2013 season in that both bins showed significant tuber decay in mid-February (Figures 11 and 12) with free water emanating from both bulk potato piles in the plenums (Figures 13 and 14). The smell of the tuber rot was more evident from the control bin, but Ozone was believed to be masking the smell from the treatment bin. The ozone-treated bin had over 6 percent more tubers exhibiting pressure bruise with the amount and severity of pressure bruise in the lower third of the bin comparatively higher than in the control bin. The amount of discoloration under the skin at the pressure bruise site was observed at a similar rate in both the treatment and the control bins. Potatoes from the 2013-2014 project chip processed successfully in mid-February 2014. A three percent higher finished chip defect score was recorded in the chips that came from the treatment bin.

Figure 13. Plenum under bin 8 (control bin) on the date of shipment 2/17/2014. Note leakage on bottom and sides.

Figure 14. Plenum under bin 9 (ozone treatment) on date of shipment 2/17/2014. Note leakage on bottom and sides.

Conclusions

After assessing the results from the two storage seasons, it is difficult to recommend ozone gas injection into bulk storage potatoes as a means to control or prevent the spread of storage pathogens. It is recognized that ozone is an effective oxidizing agent and has many commercial applications. In this study, it was difficult to see the benefits in pathogen reduction or improved tuber quality, though ozone application did not appear to substantially affect tuber chip quality. No further testing of ozone for disease control in potatoes is planned.

Contents

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Potato Response to Phosphorus Fertilizer

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Soil Fertility & Nutrient Management
Dept. of Plant, Soil, and Microbial Sciences, Michigan State University

Location: Montcalm Research Farm	**Tillage**: Conventional
Planting Date: May 20, 2014 (Vinekill 9/3/14)	**Trt's**: See below
Soil Type: Loamy sand; 1.9 OM; 6.4 pH; 143 ppm P; 140 ppm K	**Population**: 34 in rows, 11 in. spacing
Variety: EXP. 1 (~ 110-120 day maturity)	**Replicated**: 4 replications

Total P Rate (lb. P_2O_5/A)	**Petiole Phosphate 30 DAE**	**Petiole Phosphate 45 DAE**	**Petiole Phosphate 60 DAE**
	Percent (%)		
0	0.26	0.21	0.16
40	0.30	0.21	0.14
80	0.33	0.19	0.15
120	0.35	0.19	0.14
160	0.41	0.20	0.14
200	0.44	0.20	0.16
$LSD_{(0.10)}$[a]	**0.03**	**NS**	**0.01**

[a] LSD, least significant difference between means within a column at ($\alpha = 0.10$).

Total P Rate (lb. P_2O_5/A)	**Total Yield (cwt/A)**	**Yield A's (cwt/A)**	**Yield B's (cwt/A)**	**Yield Oversize (cwt/A)**	**Specific Gravity**
0	264	232	11	21	1.04
40	301	253	10	38	1.04
80	266	203	9	54	1.04
120	289	234	7	48	1.04
160	368	294	9	65	1.04
200	348	276	5	67	1.04
$LSD_{(0.10)}$[a]	**40**	**NS**	**NS**	**NS**	**NS**

[a] LSD, least significant difference between means within a column at ($\alpha = 0.10$). Yield data are representative of an 85% stand due to 15% stand loss from heavy precipitation soon after planting.

Summary: Trial was conducted to study the P response of potato across a range of P rates ranging from 0 – 200 lbs P_2O_5/A. Baseline soil fertility levels were 143 ppm Bray P1 and 140 ppm K. All treatments received starter fertilizer in the form of 25 and 205 lbs/A of N and K_2O, respectfully. Starter N and all P applications were banded at planting while 100 lbs K2O was band-applied at planting with the remaining 105 lbs K2O pre-plant incorporated. Phosphorus applications were applied at planting with rates pertaining to individual treatments. Nitrogen applications totaled 275 lbs/A and were split with 25 lbs applied as starter, 83 lbs as ammonium sulfate at emergence, and 167 lbs of the remaining N applied as urea at hilling.

Petiole phosphate analyses at 30 DAE indicated significant differences with regards to P application rate. Petiole phosphate has a tendency to sharply decrease between 30-45 DAE. Petiole phosphate at 45 and 60 DAE indicated few if any biologically significant differences further indicating the importance of early-season P management and petiole phosphate levels. Total yield was significantly impacted by total P application rate. Results from the first year of this trial under 2014 environmental conditions for this maturity length indicate that total yield was significantly increased at 160 lbs P_2O_5/A. Differences in total yield were driven by differences in yield of total A's with 160 lbs P_2O_5/A maximizing potato yield. With reference to total yield, few statistical differences occurred between P rates of 0 – 120 lbs P_2O_5/A. This response to P was achieved under 2014 precipitation and temperature patterns both of which may greatly affect potato response to P fertilizer. Factors including variety, rooting ability, and management regime will greatly affect potato response to P fertilizer. Phosphorus fertilizer should be incorporated into the soil to prevent P losses in runoff water especially in areas subject to soil erosion.

Conventional and Liquid Fertilizer Programs in Potato

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Dept. of Plant, Soil, and Microbial Sciences, Michigan State University

Location: Montcalm Research Farm	**Tillage**: Conventional
Planting Date: May 20, 2014 (Vinekill 9/3/14)	**Trt's**: See below
Soil Type: Loamy sand; 1.9 OM; 6.4 pH; 143 ppm P; 140 ppm K	**Population**: 34 in rows, 11 in. spacing
Variety: EXP. 1 (~ 110-120 day maturity)	**Replicated**: 4 replications

Fertilizer Treatment	**Petiole Phosphate 30 DAE**	**Petiole Phosphate 60 DAE**
	Percent (%)	
Dry Standard	0.36	0.15
Wet Standard	0.38	0.14
Wet w/ Pro-Germinator	0.33	0.16
Wet Grower Program	0.32	0.15
Wet Grower w/ Kalibrate K	0.30	0.15
$LSD_{(0.10)}$[a]	**0.04**	**NS**

[a] LSD, least significant difference between means within a column at (α = 0.10).

Fertilizer Treatment	**Total Yield (cwt/A)**	**Yield A's (cwt/A)**	**Yield B's (cwt/A)**	**Yield Oversize (cwt/A)**	**Specific Gravity**
Dry Standard	385	315	11	55	1.10
Wet Standard	371	284	8	71	1.09
Wet w/ Pro-Germinator	354	286	10	57	1.09
Wet Grower Program	342	266	8	65	1.09
Wet Grower w/ Kalibrate K	339	263	10	58	1.10
$LSD_{(0.10)}$[a]	**NS**	**NS**	**NS**	**NS**	**< 0.01**

[a] LSD, least significant difference between means within a column at (α = 0.10).

Treatments:

Treatment	Source	Rate/A	Timing
Dry Standard (275-120-150-86S)	MAP (11-52-0)	120 lbs P2O5	Planting – Banded
	MOP (0-0-62)	150 lbs K2O	Planting - 100 lbs banded and 50 lbs b-cast incorp.
	Urea (46-0-0)	25 lbs N	Planting – Banded
	Micro-500	2 qts/A	Planting - Banded
	AS (21-0-0-24)	75 lbs N	Emergence - banded
	Urea (46-0-0)	150 lbs N	Hilling - banded
Wet Standard (275-120-150-86S)	MOP (0-0-62)	150 lbs K2O	Planting - 100 lbs banded and 50 lbs b-cast incorp.
	MAP (11-52-0)	40 lbs P2O5	Planting – Banded
	10-34-0	20 gpa	Planting – Banded
	UAN (28-0-0)	10 gpa	Planting – Banded
	Micro-500	2 qts/A	Planting - Banded
	AS (21-0-0-24)	70 lbs N	Emergence - banded
	UAN (28-0-0)	48 gpa	Hilling - banded
Wet w/ Pro-Germinator (275-32-150-86S)	MOP (0-0-62)	150 lbs K2O	Planting - 100 lbs banded and 50 lbs b-cast incorp.
	Urea (46-0-0)	38 lbs N	Planting – Banded
	Pro-Germinator	12 gpa	Planting – Banded
	Micro-500	2 qts/A	Planting – Banded
	AS (21-0-0-24)	75 lbs N	Emergence - banded
	Urea (46-0-0)	150 lbs N	Hilling - banded
Wet Grower Program (267-33-103-87S)	MOP (0-0-62)	100 lbs K2O	Planting - 100 lbs banded
	Pro-Germinator	12 gpa	Planting – Banded
	High NRG-N	10 gpa	Planting – Banded
	Sure-K	5 gpa	Planting – Banded
	Micro-500	2 qts/A	Planting – Banded
	AS (21-0-0-24)	75 lbs N	Emergence - banded
	UAN (28-0-0) with eNhance	50 gpa 40 mL per gall 28%	Hilling - banded
Wet Grower w/ Kalibrate K (267-32-105-90S)	MOP (0-0-62)	100 lbs K2O	Planting - 100 lbs banded
	Pro-Germinator	12 gpa	Planting – Banded
	High NRG-N	10 gpa	Planting – Banded
	Kalibrate	5 gpa	Planting – Banded
	Micro-500	2 qts/A	Planting – Banded
	AS (21-0-0-24)	75 lbs N	Emergence - banded
	UAN (28-0-0) with eNhance	50 gpa 40 mL per gall 28%	Hilling - banded

Pro-Germinator: (9-24-3)

Micro-500: (0.02% B, 0.25% Cu, 0.37% Fe, 1.20% Mn, 1.80% Zn)

High NRG-N: (27-0-0-1S)

Sure-K: (2-1-6)

eNhance: (8.7% S, 0.07% Mn, 0.07% Zn)

Kalibrate: (2-0-10-6S)

Disclaimer: *Mention of proprietary product is included for the reader's convenience and does not imply any endorsement or preferential treatment.*

Summary: Trial was conducted to study the effects of dry, liquid, and dry/liquid hybrid fertilizer programs for Michigan potato production. Baseline soil fertility levels were 143 ppm Bray P1 and 140 ppm K. A fertilizer recommendation of 275-120-150 was used as a standard fertilizer rate. Nutrients were not equalized amongst treatments due to anecdotal data indicating differing efficiency factors between granular and liquid products. All starter N and P were banded by seed at planting. Potash (100 lbs K2O) was banded by seed at planting while the remaining 50 lbs K2O were broadcast applied and incorporated. Nitrogen applications consisted of ammonium sulfate and urea applied at 1/3 remaining total N at emergence and 2/3 remaining total N at hilling.

Petiole phosphate analyses at 30 DAE indicated some significant differences with regards to fertilizer treatment. The wet standard program utilizing 10-34-0 and 28-0-0 at planting resulted in the greatest tissue P but statistically similar to the dry standard fertilizer program with all other treatments maintaining significantly lower levels of tissue P. Petiole phosphate has a tendency to sharply decrease between 30-45 DAE. Petiole phosphate at 60 DAE indicated no significant differences amongst any of the fertilizer programs. Preliminary first-year results from this trial under 2014 environmental conditions for this maturity length indicated few significant differences amongst overall potato production. Total yield, total A's, total B's, and oversize were not significantly impacted by fertilizer program. Total A grade potato production followed a general pattern of dry standard > wet standard, wet w/ Pro-Germinator > wet grower program, wet grower program w/ Kalibrate K.