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MICHIGAN POTATOES
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Michigan Potato Industry Commission

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To All Michigan Potato Growers & Shippers:

The Michigan Potato Industry Commission, Michigan State University's Agricultural Experiment Station and Co-operative Extension Service are pleased to provide you with a copy of the results from the 2005 potato research projects.

This report includes research projects funded by the Michigan Potato Industry Commission, the USDA Special Grant and special allocations by the Commission. Additionally, the Commission expresses appreciation to suppliers of products for research purposes and special grants to the Commission and researchers.

Providing research funding and direction to principal investigators at MSU is a function of the Michigan Potato Industry Commission's Research Committee.

Best wishes for a prosperous 2006 season.

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2005 MICHIGAN POTATO RESEARCH REPORT

C. M. Long, Coordinator

INTRODUCTION AND ACKNOWLEDGMENTS

The 2005 Potato Research Report contains reports of the many potato research projects conducted by MSU potato researchers at several locations. The 2005 report is the 37th volume, which has been prepared annually since 1969. This volume includes research projects funded by the Special Federal Grant, the Michigan Potato Industry Commission (MPIC), GREEEN and numerous other sources. The principal source of funding for each project has been noted at the beginning of 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 Special Federal Grant have had on the scope and magnitude in several research areas.

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 Dick Crawford for the management of the MSU Montcalm Research Farm and the many details which are a part of its operation. We also want to recognize Barb Smith at MPIC and Sheila Crooks for helping with the details of this final draft.

WEATHER

The overall 6-month average temperatures during the 2005 growing season were slightly higher than the 6-month average for the 2004 season and were higher than the 15-year average (Table 1). There were four recorded temperature readings of 90 °F or above in 2005. Three of these days occurred in late June and one in early August. For two nights in June the minimum temperature remained above 70 ºF. There were 14 days in April and 2 in early May that the temperature was below 32 °F. There was no daytime low, near 32 °F, during harvest (September to October). The average maximum temperatures for June, July, August and September of 2005 were well above the 15-year average (Table 1).

Rainfall for April through September was 15.05 inches (Table 2). Rainfall recorded during the months of May and August was well below the 15-year averages for the same months. Rainfall recorded during the month of April was the lowest recorded for that month in 15 years. Irrigation at MRF was applied 10 times from June 22nd to August 31st averaging 0.69 inches for each application. The total amount of irrigation water applied during this time period was 6.9 inches.

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

Year	April		May		June		July		August		September		6-Month Average	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1991	60	40	71	47	82	59	81	60	80	57	69	47	74	52
1992	51	34	70	42	76	50	76	54	75	51	69	46	70	46
1993	54	33	68	45	74	55	81	61	79	60	64	46	70	50
1994	57	34	66	43	78	55	79	60	75	55	73	51	71	50
1995	51	31	66	45	81	57	82	60	82	65	70	45	72	51
1996	50	31	64	44	75	57	76	55	80	59	70	51	69	50
1997	54	31	59	39	79	56	80	57	73	55	69	50	69	48
1998	60	37	75	51	77	56	82	58	81	60	76	52	75	52
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**
15-Year Average	57	35	67	45	78	56	81	58	78	58	72	49	72	50

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

Year	April	May	June	July	August	September	Total
1991	4.76	3.68	4.03	5.73	1.75	1.50	21.45
1992	3.07	0.47	1.18	3.51	3.20	3.90	15.33
1993	3.47	3.27	4.32	2.58	6.40	3.56	23.60
1994	3.84	2.63	6.04	5.16	8.05	1.18	26.90
1995	3.65	1.87	2.30	5.25	4.59	1.38	19.04
1996	2.46	3.99	6.28	3.39	3.69	2.96	22.77
1997	2.02	3.13	3.54	2.80	2.71	1.46	15.66
1998	2.40	2.21	1.82	0.40	2.22	3.05	12.10
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**
15-Year Average	2.91	3.78	3.64	3.40	4.17	2.70	21.00

GROWING DEGREE DAYS

Table 3 summarizes the cumulative, base 50°F growing degree days (GDD) for May through September, 2005. The total GDD for 2005 were 2,458 which is 398 GDD higher than 2004, and third highest in the 10-year average.

Table 3. Growing Degree Days* - Base 50°F.

Cumulative Monthly Totals					
Year	May	June	July	August	September
1996	201	681	1177	1776	2116
1997	110	635	1211	1637	1956
1998	427	932	1545	2180	2616
1999	317	865	1573	2070	2401
2000	313	780	1301	1851	2256
2001	317	808	1441	2079	2379
2002	319	903	1646	2214	2613
2003	330	762	1302	1922	2256
2004	245	662	1200	1639	2060
2005	195	826	1449	2035	2458
10-Year Average	277	785	1385	1940	2311

*1996-2005 data from the weather station at MSU Montcalm Research Farm (Michigan Automated Weather Network system Entrican, MI.)

PREVIOUS CROPS, SOIL TESTS AND FERTILIZERS

The general potato research area utilized in 2005 was rented from Steve Comden, directly to the West of the Montcalm Research Farm. This acreage was planted to a soybean cover crop in the spring of 2004 and was disked under in the fall do to poor yield. In the spring of 2005, the recommended rate of potash was applied and disked into the remaining soybean stubble. The ground was moldboard plowed for direct potato planting. The area was not fumigated prior to potato planting. Potato early die was not an issue in 2005.

The soil test analysis for the general crop area was as follows:

	lbs/A			
pH	P_2O_5	K_2O	Ca	Mg
6.2	346 (173 ppm)	172 (86 ppm)	768 (384 ppm)	134 (67 ppm)

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

Application	Analysis	Rate	Nutrients ($N-P_20_5-K_20$)
Broadcast at plow down	0-0-60	250 lbs/A	0-0-150
At planting	19-17-0	19 gpa	40-36-0
At emergence	46-0-0	145 lbs/A	67-0-0
1st Early side dress	46-0-0	164 lbs/A	76-0-0
2nd Late side dress (late varieties)	46-0-0	240 lbs/A	110-0-0

HERBICIDES AND PEST CONTROL

Hilling was done in late May, followed by a pre-emergence application of Lorox at 1.5 lb/A and Cinch at 1.25 pints/A.

Platinum was applied at planting at a rate of 8 Fl oz/A. Asanna XL was applied once in early June at 9.6 Fl oz/A. Fungicides used were Bravo, Dithane DF and Manzate over 11 applications. Potato vines were desiccated with Reglone in late August and again in early September at a rate of 1 pint/A.

2005 POTATO BREEDING AND GENETICS RESEARCH REPORT

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INTRODUCTION

At Michigan State University we are breeding potatoes for the chip-processing and tablestock markets. The program is one of four integrated breeding program in the North Central region. At MSU, we conduct a multi-disciplinary program for potato breeding and variety development that integrates traditional and biotechnological approaches. In Michigan, it requires that we develop high yielding round white potatoes with excellent chip-processing from the field and/or storage. We conduct variety trials of advanced selections and field experiments at MSU research locations (Montcalm Research Farm, Lake City Experiment Station, Muck Soils Research Farm and MSU Soils Farm), we ship seed to other states and Canadian provinces for variety trials, and we cooperate with Chris Long on 11 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). 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 solids, insect resistance, disease resistance and nutritional enhancement. 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 and early die), 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. We are also developing potato tuber moth resistant lines as a component of our international research project. If these goals can be met, we will be able to reduce the grower's 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 material moving through the program. These include the establishment and expansion of the scab nursery, the development of the Muck Soils Research Farm 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 Farm, new land at the Lake City Experiment Station along with a well for irrigation and expanded land at the Montcalm Research Farm.

PROCEDURE

I. Varietal Development

Each year, during the winter months, 500-1000 crosses are made using about 150 of the most promising cultivars and advanced breeding lines. The parents are chosen on the basis of yield potential, tuber shape and appearance, chip quality, specific gravity, disease resistance, adaptation, lack of internal and external defects, etc. These seeds are then used as the breeding base for the program. We also obtain seedling tubers or crosses from other breeding programs in the US. The seedlings are grown annually for visual evaluation (size, shape, set, internal defects) at the Montcalm and Lake City Research Farms as part of the first year selection process of this germplasm each fall. Each selection is then evaluated post harvest for specific gravity and chip processing. These selections each represent a potential variety. This system of generating new seedlings is the initial step in an 8-12 year process to develop new varieties. This step is followed by evaluation and selection at the 8-hill, 20-hill and 30-hill stages. The best selections out of the four-year process are then advanced for testing in replicated trials (Preliminary, Adaptation, Dates-of-Harvest, Grower-cooperator trials, North Central Regional Trials, Snack Food Association Trials, and other out-of-state trials) over time and locations. The agronomic evaluation of the advanced breeding lines in the replicated trials is reported in the annual Potato Variety Evaluation Report.

II. Evaluation of Advanced Selections for Extended Storage

With the Demonstration Storage facility adjacent to the Montcalm Research Farm we are positioned to evaluate advanced selections from the breeding program for chip-processing over the whole extended storage season (October-June). Tuber samples of our elite chip-processing selections are placed in the demonstration storage facility in October and are sampled monthly to determine their ability to chip-process from colder (42-48°F) and/or 50˚F storage. In addition, Chris Long evaluates the more advanced selections in the 10 cwt box bins and manages the 500 cwt. storage bins which may have MSU lines.

III. Germplasm Enhancement

To supplement the genetic base of the varietal breeding program, we have a "diploid" (2x = 24 chromosomes) breeding program in an effort to simplify the genetic system in potato (which normally has 4x chromosomes) and exploit more efficient selection of desirable traits. This added approach to breeding represents a large source of valuable germplasm, which can broaden the genetic base of the cultivated potato. The diploid breeding program germplasm base at MSU is a synthesis of seven species: *S. tuberosum* (adaptation, tuber appearance), *S. raphanifolium* (cold chipping), *S. phureja* (cold-chipping, specific gravity, PVY resistance, self-compatability), *S. tarijense* and *S. berthaultii* (tuber appearance, insect resistance, late blight resistance, verticillium wilt resistance), *S. microdontum* (late blight resistance) and *S. chacoense* (specific gravity, low sugars, dormancy and leptine-based insect resistance). In general, diploid breeding utilizes haploids (half the chromosomes) from potato varieties, and diploid wild and cultivated tuber-bearing relatives of the potato. Even though these potatoes have only half the chromosomes of the varieties in the U.S., we can cross these potatoes to transfer the desirable genes by conventional crossing methods via 2n pollen.

IV. Integration of Genetic Engineering with Potato Breeding

Through transgenic approaches we have the opportunity to introduce new genes into our cultivated germplasm that otherwise would not be exploited. It has been used in potato as a tool to improve commercially acceptable cultivars for specific traits. Our laboratory has 13 years experience in *Agrobacterium*-mediated transformation to introduce genes into important potato cultivars and advanced breeding lines. We are presently using genes in vector constructs that confer resistance to Colorado potato beetle and potato tuber moth (*Bt-cry3A, Bt-cry1Ia1* and avidin), potato tuber moth, late blight resistance via the *RB* gene, drought resistance (*CBF1*) and vitamin E. Furthermore, we are investing our efforts in developing new vector constructs that use alternative selectable markers and give us the freedom to operate from an intellectual property rights perspective. In addition, we are exploring transformation techniques that eliminate the need for a selectable marker (antibiotic resistance) from the production of transgenic plants.

RESULTS AND DISCUSSION

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 2005 field season, progeny from over 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. In addition to crosses from the MSU breeding program, crosses were planted and evaluated from collaborative germplasm exchange from other breeding programs including North Dakota State University, University of Minnesota, and the USDA/ARS program at the University of Wisconsin as part of the Quad state cooperative effort. During the 2005 harvest, over 1000 selections were made from the 45,000 seedlings produced. All potential chip-processing selections will be tested in January or March 2006 directly out of 40°F and 45°F storages. Atlantic (50°F chipper) and Snowden (45°F chipper) are chipped as check cultivars. Selections have been identified at each stage of the selection process that have desirable agronomic characteristics and chip-processing potential. At the 8-hill and 20-hill evaluation state, 231 and 87 selections were made, respectively. 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.

Chip-Processing

About 82% of the single hill selections have a chip-processing parent in their pedigree. Based upon the pedigrees of the parents we have identified for breeding cold-chipping potato varieties, there is a diverse genetic base. We have at least eight cultivated sources of cold-chipping. Examination of pedigrees shows up to three different cold-chipping germplasm sources have been combined in these selections. Our promising chip-processing lines are MSH095-4, MSJ036-A (scab resistant), MSH228-6 (moderate scab resistance), MSJ147-1, MSJ126-9Y (moderate scab resistance), MSJ316-A (moderate scab resistance), MSK061-4 (moderate scab resistance), MSK409-1 (scab resistant), MSM051-3 (scab resistant) and late blight resistant chipper MSJ461-1.

Dr. Joe Sowokinos, Univ. of Minnesota, has conducted biochemical analyses of our best chipping lines and has discovered that our lines differ from older varieties in their proteins (UGPase) involved in chipping. Some of these lines are MSJ147-1, MSG227-2 and MSJ126-9Y. Moreover, MSJ147-1 and MSJ126-9Y have the desirable levels of acid invertase to chip process from colder storage. His analysis will also allow us target specific crosses to find improved chip-processing varieties that will allow processing from colder storage temperatures.

Tablestock

Efforts have been made to identify lines with good appearance, low internal defects, good cooking quality, high marketable yield and resistance to scab and late blight. 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. 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 long, russet type and 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 2005, while others were tested under replicated conditions at the Montcalm Research Farm. Promising tablestock lines include MSE221-1 as a scab resistant tablestock, and MSN084-3, a round white with a smooth round shape and bright skin. We have a number of tablestock selections with late blight resistance. These are MSK128-A, MSL072-C and MSM171-A. MSL211-3 and MSN105-1 has late blight and scab resistance. MSE192-8RUS and MSA8254-2BRUS are two russet table selections that have scab resistance. MSI005-20Y is a yellow-fleshed line with smooth round appearance and high yield potential.

At the Great Lakes Expo the MPIC sponsored a booth where we helped promote the sale of Michigan Purple, Jacqueline Lee and Liberator seed to the roadside stand and farm market operations.

Disease and Insect Resistance Breeding

Scab: Disease screening for scab has been an on-going process since 1988. Results from the 2005 MSU scab nursery indicate that 95 of 201 lines evaluated demonstrated little to no infection to common scab. The limitation of breeding for scab resistance is the reliance on the scab nursery. The environmental conditions can influence the infection each year, thus multiple year data provides more reliable data. A laboratory-based screening process is currently under development that would use thaxtomin in tissue culture to expedite selection of material with potential scab resistance. In 2004, we expanded the scab nursery with an additional acre of land nearby. This expansion has allowed us to conduct early generation selection for scab resistance among our breeding material. In 2005, 156 of 464 early generation selections showed moderately to strong scab resistance. These data were incorporated into the early generation evaluation process at Lake City. We expect that this expanded effort will lead to more scab resistant lines advancing through the breeding program.

Late Blight: The Muck Soils Research Farm, Bath, Michigan has become an excellent North American site for late blight testing because of the humid microclimate and isolation from major commercial potato production. As a result, late blight infection has been consistently achieved each year making breeding efforts to select late blight resistant germplasm very efficient. In 2005 we evaluated over 100 advanced breeding lines for late blight resistance. Forty one lines were classified as resistant. Ninety eight of 801 early generation selections were resistant. The breeding program has been able to identify advanced breeding lines with strong foliar resistance to late blight. MSJ461-1, a round white chip-processor, is being considered for release and commercialization. MSJ461-1, the chip-processing selection, has the same late blight resistance source as Jacqueline Lee. Our other promising late blight resistant lines that have been tested in replicated agronomic trials (see Potato Variety Evaluation Report for agronomic data). In each of these lines, the resistance is based on a single resistance source. If we rely on a single source of resistance, the varieties developed from this strategy may be overcome by *P. infestans* at some future date that we cannot predict. Therefore, the most effective breeding strategy is to combine resistance from different pedigrees to build a more durable resistance. Our efforts are now focusing on pyramiding the different resistance sources. These lines are in the early generation phase of the breeding program.

The Muck Soils Research Farm is also used for early generation selection for late blight (801 lines evaluated), genetic studies involving late blight resistance, screening germplasm from other US breeding programs (USDA/ARS funded) and Dr. Kirk-led fungicide x variety management studies to determine schemes to reduce fungicide usage when late blight resistant cultivars are grown. In 2005 we also screened our *RB*-transgenic potatoes for their foliar resistance to late blight. This gene holds promise to introduce or increase late blight resistance in our advanced material.

Colorado potato beetle: With support from GREEEN, we also introduced an early generation Colorado potato beetle screen at the Montcalm Research Farm. In 2005, 69 breeding lines from the MSU potato breeding program that had Colorado potato beetle resistant germplasm in their pedigree were evaluated at the Montcalm Research Farm Beetle Nursery. The beetle pressure was extremely high leading to complete defoliation in all susceptible check lines. Percent defoliation was visually estimated during the beetle infestation in June and July. The lines were then sorted into four categories: susceptible, reduced susceptibility, moderately resistant and resistant. The majority of the lines were susceptible, but 6 and 4 lines were classified as moderately resistant and resistant, respectively. The majority of the lines that were moderately resistant or resistant can be attributed to the expression of the *Bt-cry3A* gene or glycoalkaloid/leptine based mechanisms. The most resistant material was selected for further advancement in the breeding program and also for use in the next round of crossing to develop beetle resistant cultivars. Concurrently, a field cage (no-choice) experiment was conducted to evaluate 6 lines. In 2005 beetle behavior was evaluated in lines that expressed differing levels of Bt genes. The data from this experiment has not been analyzed yet. The study will be repeated in 2006**.**

It is a great challenge to achieve host plant resistance in a commercially acceptable line. We have some promising advanced selections with partial resistance to Colorado potato beetle. In addition, we have *Bt-cry3A* transgenic lines that could be commercialized if the processors renewed their acceptance and regulatory environment was modified to reduce costs. I am on a national committee to help build infrastructure to so that transgenic specialty crops like potato can be deregulated in a more efficient and less costly manner.

II. Evaluation of Advanced Selections for Extended Storage: MSU Potato Breeding Chip-processing Results From the MPIC Demonstration Commercial Storage (October 2004 - June 2005)

The MSU Potato Breeding Program has been conducting chip-processing evaluations each year on potato lines from the MSU breeding program and from other states. For 6 years we have been conducting a long-term storage study to evaluate advanced breeding lines with chip-processing potential in the Dr. B. F. (Burt) Cargill Potato Demonstration Storage facility directly adjacent to the MSU Montcalm Research Farm to identify extended storage chippers. We are positioned to evaluate advanced selections from the breeding program for chip-processing over the whole extended storage season (October-June). Tuber samples of our elite chip-processing selections are placed in the demonstration storage facility in October and are sampled monthly to determine their ability to chip-process from storage. In addition, Chris Long evaluates the more advanced selections in the 10 cwt box bins and manages the 500 cwt. storage bins which may have MSU lines.

In October 2004, tuber samples from 10 MSU lines, three Frito Lay lines, B0776-3, along with Pike and Atlantic from the Montcalm Research Farm trials were placed in the bin to be cooled to 52°F. The bin temperature in November was 58°F and reached a low of 55.8°F in March. Tubers from 5 other MSU lines and Snowden were placed in the bin that was to be cooled to 48°F. The bin was at 54°F in November and held at 49.2°F. The first samples were chip-processed at MSU in October and then, each month until May 2005. Samples were evaluated for chip-processing color and quality.

Table 1 summarizes the chip-processing color of select lines over the 8-month storage season. In the standard temperature bin, Atlantic and Pike were the check varieties. From November to March all lines chip-processed acceptably. The storage test was terminated in mid-May. The tubers were physiologically stressed and many of the tubers had a black necrosis in the flesh and resultant chips. Only Beacon Chipper (UEC) and FL1922 were free of the black necrosis. Based upon chip color and defects the most promising chip-processing lines for long term storage are Beacon Chipper, MSM051-3, MSJ036-A, and FL1922. MSM051-3, MSJ036-A and FL1922 offer scab resistance in addition to their chip-processing ability. MSJ461-1 also has strong foliar resistance to late blight.

In the bin for colder temperature storage, Snowden was used as check variety and chip-processed acceptably through May, but had some black necrosis in the May chip sample. MSG227-2, MSH095-4, MSJ080-1, MSJ126-9Y and MSJ147-1 produced acceptable chips throughout the storage season. Unlike Snowden, none of the MSU lines had black necrosis in the tuber or chip samples. MSJ080-1 is being dropped because of the low specific gravity. MSG227-2 and MSJ126-9Y offer scab resistance along with their ability to chip-process. MSG227-2, Beacon Chipper, MSJ461-1 and Liberator were also in the 500 cwt storage bins. See Chris Long's storage report for those results and results from the box bins.

III. Germplasm Enhancement

In 2005, less than 5% of the populations evaluated as single hills were diploid. From this breeding cycle, we plan to screen the selections chip-processing from storage. In addition, selections were made from over progeny that was obtained from the USDA/ARS at the University of Wisconsin. These families 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. Through GREEEN funding, we were able to initiate a breeding effort to introgress leptine-based insect resistance. From previous research we determined that the leptine-based resistance is effective against Colorado potato beetle. We will continue conducting extensive field screening for resistance to Colorado potato beetle at the Montcalm Research Farm and at the Michigan State University Horticulture Farm in 2006. In 2004 we made crosses with late blight resistant diploid lines derived from *Solanum microdontum* to our tetraploid lines. This *S. microdontum*-based resistance is unique and very effective against the US-8 strains. These progeny are being grown in the greenhouse and now we have used DNA marker analysis to identify which lines have the late blight resistance. We will evaluated these lines are the Muck Farm in 2006.

IV. Integration of Genetic Engineering with Potato Breeding

Combining engineered and natural host plant resistance to *Phytophthora infestans* in cultivated potato

General susceptibility of potato cultivars to *Phytophthora infestans* (Mont.) de Bary is a major concern for potato production. The major resistance gene *RB* was cloned from *Solanum bulbocastanum* Dun.a diploid (2n=2x=24) Mexican species that is highly resistant to all known races of *P. infestans*. The objective of this work is to combine conventionally bred sources of resistance with the *RB* gene via *Agrobacterium* transformation. Our hypothesis is that by pyramiding engineered resistance with natural plant resistance we expect to obtain stronger and more durable resistance to potato late blight. Therefore, this study was undertaken to test the effectiveness of the *RB* gene on its own by transforming late blight-susceptible clones (Atlantic, and the breeding line MSE149-5Y), and to test the effectiveness of the gene in combination with natural late blight resistance by transforming resistant clones (Stirling, and the advanced breeding line MSJ461-1). In 2005 we identified 5 lines with RB-based late blight resistance (MSE149-5Y, Spunta and MSG227-2) at the Muck Soils Research Farm trials. The Spunta and MSE149-5Y lines were used in crosses to transfer the RB-based resistance to other genetic backgrounds in the breeding program.

Insecticidal activity of avidin against Colorado potato beetle larvae, *Leptinotarsa decemlineata* (Say)

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), is the most destructive insect pest of potato, *Solanum tuberosum* (L.) in eastern North America. The insect has adapted to every insecticide used to manage it. Avidin is a protein found in chicken egg whites that has demonstrated insecticidal properties against a number of Lepidopteran and Coleopteran pests. This protein protects the chicken embryo by sequestering biotin from disease causing organisms. Biotin is an essential co-enzyme required for all organisms, including insects. Biotin is a cofactor of a carboxylase which is required for many important processes like lipogenesis, gluconeogensis, fatty acid and amino acid catabolism. Without this co-enzyme, an insect’s growth is severely stunted, eventually leading to death. The gene for avidin production has been cloned and inserted into a few crops, including maize, tobacco and potato and has demonstrated resistance to a wide spectrum of insect pests. We have expressed avidin in two potato lines: MSE149-5Y, a susceptible potato line, and ND5873-15, a high glycolakaloid line. Detached leaf bioassays were performed on transgenic and non-transgenic clones of MSE149-5Y and ND5873-15 using Colorado potato beetle neonates and third instars. Survivorship and consumption were measured every 2d over a 12d period for neonates and avidin was effective in reducing growth and increasing larval morality. These tests were repeated in 2005 with similar results. We are excited that avidin is protein that we can use to complement the natural or Bt-based resistances.

USAID-funded International project to Develop Potato Tuber Moth Resistant Potatoes

Potato tuber moth, *Phthorimaea operculella* (Zeller), is the most serious insect pest of potatoes worldwide. The introduction of the *Bacillus thuringiensis* (Bt) toxin gene via genetic engineering offers host plant resistance for the management of potato tuber moth. The primary insect pest in Egyptian potato production, like many other countries in the Middle East, is the potato tuber moth. Recently it has emerged as a pest in Washington State and has also been a serious problem in Mexico.

Two transgenic 'Spunta' clones, G2 and G3, have been identified that produced high control levels of mortality in first instars of potato tuber moth in laboratory tuber tests (100% mortality), and field trials in Egypt (99-100% undamaged tubers). Reduced feeding by Colorado potato beetle first instars was also observed in detached-leaf bioassays (80-90% reduction). Field trials in the U.S. demonstrated that the agronomic performance of the two transgenic lines was comparable to 'Spunta'. In 2004 and 2005 the Spunta lines were resistant to the potato tuber moth and the Colorado potato beetle in Washington State. We are currently working with USAID, Syngenta and South Africa to commercialize the Spunta-G2 line. We have also transformed Ranger Russet, Jacqueline Lee and some South African varieties with the *Bt-cry1Ia1*.

V. Variety Release

No lines are planned for release in 2006, but we are continuing to promote the seed production and testing of Beacon Chipper, a 2005 release. In addition, we are continuing to promote Liberator, Michigan Purple and Jacqueline Lee for the tablestock markets. Lastly, commercial seed of MSJ461-1, MSE192-8RUS, MSH228-6, MSJ147-1 and MSJ036-A are being produced and we will continue to seek commercial testing of these lines.

Table 1.

2004-2005 Demonstration Storage Chip Results
Michigan State University Potato Breeding and Genetics
Montcalm Research Farm
Chip Scores: SFA Scale†

		Sample Dates:					
	Date:	11/3/2004	12/1/2004	1/12/2005	2/9/2005	3/9/2005	5/19/2005
Line	**Temp:**	58 °F	58 °F	58 °F	58 °F	56 °F	55 °F
ATLANTIC		**1.5**	**1.0**	**1.0**	**1.0**	**1.0**	**2.5**
Beacon Chipper (UEC)		1.0	1.0	1.0	1.0	1.0	1.0
B0766-3		1.5	1.0	1.0	1.5	1.0	1.0
FL1833		1.0	1.0	1.0	1.0	1.0	1.0
FL1879		1.5	1.0	1.0	1.0	1.0	2.0
FL1922		1.0	1.0	1.0	1.0	1.0	1.0
LIBERATOR		1.0	1.0	1.0	1.0	1.0	2.0
MSH228-6		1.0	1.0	1.0	1.5	1.0	2.0
MSJ036-A		1.0	1.0	1.0	1.0	1.0	1.0
MSJ461-1		1.0	1.0	1.0	1.5	1.0	2.0
MSK061-4		1.5	1.0	1.0	1.0	1.0	1.5
MSK128-A		1.0	1.0	1.0	1.0	1.0	2.5
MSK136-2		1.5	1.0	1.0	1.5	1.0	2.5
MSL007-B		1.0	1.0	1.0	1.0	1.0	1.0
MSM051-3		1.5	1.0	1.0	1.0	1.0	1.0
PIKE		**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**2.0**
	Temp:	54 °F	54 °F	51 °F	49 °F	49 °F	55 °F
MSG227-2		1.0	1.0	1.0	1.0	1.0	1.0
MSH095-4		1.0	1.0	1.0	1.0	1.0	1.0
MSJ080-1		1.0	1.0	1.5	1.0	1.0	1.5
MSJ126-9Y		1.0	1.0	1.5	1.0	1.0	ND
MSJ147-1		1.5	1.0	1.0	1.0	1.0	1.0
SNOWDEN		**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

†Snack Food Association Chip Score

Ratings: 1 - 5
1: Excellent
5: Poor

Chip scores were from two-slice samples from five tubers of each line collected at each sample date.

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2005 POTATO VARIETY EVALUATIONS

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INTRODUCTION

Each year we conduct a series of variety trials to assess advanced potato selections from the Michigan State University and other potato breeding programs at the Montcalm Research Farm. The evaluation also includes disease evaluation in the scab nursery and foliar and tuber late blight evaluation at the Muck Soils Research Farm. The objectives of the evaluations are to identify superior varieties for fresh market or for processing and to develop recommendations for the growing of those varieties. The varieties were compared in groups according to the tuber type and 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 field, 45°F and 50°F storage), as well as susceptibilities to late blight (foliar and tuber), common scab, and blackspot bruising are determined.

PROCEDURE

Ten field experiments were conducted at the Montcalm Research Farm in Entrican, MI. They were planted as randomized complete block designs with two to four replications. The plots were 23 feet long and spacing between plants was 12 inches. Inter-row spacing was 34 inches. Supplemental irrigation was applied as needed. The field experiments were conducted on new potato ground that was in corn the previous year.

The round white tuber types were divided into chip-processors and tablestock and were harvested at two dates (Date-of-Harvest trial: Early and Late). The other field experiments were the Russet, North Central White, Red, Adaptation (tablestock and chip-processors), and Preliminary (tablestock and chip-processors) and Transgenic trials. In each of these trials, the yield was graded into four size classes, incidence of external and internal defects in > 3.25 in. diameter or 10 oz. potatoes were recorded, and samples for specific gravity, chipping, disease tests, bruising, and cooking tests were taken. Chip quality was assessed on 25-tuber samples, taking two slices from each tuber. Chips were fried at 365°F. The color was measured visually with the SFA 1-5 color chart. Tuber samples were also stored at 45°F and 50°F for chip-processing out of storage in January and March. Advanced selections are also placed in the Commercial Demonstration Storage for monthly sampling. The scab nursery at the MSU Soils Farm and the late blight trial at the Muck Soils Research Farm are used for scab and foliar late blight assessment of lines in the agronomic trials.

RESULTS

A. Round White Varieties:

Chip-processors and Tablestock (Tables 1 and 2)

There were 24 entries that were compared at two harvest dates. Atlantic, Snowden, Pike and three Frito Lay clones were used as checks. The plot yields were below average in the early harvest (98 days), and specific gravity values were also below average due to the high temperatures in July and August. Most lines increased at least 100 cwt/a in yield for the second harvest date (147 days). The results are summarized in **Tables 1 and 2**. Hollow heart and vascular discoloration were the prevalent internal defects. *Note that this year we changed the format of all variety trial tables so that the internal defects are presented as percentages rather than as a count.* Atlantic, MSE221-1, FL1833 and FL1879 showed the highest incidence of hollow heart between the two harvest dates. In the early harvest trial, the best yielding chipping lines were Atlantic, MSM051-3, MSE221-1, Atlantic and FL1833. MSM051-1, has high yield potential and shows scab resistance and chip-processing potential. Beacon Chipper also has high yield potential, reduced scab susceptibility and chip-processing potential. MSJ147-1 is showing promise as a chipper out of colder and long term storage. MSJ461-1 is a promising chip-processing line with strong foliar resistance to late blight that also has tablestock quality. MSL211-3 is a bright skinned round white with both late blight and scab resistance. In addition, MSM051-3, MSG227-2, MSJ036-A, MSJ316-A, MSH228-6, MSK061-4 and FL1922 offer scab resistance. MSG227-2 was discontinued after the chip-processors determined that the tuber shape is too long.

Variety Characteristics

<u>Beacon Chipper</u> – an unknown eastern chip processing line thought to be from USDA-Beltsville. It has high yield potential and scab tolerance along with excellent chip-processing quality. It is in the 500 cwt 2002, 2003 and 2004 Commercial Demonstration Storage bins. It was named and released in 2005.

<u>MSG227-2</u> – a MSU chip-processing selection with strong scab resistance was discontinued because of it shape being too long for the chip-processors.

<u>MSJ147-1</u> – a full season storage chipper that also has some early sizing. It has excellent chip-processing quality and a large percentage of A-size tubers. It has performed well in on-farm trials.

<u>MSH228-6</u> – a chip-processing line with moderate scab resistance. It has a good type and has performed well in on-farm trials.

<u>MSH095-4</u> - a mid-season maturing line with excellent chip quality and bruise susceptibility equal to Snowden. It had not yielded well in the past few years at Montcalm Research Farm or the on-farm trials. It is intermediate in scab tolerance between Atlantic and MSG227-2.

<u>MSJ461-1</u> – an MSU chip-processing selection with strong foliar resistance to late blight and maturity similar to Snowden. It has excellent chip-processing quality, smooth round shape and above average yield, but an intermediate specific gravity in most years. The chips show few defects.

It has good tablestock quality too.

MSJ036-A – an MSU chip-processing selection. In 2003, MSJ036-A was the highest yielding line. It also has a high specific gravity reading and scab resistance. The tuber type of MSJ036-A is also round and attractive.

MSJ316-A – an MSU chip-processing selection. Has high yield potential and scab resistance and bright skin appearance. Currently in on-farm trials.

MSE221-1 – an MSU tablestock selection. A 'Superior-type' potato that has moderate scab resistance and a higher yield potential than the variety Superior. The tuber type is also more attractive than Superior.

Note: In December 2004 and 2005, MPIC sponsored a booth at the Great Lakes Expo to market Liberator, Michigan Purple and Jacqueline to the farm market/ roadside stand market segment. This grass roots effort may be the method to have these potatoes reach the consumers. The description of these varieties are below.

MICHIGAN PURPLE - a tablestock selection with an attractive purple skin. This selection has high yield potential and the tubers have a low incidence of internal defects. The vine maturity is mid-season to mid-early. Do not let the tubers oversize. A thin skin makes this variety a challenge market on a large scale without making adjustments in harvest, washing and grading process. We regard this as a variety that can compete in the red market. It has great potential in the roadside stand and farm markets.

JACQUELINE LEE – an MSU oval/oblong tablestock selection with a high tuber set. The tubers have the bright skinned, smooth and attractive appearance that is typical of many European cultivars. The tubers have very low incidence of internal defects and good baking quality. It is our best tasting potato! The strength of this selection is also its strong foliar resistance to the US8 genotype of late blight. Vine maturity is similar to Snowden. There is interest in California to market this variety. It has great potential in the roadside stand and farm markets.

LIBERATOR - a MSU selection for chip-processing with strong scab resistance. In 2005 it was being grown as a bright skinned tablestock potato.

B. North Central Regional Round White Trial (Table 3)

The North Central Trial is conducted in a wide range of environments (11 locations) to provide adaptability data for the release of new varieties from North Dakota, Minnesota, Wisconsin, Michigan and Canada. Sixteen breeding lines and 5 varieties were tested in Michigan. The results are presented in **Table 3**. The range of yield was very wide (424 cwt – 98 cwt) which is typical for this trial each year. Moreover, the yields were below average this year, while the specific gravity readings were average. The MSU lines MSJ461-1, MSI152-A, MSH095-4, MSH356-A and MSI005-20Y were the Michigan representatives included in the North Central Trial. Both MSJ461-

1and MSI152-A have nice type and both have foliar late blight resistance. We will continue to evaluate MSH095-4 because of its excellent sugar profile in storage. NY126 and MSI005-20Y are yellow-fleshed lines with high yield potential and attractive round appearances. B0766-3 has high yield but was plagued by hollow heart. The most promising Wisconsin selections were Megachip, W2128-8 and W2133-1. Monticello was below average in yield and the most blackspot susceptible line in 2005.

C. Russet Varieties (Table 4)

The russet trial had 19 lines evaluated in 2005. GoldRush and Russet Norkotah were the standard varieties in the trial and the results are summarized in **Table 4**. Scab resistance was prevalent among the lines tested. Hollow heart was the most prevalent internal defect. At least 33% hollow heart was observed in CO904035-15RU, W2683-2RUS, AC92009-4RU, TXNS287, GemStar and TXA549-1RU. Specific gravity measurements were below average with Russet Norkotah and GoldRush having 1.065 and 1.064 readings, respectively. The yield of the overall trial was below average for 2005, which has been typical for the Russet trials at Montcalm Research Farm. Off type and cull tubers were found in all lines tested, but the frequency was generally low in 2005. Vine maturity varied among lines but it did not correlate with yield. Gemstar and Silverton Russet show the most promise, however, the varietal choice should take into account whether a new variety is a symptomless carrier of PVY. MSA8254-2BRUS is a high yielding MSU selection that has yielded well in on-farm trials. MSL794-BRUS had foliar late blight resistance, but did not exhibit strong resistance to scab. Stampede Russet has a very attractive type, but has a low yield. MSE192-8RUS has similar features. TXDH99-1RU has many valuable agronomic features and should be looked at further.

D. Red-Skinned Tablestock Trial

Thirteen lines were tested in the red trial. The top yielding lines were Michigan Purple, NDTX4271-5R and ND5281-2R. In general, internal quality was good. Tolerance to scab was generally high among the lines in the trial. MSN230-1RY has a rose skin, yellow flesh and late blight resistance. NDTX42715R has a deep red color, attractive round shape and an early maturity. MSN215-2P is a hybrid between Norland and Michigan Purple that has a stronger purple skin than Michigan Purple. Some purple and red-fleshed lines were also in the trial which may offer some novelty tablestock market niches.

E. Adaptation Trial (Tables 6 and 7)

The Adaptation trial was divided into chip-processing and tablestock trials. Two cultivars (Snowden and Atlantic) and 16 advanced breeding lines are reported in the chip-processing trial. The trial was harvested after 139 days and the results are summarized in **Table 6**. Lines that combine scab resistance and chip-processing are MSM058-A, MSL292-A, MSL007-B, MSK409-1 and MSJ126-9Y. Three lines have foliar late blight resistance, but only MSL603-319-Y shows promise as a chip-processing line. MSM182-1 has late blight resistance, but should be considered for the tablestock market.

In the tablestock trial Onaway was the check variety and 11 advanced breeding lines are summarized in the table. The trial was harvested after 139 days and the results are summarized in **Table 7**. Six of the 11 lines have late blight resistance and 6 lines have moderate to strong scab resistance. In general the yield was good in this trial and internal defects were low. The most noteworthy lines are MSM037-3 due to its high yield and scab resistance; MSN105-1, a scab and late blight resistant line with a bright appearance and early maturity, MSM171-A, a late blight resistant line with early maturity; MSN106-2, a scab resistant line with a smooth attractive netted appearance and MSL228-1, a purple and white splashed skin with an appealing taste.

F. Preliminary Trial (Tables 8 and 9)

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 chip-processing and tablestock utilization. Thirty-one advanced selections and three check varieties (Atlantic, Snowden and Pike) were reported in the chip-processing Preliminary trial. The chip-processing trial is summarized in **Table 8** was harvested after 127 days. Most lines chip-processed well from the field and the most exceptional chipper tended to have a lower marketable yield. Specific gravities were average, but yield was average. Many lines were also classified to be resistant or moderately resistant to scab. Five lines have late blight resistance: MSP515-2, MSP542-04, MSL268-D, MSP542-11 and MSP459-5,. The most overall promising lines chip-processing lines were MSP515-2, MSN170-A, MSN238-A and MSN123-B. MSM060-3 had exceptional chip color, high specific gravity, scab resistance, but a low yield similar to Pike. **Table 9** summarizes the tablestock lines with Onaway as a check. Interestingly, many have foliar late blight resistance like we saw in the 2004 trial. This tablestock trial was harvested and evaluated after 127 days. Twelve of the 24 lines were late blight resistant. Despite the late blight resistance, the vine maturities were not late in all cases. Five of the lines had specific gravity and chip scores to be considered for chip-processing. Three Idaho russet lines were also evaluated. A95109-1 shows the most promise with high yield, good sizing, good type and scab resistance. The most promising lines combining tablestock qualities and late blight resistance are MSP408-14Y, MSL082-A, MSP408-10Y, MSP403-2 and MSM148-A. MSN084-3 is a selection with bright, round tubers. It is a cross between Boulder and Chaleur. MSN099-B may show promise as a chip-processor.

G. Transgenic Trial (Table 10)

A field trial was conducted to evaluate *Bt-cry1Ia1* transgenic potato lines. The results are summarized in **Table 10.** Spunta G2 and Spunta G3 have good agronomic performance and good type. We are attempting to commercialize Spunta-G2 in South Africa. Due to the tuber moth problem in the Pacific Northwest, We have tested these lines in Washington State and the resistance is complete in the field. We also have a transgenic line of Jacqueline Lee (MSG274-35.1) that is agronomically equivalent to Jacqueline Lee.

H. Potato Scab Evaluation (Table 11)

Each year a replicated field trial at the MSU Soils Farm is conducted to assess resistance to common and pitted scab. We are using a modified scale of a 0-5 ranking 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. **Table 11** categorizes many of the varieties and advanced selections tested in 2005 at the MSU Soils Farm Scab Nursery over a three-year period. The varieties and lines are placed into six arbitrary categories based upon scab infection level and lesion severity. A rating of 0 indicates zero infection. A score of 1.0 indicates a trace amount of infection. A moderate resistance (1.2 – 1.8) correlates with <10% infection. Scores of 4.0 or greater are found on lines with >50% infection and severe pitted lesions. This disease trial is a typically a severe test, but the scab infection in 2005 was low. As a consequence, the scab rating in 2005 is an average score that is biased towards a low value. If one looks at the worst plot score in 2005, this value may indicate the potential susceptibility of the line tested. The check varieties Russet Burbank, GoldRush, Onaway, Pike, Atlantic and Snowden can be used as references (bolded in **Table 11**). In general, most russet lines were scab resistant. This year's results, like 2004, indicate that we have been able to breed numerous lines for the chip-processing and tablestock markets with resistance to scab. Most notable scab resistant MSU lines are Liberator, MSG227-2, MSE192-8RUS, MSE202-3RUS, MSE221-1, MSH228-6, MSK409-1, MSL211-3, MSN105-1, MSJ126-9Y, MSK061-4, MSM051-3, MSL007-1 and MSJ036-A. The greater number of MSU lines in the resistant and moderately resistant categories indicates we are making progress in breeding more scab resistant lines for the chip-processing and tablestock markets. Scab results from the disease nursery are also found in the Trial Summaries (**Tables 2-10**).

J. Late Blight Trial (Table 12)

In 2005, a late blight trial was conducted at the Muck Soils Research Farm. Over 100 entries were evaluated in replicated plots. The field was planted on June 2 and inoculated July 26 with a combinations of isolates (see Table 12 for isolates), and ratings were taken throughout August. Most lines were highly susceptible to the US-8 genotype of late blight. Included in this trial are the varieties and lines from the MSU trials at the Montcalm Research Farm. The partial results are summarized in **Table 12**. The first column lists the lines classified as resistant, while the second column lists select varieties that are susceptible. The late blight differential lines LBR8 and LBR9 were resistant in 2004 as in previous years (not shown in table). Forty MSU lines were highly resistant to late blight. Resistance of the MSU lines is derived from Tollocan (a Mexican variety), B0718-3 (USDA clone), AWN96518-2 (USDA clone), Stirling (Scottish variety), Torridon (Scottish variety), NY121 (Cornell University clone) and Jacqueline Lee (MSU variety). These resistant progeny indicate that we can continue to breed for resistance using this group of resistant clones. We find these late blight resistant lines valuable because many of them also have marketable maturity and some are more tolerant to scab as compared to the first generation of late blight resistant lines. Also, some of these lines have chip-processing quality. Tuber late blight resistance is being evaluated on many of the selections with foliar late blight resistance.

K. Blackspot Susceptibility (Table 13)

Increased evaluations of advanced seedlings and new varieties for their susceptibility to blackspot bruising have been implemented in the variety evaluation program over the past decade. Based upon the results collected over the past three years we decided to eliminate the check sample from our bruise assessment. Therefore a composite bruise sample of each line in the trials was collected. The sample consisted of 25 tubers (a composite of 4 reps) from each line at the time of grading. The 25 tuber sample was held in 50°F 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 12**. 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. Conducting the simulated bruise on 50°F tubers is helping to standardize the bruise testing. We are observing less variation between trials since we standardized the handling of the bruise sample. In 2005 the bruise levels were comparable to other years. The most bruise resistant lines this year were FL1922, MSM051-3, MSH228-6, MSJ036-A, MSL211-3, MSK061-4, MSM171-A, MSN105-1, MSM037-3, MSP270-1, MSN084-3, MSL072-C, MSI005-20Y, GoldRush and Russet Norkotah. The most susceptible lines were Beacon Chipper, NY132, MSN180-3, Monticello, W2133-1, W2310-3, W2683-2RUS, Snowden and Atlantic.

Table 1

DATE OF HARVEST TRIAL: EARLY HARVEST
MONTCALM RESEARCH FARM
May 4 - August 9, 2005 (98 days)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	PERCENT (%) TUBER QUALITY[3]				3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	HH	VD	IBS	BC	CWT/A
MSM051-3	294	312	94	6	90	4	0	1.074	1.0	5	0	0	0	-
MSE221-1	267	285	94	6	84	10	1	1.066	1.5	35	0	0	0	-
Atlantic	**261**	**287**	**91**	**9**	**89**	**2**	**0**	**1.082**	**1.0**	**23**	**0**	**0**	**0**	**263**
FL1833	247	265	93	6	88	5	0	1.075	1.0	18	3	0	0	257
Snowden	**222**	**263**	**84**	**16**	**84**	**0**	**0**	**1.076**	**1.0**	**0**	**0**	**0**	**0**	**222**
FL1879	207	221	94	6	90	4	0	1.069	1.0	20	0	0	0	228
Beacon Chipper	206	224	92	8	91	1	0	1.078	1.0	5	0	0	0	210
MSJ147-1	202	233	87	13	86	1	0	1.077	1.0	3	0	3	0	248
MSK498-1Y	199	237	84	16	84	0	0	1.067	1.5	0	0	0	0	-
MSL211-3[LBR]	185	214	86	14	80	7	0	1.063	3.0	0	0	0	0	-
MSJ461-1[LBR]	176	233	76	24	76	0	0	1.067	1.5	0	0	0	0	185
MSJ036-A	169	214	79	21	79	0	0	1.072	1.5	0	0	0	0	-
MSK128-A[LBR]	157	177	89	11	88	1	0	1.080	1.0	8	0	3	0	-
Pike	**150**	**187**	**80**	**20**	**80**	**0**	**0**	**1.075**	**1.0**	**0**	**3**	**0**	**0**	**-**
NY132	149	188	79	21	79	0	0	1.077	1.0	0	0	0	0	-
MSG227-2	146	168	87	13	87	0	0	1.072	1.0	0	0	0	0	187
A91814-2	140	177	79	20	79	0	1	1.078	1.0	0	0	0	0	-
MSK009-B	137	165	83	17	83	0	0	1.068	1.0	0	0	0	0	-
FL1922	129	160	81	18	80	1	2	1.071	1.0	0	0	0	0	157
MSH228-6	120	143	84	16	84	0	0	1.071	1.0	0	0	0	0	161
W2128-8	116	146	80	20	79	1	0	1.085	1.0	0	0	0	0	-
MSJ316-A	87	111	78	22	78	0	0	1.069	1.0	0	0	0	0	-
MSK061-4	87	135	64	36	64	0	0	1.080	1.0	0	3	0	0	-
MSK049-A	61	170	36	64	36	0	0	1.076	1.0	3	0	0	0	-
MEAN	171	205						1.074						
$LSD_{0.05}$	45	45						0.003						

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

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

Table 2

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

DATE OF HARVEST TRIAL: LATE HARVEST
MONTCALM RESEARCH FARM
May 4 - September 27, 2005 (147 days)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	PERCENT (%) TUBER QUALITY[3]						3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	HH	VD	IBS	BC	SCAB[4]	MAT[5]	CWT/A
Beacon Chipper	414	431	96	3	80	16	1	1.083	1.0	23	5	0	0	1	3.5	332
Atlantic	**351**	**374**	**94**	**5**	**85**	**8**	**1**	**1.087**	**1.0**	**45**	**3**	**5**	**0**	**0-3**	**2.0**	**347**
MSK498-1Y	350	393	89	11	89	0	1	1.075	1.0	0	0	0	0	1-2	3.3	-
MSM051-3	344	364	95	5	86	8	0	1.075	1.0	10	0	0	0	1	1.5	-
Snowden	**338**	**375**	**90**	**10**	**86**	**4**	**0**	**1.081**	**1.0**	**28**	**8**	**0**	**0**	**0-3**	**2.5**	**295**
FL1879	336	349	96	3	79	17	1	1.076	1.5	55	13	0	0	2-3	1.8	316
MSE221-1	336	361	93	3	80	13	4	1.071	-	28	3	0	0	1	1.3	-
MSJ461-1[LBR]	331	381	87	13	87	0	0	1.075	1.0	0	0	0	0	1-2	3.3	315
FL1833	330	346	95	4	87	8	1	1.081	1.0	38	8	0	0	1-2	2.5	303
MSJ316-A	306	335	91	9	89	2	0	1.082	1.0	5	0	5	0	1	4.0	-
A91814-2	287	353	81	15	81	0	4	1.087	1.0	0	5	0	0	1-2	3.3	-
MSJ036-A	286	333	86	14	85	0	0	1.080	1.0	5	0	0	0	0-1	2.0	-
MSJ147-1	276	301	92	8	86	6	1	1.084	1.0	5	0	0	0	2	3.0	293
MSL211-3[LBR]	267	295	91	8	82	9	1	1.067	-	0	3	0	0	1	1.5	-
NY132	250	286	87	12	86	1	0	1.086	1.0	3	0	0	0	1-2	2.8	-
MSK128-A[LBR]	236	271	87	12	86	1	1	1.083	1.0	0	0	0	0	1-3	1.0	-
FL1922	234	257	91	7	89	2	1	1.077	1.0	18	5	0	0	1	1.8	211
W2128-8	234	271	86	12	81	5	1	1.090	1.0	10	0	13	0	0-1	2.5	-
MSK061-4	227	269	84	16	84	0	0	1.088	1.0	0	13	0	0	0-1	2.8	-
MSK009-B	225	257	88	11	84	4	1	1.077	1.0	8	3	0	0	0-1	1.5	-
Pike	**219**	**261**	**84**	**16**	**84**	**0**	**0**	**1.081**	**1.0**	**0**	**0**	**0**	**0**	**1**	**2.0**	**-**
MSK049-A	199	304	65	34	64	1	0	1.087	1.0	3	13	5	0	1-3	3.3	-
MSG227-2	195	263	74	13	74	0	13	1.079	1.0	20	0	0	0	1	2.8	259
MSH228-6	191	222	86	11	83	3	2	1.077	1.0	15	5	0	0	1	2.5	243
MEAN	282	319						1.080								
$LSD_{0.05}$	68	69						0.003								

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

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

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

[5]MATURITY RATING: August 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 3

ROUND WHITE TRIAL
MONTCALM RESEARCH FARM
May 4 - September 12, 2005 (132 days)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	PERCENT (%) TUBER QUALITY[3]						3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	HH	VD	IBS	BC	SCAB[4]	MAT[5]	CWT/A
NY126	424	443	96	4	92	4	1	1.078	1.5	15	3	0	0	1	2.5	-
MSJ461-1[LBR]	400	475	84	15	83	1	0	1.076	1.5	0	0	0	0	1-2	3.5	-
MSI005-20Y	400	433	92	7	87	6	1	1.073	-	0	0	0	0	1-2	2.0	-
B0766-3	385	413	93	4	84	9	3	1.083	1.5	90	0	0	0	2-3	3.5	299*
Snowden	**382**	**423**	**90**	**9**	**88**	**2**	**1**	**1.080**	**1.0**	**13**	**0**	**0**	**0**	**0-3**	**1.0**	**-**
Atlantic	**380**	**411**	**92**	**6**	**87**	**5**	**2**	**1.088**	**1.5**	**33**	**5**	**5**	**0**	**0-3**	**1.5**	**-**
MSI152-A[LBR]	338	390	87	13	86	1	1	1.072	-	0	0	0	0	1	3.3	-
MegaChip	336	377	89	5	86	4	5	1.092	1.0	20	13	0	0	0-2	3.0	-
W2128-8	333	367	91	8	85	5	1	1.093	1.5	23	3	25	3	0-1	2.0	-
W2133-1	269	315	85	14	83	2	1	1.086	1.0	8	0	5	0	1	2.3	-
MSH095-4	254	274	93	6	78	14	1	1.082	1.0	10	8	0	0	1-2	1.5	256
Liberator	238	272	88	9	82	5	4	1.079	1.5	5	5	0	0	0-1	2.5	237
MSH356-A	235	250	94	6	85	9	0	1.073	1.0	35	0	0	0	1-2	1.3	-
CO95051-7W	231	280	83	16	83	0	1	1.089	1.5	0	0	3	3	0-1	3.0	-
Monticello	229	264	87	13	86	1	0	1.081	1.0	3	5	0	0	1	1.3	-
W2717-5	226	259	87	11	87	0	2	1.085	1.5	20	25	5	0	1-3	1.0	-
W2310-3	220	251	88	10	88	0	3	1.093	1.0	0	0	3	0	1-2	2.3	-
MN99380-1	156	218	72	26	72	0	2	1.071	1.0	0	0	3	0	-	2.0	-
W4013-1	153	210	73	27	73	0	1	1.083	1.0!	0	0	0	0	2	1.0	-
W2309-7	101	139	72	24	71	1	3	1.082	1.5	20	0	3	0	1-2	1.8	-
MN99144-1	98	152	64	31	64	0	4	1.072	1.5	0	13	7	0	1-2	2.0	-
MEAN	276	315						1.081								
$LSD_{0.05}$	53	53						0.002								

* Two-Year Average

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

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

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

[5]MATURITY RATING: August 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 4

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

RUSSET and LONG TYPES TRIAL
MONTCALM RESEARCH FARM
May 4 - September 12, 2005 (132 days)

	CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]						3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]	CWT/A
MSL794-BRUS[LBR]	348	411	85	10	67	17	5	1.082	0	0	20	0	1-2	3.3	287*
MSA8254-2BRUS	295	386	76	18	68	8	5	1.070	23	0	0	0	0	2.5	292
CO904035-15RU	290	367	79	19	74	5	2	1.071	40	0	0	0	1	4.0	-
W2683-2RUS	287	371	77	16	64	13	7	1.070	38	0	0	0	0-1	2.5	-
TXDH99-1RU	281	345	81	17	74	7	2	1.085	0	0	0	0	1	3.5	-
MWTX2609-2RU	277	333	83	15	71	12	2	1.082	5	0	0	0	1-5	3.3	-
Silverton Russet	263	305	86	13	68	19	1	1.069	7	0	0	0	0-1	2.8	245
Stampede Russet	224	297	75	20	65	10	4	1.058	7	3	0	0	1	1.3	159*
AC92009-4RU	216	269	80	15	71	9	5	1.081	45	0	0	0	0-3	2.3	-
CO93001-11RU	206	285	72	27	68	4	0	1.064	5	8	0	0	0-2	1.3	-
GoldRush	197	253	78	17	67	11	5	1.064	5	13	0	0	0-1	1.5	196
A8893-1	187	278	67	31	64	4	1	1.079	30	0	0	0	0-1	3.0	200*
TXNS287	184	267	69	26	64	5	5	1.067	33	3	0	0	1-2	1.5	-
ND7994-1RUS	183	265	69	26	67	2	5	1.076	0	13	0	0	0-1	1.8	-
GemStar	182	228	80	18	67	13	2	1.078	33	3	0	0	0	3.0	251*
TXA549-1RU	176	245	72	22	62	10	6	1.073	45	5	0	0	0-1	2.5	-
MN99460-21	152	217	70	25	62	8	5	1.073	27	0	17	0	-	2.8	106*
Russet Norkotah	136	193	71	27	67	4	3	1.065	18	10	0	0	1-2	1.5	131*
W1879-1RUS	129	205	63	36	57	5	1	1.072	18	0	0	0	0-1	1.8	-
MEAN	222	290						1.073							
$LSD_{0.05}$	59	65						0.002							

* Two-Year Average

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

[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 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 5

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

RED-SKINNED TABLESTOCK TRIAL
MONTCALM RESEARCH FARM
May 5 - September 7, 2005 (127 days)

	CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]					
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]
Michigan Purple	400	448	89	4	76	13	7	1.070	5	3	0	0	1-2	1.0
NDTX4271-5R	360	412	87	8	79	8	5	1.055	0	5	0	0	1	1.5
ND5281-2R	352	409	86	10	86	0	4	1.067	13	5	0	0	2	1.0
NDTX4304-1R	294	352	84	7	74	10	9	1.055	5	0	0	0	1-3	1.0
MSN109-7PP	284	313	91	4	72	18	5	1.062	8	0	0	0	-	3.3
MSN111-4PP	265	286	93	7	91	2	0	1.070	0	0	0	0	1-3	1.8
MSN230-1RY[LBR]	257	311	83	14	81	1	4	1.085	0	8	0	0	0-1	3.3
NDTX731-1R	250	297	84	10	81	3	6	1.049	0	3	0	0	1	2.3
CO89097-2R	242	308	79	11	75	3	10	1.066	8	8	0	0	1	1.5
MSN215-2P	221	274	81	11	81	0	8	1.076	0	0	0	0	1	1.0
MSN109-6RR	203	299	68	29	68	0	4	1.066	0	0	0	0	-	3.8
Villetta Rose	197	259	76	22	68	8	2	1.056	0	3	0	0	0-1	1.0
MN96013-1R	109	140	78	19	76	2	3	1.066	0	0	0	0	-	2.0
MEAN	264	316						1.065						
$LSD_{0.05}$	80	86						0.004						

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

[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 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADAPTATION TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 4 - September 19, 2005 (139 days)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	PERCENT (%) TUBER QUALITY[3]					
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	HH	VD	IBS	BC	SCAB[4]	MAT[5]
Atlantic	**366**	**393**	**93**	**5**	**89**	**4**	**1**	**1.088**	**1.0**	**33**	**0**	**0**	**0**	**0-3**	**1.5**
MSM058-A	339	356	95	4	93	2	1	1.074	1.5	3	0	0	0	0-1	2.3
MSN180-3	328	342	96	4	82	14	0	1.088	1.5	15	8	0	0	2-3	2.5
MSN143-3	323	342	94	5	81	13	0	1.071	1.5	35	0	0	0	1-2	1.5
Snowden	**295**	**328**	**90**	**10**	**88**	**2**	**0**	**1.084**	**1.0**	**8**	**5**	**0**	**0**	**0-3**	**1.5**
MSM182-1[LBR]	273	337	81	19	81	0	0	1.072	3.0	5	3	0	0	1-2	2.0
MSL292-A	269	291	92	8	88	5	0	1.079	1.0	13	3	0	0	1	1.0
MSL007-B	268	306	88	12	87	0	0	1.078	1.0	15	3	0	0	0-1	2.8
MSL603-319Y[LBR]	267	293	91	8	88	3	1	1.083	1.5	15	0	3	0	1-2	3.3
MSN073-2	265	289	91	7	89	2	1	1.076	1.0	15	0	0	0	1-2	1.0
MSN184-2	264	285	93	7	86	7	0	1.072	1.0	0	0	0	0	1	2.8
MSK409-1	232	283	82	18	81	1	0	1.084	1.0	15	3	0	0	0-1	1.3
MSK437-A	221	227	97	2	75	23	0	1.073	1.0	50	0	0	0	1-3	3.3
MSJ126-9Y	217	250	87	13	84	3	1	1.073	1.5	10	0	0	0	1	1.0
MSN191-2Y	200	237	84	16	82	2	0	1.091	1.5	5	0	0	0	1-2	2.0
MSM053-4	183	214	86	14	86	0	0	1.090	2.0	28	3	3	3	1-2	3.8
MSN200-2[LBR]	175	281	62	37	62	0	0	1.088	1.5	0	5	0	0	2-3	2.8
MSM297-AY	111	139	80	20	79	1	1	1.080	1.0	0	0	0	0	1	1.0
MEAN	255	289						1.080							
$LSD_{0.05}$	66	70						0.003							

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

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

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

[5]MATURITY RATING: August 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 7

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADAPTATION TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 4 - September 19, 2005 (139 days)

	CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]					
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]
MSM037-3	422	457	92	5	90	2	2	1.074	0	3	0	0	1.0	3.3
MSM224-1[LBR]	386	434	89	7	81	8	4	1.075	15	0	0	0	1-2	3.8
MSL045-AY	355	397	90	7	82	7	3	1.070	0	10	0	0	0-1	2.3
MSN105-1[LBR]	308	362	85	14	85	1	0	1.082	3	5	0	0	1	1.3
MSL183-AY[LBR]	303	350	87	13	86	1	1	1.065	3	5	0	0	2	1.5
MSM171-A[LBR]	302	340	89	6	73	16	6	1.059	5	0	0	0	1?	1.0
MSN106-2	288	300	96	3	80	16	1	1.098	10	8	0	0	1	3.8
ONAWAY	276	320	86	4	76	11	10	1.062	0	18	0	0	1	1.0
MSM183-1[LBR]	275	360	76	17	76	0	7	1.088	3	0	0	0	0-1	2.3
MSN159-4[LBR]	240	277	87	13	82	5	0	1.078	5	13	0	0	1-3	2.8
MSL228-1	222	257	87	11	82	5	3	1.075	0	3	3	0	1-3	1.0
MSN188-1	213	293	73	13	73	0	14	1.073	10	8	0	0	1-3	2.8
MEAN	299	346						1.075						
$LSD_{0.05}$	72	77						0.004						

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

[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 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 8

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 5 - September 7, 2005 (127 days)

LINE	CWT/A		PERCENT OF TOTAL[1]					SP GR	CHIP	PERCENT (%) TUBER QUALITY[3]				SCAB[4]	MAT[5]
	US#1	TOTAL	US#1	Bs	As	OV	PO		SCORE[2]	HH	VD	IBS	BC		
MSP515-2[LBR]	408	444	92	7	76	16	1	1.079	1.0	40	0	0	0	1	4.0
MSM070-1	408	440	93	7	85	8	0	1.077	1.5	0	0	0	0	1-2	2.0
MSN170-A	389	420	93	6	89	4	1	1.083	1.0	0	0	0	0	1	2.5
MSP497-1	385	425	91	9	88	2	0	1.077	2.0	5	0	0	0	1-2	4.0
MSN238-A	358	373	96	4	89	7	0	1.085	1.0	20	0	0	0	1	3.0
MSN123-B	357	397	90	10	89	1	0	1.092	1.0	0	5	0	0	1-3	3.0
Snowden	**339**	**393**	**86**	**14**	**85**	**1**	**0**	**1.084**	**1.0**	**5**	**5**	**0**	**0**	**0-3**	**2.5**
Atlantic	**330**	**354**	**93**	**4**	**81**	**12**	**3**	**1.087**	**1.0**	**70**	**5**	**0**	**0**	**0-3**	**2.5**
MSN252-HY	329	411	80	17	80	0	3	1.087	2.5	0	0	0	0	-	3.5
MSP542-04[LBR]	326	368	88	11	88	0	0	1.082	1.0	30	0	0	0	1-2	3.0
MSM246-B	319	352	91	9	91	0	0	1.079	1.5	0	0	0	0	0-2	2.0
MSP238-1	304	338	90	6	84	6	4	1.070	2.5	0	0	75	0	1	3.0
MSP450-2	300	317	95	5	83	11	0	1.071	2.0	0	0	5	0	0-1	3.0
MSN313-A	291	336	86	13	86	0	1	1.098	1.0	10	0	0	0	0-2	3.5
MSP365-1	285	304	94	6	91	3	0	1.076	1.0	0	0	0	0	1-3	2.0
MSL268-D[LBR]	285	323	88	8	85	3	3	1.077	1.0	0	10	5	0	0-2	3.0
MSN148-A	279	317	88	10	84	4	2	1.087	1.0	5	0	0	0	1-2	3.5
MSP542-11[LBR]	278	457	61	37	61	0	2	1.077	1.0	0	0	0	0	1-3	3.0
MSP252-3	272	305	89	11	84	5	0	1.08	1.5	5	0	0	0	0-1	2.0
MSP368-1	263	298	88	9	84	5	3	1.084	1.0	25	0	5	0	1	3.0
MSP270-1	259	292	89	11	89	0	0	1.075	1.0	0	0	0	0	1.0	3.5
MSP327-6	245	292	84	15	84	0	1	1.075	1.5	5	0	0	0	1.0	2.5
MSP292-7	240	259	93	7	86	6	0	1.081	1.0	5	0	0	0	1.0	1.0
MSP239-1	239	278	86	11	86	0	3	1.071	1.0!	0	0	0	0	1	1.5
MSN190-2	238	289	83	17	81	1	1	1.085	1.0	45	0	0	0	1-2	1.0
Pike	**229**	**266**	**86**	**12**	**86**	**0**	**2**	**1.087**	**1.0**	**0**	**0**	**0**	**0**	**1**	**3.0**

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
May 5 - September 7, 2005 (127 days)

	CWT/A		PERCENT OF TOTAL[1]							PERCENT (%) TUBER QUALITY[3]					
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	CHIP SCORE[2]	HH	VD	IBS	BC	SCAB[4]	MAT[5]
continued:															
MSP382-13	221	253	87	12	85	2	1	1.088	1.0	35	0	0	0	1-2	3.5
MSM060-3	219	298	73	27	73	0	0	1.093	1.0!	0	0	0	0	1	1.0
MSP459-5[LBMR]	205	255	81	19	81	0	0	1.075	1.0!	5	10	0	0	1-2	2.5
MSN236-A	187	260	72	28	72	0	0	1.074	1.0!	0	0	0	0	2	2.0
MSP262-4	161	189	85	15	85	0	0	1.085	1.0!	0	0	10	0	0-2	2.0
MSN085-2Y	150	193	78	22	78	0	0	1.088	1.0!	5	0	0	0	2-3	3.0
MSM108-A	147	202	73	26	73	0	1	1.084	1.0!	20	5	5	5	1-3	2.5
MSM102-A	129	165	78	22	78	0	0	1.087	1.0	0	0	0	0	1.0	3.0
MEAN	276	320						1.082							
$LSD_{0.05}$	102	102						0.005							

LBR Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

[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]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 20 Oversize and/or A-size tubers cut.

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

[5]MATURITY RATING: August 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 9

PRELIMINARY TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
May 5 - September 7, 2005 (127 days)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	PERCENT (%) TUBER QUALITY[3]					
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[2]	HH	VD	IBS	BC	SCAB[4]	MAT[5]
MSP464-4[LBR]	436	469	93	4	88	5	3	1.090	1.5	20	0	0	0	0-1	3.5
MSP408-14Y[LBR]	406	458	89	6	82	6	5	1.069	1.5	0	0	0	0	1-3	3.0
A95109-1	383	418	92	5	72	20	3	1.076	-	25	0	0	0	0	2.5
MSL082-A[LBR]	379	437	87	7	87	0	6	1.076	-	0	0	0	0	0-2	2.5
MSP408-10Y[LBR]	376	440	85	15	85	0	0	1.079	-	0	0	0	0	0-2	3.0
MSP197-1	371	385	96	3	87	9	0	1.067	-	50	5	0	0	1-2	2.0
MSL072-C[LBR]	366	427	86	7	83	2	7	1.074	-	5	0	0	0	1-3	3.0
MSP403-2[LBR]	323	382	85	9	85	0	6	1.082	-	5	0	0	0	0-1	4.0
MSN205-A[LBR]	322	346	93	6	82	11	1	1.073	-	25	0	0	0	2	3.5
Onaway	**295**	**351**	**84**	**6**	**74**	**10**	**10**	**1.059**	**-**	**0**	**0**	**0**	**0**	**1**	**2.0**
MSN084-3	294	303	97	3	73	24	0	1.065	-	5	10	0	0	1-3	1.5
MSN099-B	291	328	89	9	84	5	2	1.078	1.0	5	0	0	0	1-2	1.0
MSP216-1R	290	352	82	14	82	0	4	1.062	-	0	0	0	0	0-1	2.5
MSM148-A[LBR]	271	341	79	18	79	1	3	1.079	1.0	0	10	0	0	0-1	2.5
MSP445-2P[LBR]	268	345	78	21	78	0	2	1.088	-	40	0	0	0	-	3.0
MSM231-CY[LBR]	254	338	75	24	74	1	0	1.079	1.0	0	0	0	0	0-1	3.0
A9045-7	245	282	87	11	78	9	2	1.077	-	0	0	0	0	1-2	3.0
A93157-6LS	240	313	77	17	66	11	6	1.086	1.0	90	0	0	0	0-2	2.5
MSP420-7Y[LBR]	233	339	69	30	69	0	1	1.086	-	0	0	0	0	2-3	3.0
MSN222-ARUS	216	260	83	10	82	1	7	1.066	-	15	0	0	0	0-1	1.0
MSN199-B[LBR]	184	264	70	30	70	0	0	1.079	-	0	0	0	0	1-2	1.0
ARS4036-2	180	242	75	25	75	0	0	1.083	-	0	0	0	0	0-1	2.5
MSI201-2PYsport	151	242	62	38	62	0	0	1.065	-	0	0	0	0	2-3	1.0
MSN224-AR	146	184	79	7	79	0	14	1.056	-	5	0	0	0	1	3.0
MEAN	288	344						1.075							
$LSD_{0.05}$	111	113						0.004							

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials at the MSU Muck Soils Research Farm.

[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]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot. Percent of 20 Oversize and/or A-size tubers cut.

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

[5]MATURITY RATING: August 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 10

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

Bt TRANSGENIC TRIAL
MONTCALM RESEARCH FARM
May 4 - September 7, 2005 (127 days)

	CWT/A		PERCENT OF TOTAL[1]						PERCENT (%) TUBER QUALITY[2]					
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	SCAB[3]	MAT[4]
Spunta	**460**	**520**	**89**	**4**	**75**	**14**	**7**	**1.062**	**18**	**8**	**3**	**0**	**1.0**	**2.5**
Spunta-G2	425	477	89	6	74	16	5	1.064	5	3	0	0	0.8	2.5
Spunta-6A3	397	457	87	6	73	14	7	1.062	10	3	3	0	1.0	2.5
Spunta-G3	374	430	87	9	77	10	4	1.063	3	3	3	3	1.3	2.5
Jacqueline Lee	**348**	**465**	**75**	**19**	**74**	**1**	**6**	**1.081**	**0**	**5**	**0**	**0**	**2.3**	**2.0**
G274-35.1	316	440	72	17	71	1	11	1.082	0	3	0	0	1.8	1.8
MEAN	387	465						1.069						
$LSD_{0.05}$	89	92						0.002						

[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 25, 2005; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Table 11

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

2003-2005 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, EAST LANSING, MI

	2005	2005	2005	2004	2004	2004	2003	2003	2003
LINE	RATING	WORST	N	RATING	WORST	N	RATING	WORST	N
Sorted by ascending 2005 Rating;									
A8254-2BRUS	0.0	0	5	0.0	0	4	0.0	0	3
A95109-1	0.0	0	4	1.8	2	4	0.0	0	2
GemStar (A9014-2)	0.0	0	2	0.8	1	4	1.0	1	3
MSN109-6RR	0.0	0	1	-	-	-	-	-	-
Goldrush	**0.3**	**1**	**4**	**0.0**	**0**	**4**	**1.0**	**1**	**2**
A8893-1	0.3	1	3	0.5	1	2	-	-	-
W1879-1	0.3	1	3	-	-	-	-	-	-
W2683-2RUS	0.3	1	6	-	-	-	-	-	-
ARS4036-2	0.5	1	2	-	-	-	-	-	-
C095051-7W	0.5	1	2	-	-	-	-	-	-
MSH361-1	0.5	1	4	-	-	-	-	-	-
MSM231-CY	0.5	1	2	-	-	-	-	-	-
MSP403-2	0.5	1	2	-	-	-	-	-	-
MSK409-1	0.7	1	3	1.3	2	3	0.7	1	3
MSL045-AY	0.7	1	3	1.0	1	2	3.0	3	1
MSM051-3	0.7	1	3	1.0	1	4	1.0	1	1
MSM183-1Y	0.7	1	3	2.3	3	3	-	-	-
MSN222-ARUS	0.7	1	3	-	-	-	-	-	-
TXA549-1RUS	0.7	1	3	-	-	-	-	-	-
A93157-6LS	0.8	2	4	-	-	-	-	-	-
MSJ036-A	0.8	1	4	0.8	1	4	1.3	2	3
MSK009-B	0.8	1	4	1.5	2	4	3.0	3	3
MSK061-4	0.8	1	4	1.3	2	4	2.0	3	3
MSK476-1	0.8	1	4	1.3	2	4	1.0	1	3
MSL007-B	0.8	1	4	2.0	3	4	0.7	1	3
MSL175-1	0.8	1	4	2.0	3	3	2.0	2	3
Liberator	0.8	1	4	0.3	1	4	0.0	0	3
MSM058-A	0.8	1	4	-	-	-	-	-	-
MSM148-A	0.8	1	4	1.0	1	2	-	-	-
MSN230-1RY	0.8	1	4	-	-	-	-	-	-
ND7994-1RUS	0.8	1	4	0.0	0	4	-	-	-
MSP216-1R	0.8	1	4	-	-	-	-	-	-
MSP252-3	0.8	1	4	-	-	-	-	-	-
MSP450-2	0.8	1	4	-	-	-	-	-	-
MSP464-4	0.8	1	4	-	-	-	-	-	-
SPG2	0.8	1	4	2.0	3	4	-	-	-
Villetta Rose	0.8	1	4	1.0	2	4	-	-	-
W2128-8	0.9	1	7	1.4	2	8	-	-	-
Beacon Chipper	1.0	1	4	1.5	2	4	1.3	2	6
C089097-2R	1.0	1	2	-	-	-	-	-	-
C093001-11RUS	1.0	2	5	-	-	-	-	-	-
C094035-15RUS	1.0	1	2	-	-	-	-	-	-
C095086-8RUS	1.0	1	3	-	-	-	-	-	-

2003-2005 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, EAST LANSING, MI

	2005	2005	2005	2004	2004	2004	2003	2003	2003
LINE	RATING	WORST	N	RATING	WORST	N	RATING	WORST	N
Sorted by ascending 2005 Rating;									
MSE221-1	1.0	1	4	-	-	-	-	-	-
FL1922	1.0	1	4	1.0	1	4	1.3	2	3
MSG227-2	1.0	1	3	0.8	1	4	0.8	2	6
MSH228-6	1.0	1	4	1.3	2	4	0.7	1	3
MSI152-A	1.0	1	2	1.0	1	3	3.0	3	3
MSJ033-10Y	1.0	1	4	1.0	1	3	-	-	-
MSJ126-9Y	1.0	1	3	1.3	2	3	1.3	2	3
MSJ316-A	1.0	1	4	-	-	-	-	-	-
MSL082-A	1.0	2	3	-	-	-	-	-	-
MSL211-3	1.0	1	4	1.3	2	4	1.0	1	1
MSL268-D	1.0	2	4	2.0	3	3	-	-	-
MSL292-A	1.0	1	3	2.0	3	3	-	-	-
MSL603-203	1.0	1	3	-	-	-	-	-	-
MSM037-3	1.0	1	4	1.3	2	4	-	-	-
MSM060-3	1.0	1	4	1.0	1	4	0.7	1	3
MSM102-A	1.0	1	4	-	-	-	-	-	-
MSM171-A	1.0	1	3	2.5	4	4	2.0	2	3
MSM246-B	1.0	2	4	-	-	-	-	-	-
MSM297-AY	1.0	1	2	-	-	-	-	-	-
MegaChip	1.0	2	4	-	-	-	-	-	-
Monticello	1.0	1	4	-	-	-	-	-	-
MSN105-1	1.0	1	3	1.3	2	3	-	-	-
MSN106-2	1.0	1	3	-	-	-	-	-	-
MSN109-7PP	1.0	1	1	-	-	-	-	-	-
MSN170-A	1.0	1	3	-	-	-	-	-	-
MSN184-2	1.0	1	4	1.8	2	4	-	-	-
MSN215-2P	1.0	1	4	-	-	-	-	-	-
MSN224-AR	1.0	1	1	-	-	-	-	-	-
MSN238-A	1.0	1	4	-	-	-	-	-	-
MSN252-HY	1.0	1	1	-	-	-	-	-	-
MSN313-A	1.0	2	4				-	-	-
NDTX4271-5R	1.0	1	4	-	-	-	-	-	-
NDTX731-1R	1.0	1	4	-	-	-	-	-	-
NY126	1.0	1	4	1.5	2	4	-	-	-
Onaway	**1.0**	**1**	**8**	**1.0**	**1**	**5**	**1.4**	**3**	**9**
MSP238-1	1.0	1	4	-	-	-	-	-	-
MSP239-1	1.0	1	3	-	-	-	-	-	-
MSP262-4	1.0	2	4	-	-	-	-	-	-
MSP270-1	1.0	1	4	-	-	-	-	-	-
MSP292-7	1.0	1	4	-	-	-	-	-	-
MSP327-6	1.0	1	4	-	-	-	-	-	-
MSP368-1	1.0	1	4	-	-	-	-	-	-
MSP408-10Y	1.0	2	4	-	-	-	-	-	-
MSP445-2P	1.0	1	1	-	-	-	-	-	-
MSP515-2	1.0	1	4	-	-	-	-	-	-

2003-2005 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, EAST LANSING, MI

	2005	2005	2005	2004	2004	2004	2003	2003	2003
LINE	RATING	WORST	N	RATING	WORST	N	RATING	WORST	N
Sorted by ascending 2005 Rating;									
MSP556-3	1.0	2	4	-	-	-	-	-	-
Pike	**1.0**	**1**	**8**	**0.9**	**1**	**7**	**1.5**	**2**	**8**
SP6a3	1.0	1	3	2.3	3	4	-	-	-
Spunta	1.0	1	4	2.3	3	4	3.0	5	3
Stampede Russet	1.0	1	4	0.5	1	2	0.3	1	3
TXDH99-1RUS	1.0	1	3	-	-	-	-	-	-
W2133-1	1.0	1	4	1.5	2	4	-	-	-
A9045-7	1.3	2	4	-	-	-	-	-	-
AC92009-4RUS	1.3	3	4	-	-	-	-	-	-
MSH356-A	1.3	2	4	-	-	-	-	-	-
MSI005-20Y	1.3	2	4	1.3	2	4	1.0	1	3
MSL794-BRUS	1.3	2	4	2.0	3	4	-	-	-
MSM224-1	1.3	2	4	2.3	3	4	-	-	-
MSN099-B	1.3	2	4	-	-	-	-	-	-
MSN190-2	1.3	2	4	-	-	-	-	-	-
MSP303-2	1.3	2	4	-	-	-	-	-	-
MSP542-4	1.3	2	4	-	-	-	-	-	-
Russet Norkotah	**1.3**	**2**	**4**	**1.3**	**2**	**4**	**2.0**	**2**	**3**
SPG3	1.3	2	4	1.8	2	4	-	-	-
MSJ461-1	1.3	2	7	1.8	2	4	2.0	2	3
A91814-2	1.3	2	3	2.8	3	4	-	-	-
NY132	1.3	2	3	1.5	2	4	-	-	-
MSP382-13	1.3	2	3	-	-	-	-	-	-
MSP459-5	1.3	2	3	-	-	-	-	-	-
Silverton Russet	1.3	1	3	0.0	0	4	0.3	1	3
W2309-7	1.3	2	3	-	-	-	-	-	-
FL1833	1.5	2	4	2.0	3	4	1.7	2	3
MSI049-A	1.5	2	4	2.3	3	4	2.3	3	3
MSK136-2	1.5	2	2	2.5	3	4	2.0	2	3
MSK437-A	1.5	3	4	2.0	3	4	2.0	2	3
MSL252-1	1.5	3	4	-	-	-	-	-	-
MSM046-4	1.5	2	4	1.3	2	3	0.7	1	3
MSM053-4	1.5	2	4	2.0	3	4	-	-	-
MSM070-1	1.5	2	4	1.3	2	3	-	-	-
MSM108-A	1.5	3	4	-	-	-	-	-	-
Michigan Purple	1.5	2	6	3.3	4	4	2.3	4	6
MN99144-1	1.5	2	2	-	-	-	-	-	-
MSN073-2	1.5	2	2	-	-	-	-	-	-
MSN148-A	1.5	2	4	-	-	-	-	-	-
MSN191-2Y	1.5	2	2	-	-	-	-	-	-
MSN199-B	1.5	2	4	-	-	-	-	-	-
NDTX4304-1R	1.5	3	4	-	-	-	-	-	-
MSP197-1	1.5	2	4	-	-	-	-	-	-
RN278	1.5	2	2	-	-	-	-	-	-
W2310-3	1.5	2	4	-	-	-	-	-	-
Atlantic	**1.6**	**2**	**11**	**2.1**	**3**	**15**	**2.3**	**4**	**11**

2003-2005 SCAB DISEASE TRIAL SUMMARY
SCAB NURSERY, EAST LANSING, MI

	2005	2005	2005	2004	2004	2004	2003	2003	2003
LINE	RATING	WORST	N	RATING	WORST	N	RATING	WORST	N
Sorted by ascending 2005 Rating;									
MSL603-319Y	1.7	2	3	-	-	-	-	-	-
MSP497-1	1.7	2	3	-	-	-	-	-	-
MSG274-35.1	1.8	3	4	-	-	-	-	-	-
MSH095-4	1.8	2	4	2.3	3	8	1.7	2	3
MSK498-1Y	1.8	2	4	1.5	2	4	2.7	4	3
MSL766-1	1.8	3	4	2.3	3	4	2.2	3	6
MSM182-1	1.8	2	4	-	-	-	-	-	-
MSN123-B	1.8	3	4	-	-	-	-	-	-
MSN159-4	1.8	3	4	-	-	-	-	-	-
W2717-5	1.8	3	4	-	-	-	-	-	-
MSK049-A	1.8	3	5	2.3	3	4	-	-	-
MSJ147-1	2.0	2	4	1.8	2	4	1.7	3	3
MSK128-A	2.0	3	3	2.8	4	4	-	-	-
MSL072-C	2.0	3	4	2.0	2	2	-	-	-
MSL183-AY	2.0	2	4	2.0	2	2	-	-	-
MSL228-1	2.0	3	4	1.8	3	4	1.3	2	3
MSM137-2	2.0	3	4	3.0	3	4	-	-	-
MSN046-3	2.0	2	3	-	-	-	-	-	-
MSN111-4PP	2.0	3	4	-	-	-	-	-	-
MSN143-3	2.0	2	3	-	-	-	-	-	-
MSN188-1	2.0	3	4	2.3	4	4	-	-	-
MSN205-A	2.0	2	1	-	-	-	-	-	-
MSN236-A	2.0	2	2	-	-	-	-	-	-
NDC5281-2R	2.0	2	4	-	-	-	-	-	-
MSP408-14Y	2.0	3	3	-	-	-	-	-	-
MSP542-11	2.0	3	4	-	-	-	-	-	-
Snowden	**2.0**	**3**	**12**	**1.9**	**3**	**8**	**2.4**	**3**	**12**
W4013-1	2.0	2	4	-	-	-	-	-	-
MSI201-2PYSport	2.3	3	4	-	-	-	-	-	-
Jacqueline Lee	2.3	3	4	2.8	3	4	2.5	3	6
MSN084-3	2.3	3	4	-	-	-	-	-	-
MSN085-2Y	2.3	3	4	2.0	3	4	-	-	-
MSN180-3	2.3	3	4	-	-	-	-	-	-
MSP365-1	2.3	3	4	-	-	-	-	-	-
MSP420-7Y	2.3	3	4	-	-	-	-	-	-
FL1879	2.3	3	3	2.5	3	4	-	-	-
MSN309-2	2.5	3	4	-	-	-	-	-	-
MWTX2609-2RUS	2.7	5	3	-	-	-	-	-	-
MSN228-5	2.7	3	3	2.3	3	4	-	-	-
B0766-3	2.8	3	4	1.8	2	4	-	-	-
MSN200-2	2.8	3	4	-	-	-	-	-	-

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

$LSD_{0.05}$ = 0.9

Table 12

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2005 LATE BLIGHT VARIETY TRIAL
MUCK SOILS RESEARCH FARM

LINE	RAUDPC[1] MEAN	Female	Male	LINE	RAUDPC[1] MEAN
Sorted by ascending RAUDPC value:					
Foliar Resistance Category (select lines):				***Foliar Susceptibility Category (select lines)*** [2] ***:***	
MSL072-C	0.0	MSE033-1R	Tollocan	Spunta	14.3
MSL766-1	0.0	B0718-3	A91846-5R	A95109-1	14.6
MSN230-1RY	0.0	Norland	Jacqueline Lee	B0766-3	15.3
MSP445-2P	0.0	MI Purple	MSJ459-3	Russet Norkotah	15.9
MSP542-4	0.0	MSJ461-1	MSJ306-5	Liberator	15.9
MSP556-3	0.0	MSJ306-5	MSJ319-1	Snowden	16.6
MSP542-11	0.1	MSJ461-1	MSJ306-5	W2717-5	17.9
MSM183-1	0.1	Torridon	Jacqueline Lee	ND7994-1RUS	18.9
MSM231-CY	0.1	ND4093-4rus	Jacqueline Lee	Onaway	21.5
MSP403-2	0.1	MSC120-1Y	Jacqueline Lee	Monticello	21.8
MSJ461-1	0.2	Tollocan	NY88	CO93001-11RUS	22.6
MSI152-A	0.2	Mainestay	B0718-3	Atlantic	23.2
Jacqueline Lee	0.2	Tollocan	Chaleur	Beacon Chipper	24.5
MSL757-1	0.2	AWN86514-2	A84180-8	A9045-7	26.4
MSM182-1	0.2	Stirling	NY121	Pike	26.6
MSM148-A	0.4	Jacqueline Lee	MSE028-1	Silverton Russet	28.3
MSL082-A	0.4	MSE221-1	Jacqueline Lee	W4013-1	29.9
MSL603-203	0.5	Jacqueline Lee	MSG227-2	Goldrush	29.9
MSM224-1	0.5	MSB106-7	Jacqueline Lee		
MSK128-A	0.6	Jacqueline Lee	MSH094-3		
MSL045-AY	0.6	MSB107-1	Jacqueline Lee		
MSL268-D	0.6	NY103	Jacqueline Lee		
MSN159-4	0.7	MSH120-1	Jacqueline Lee		
MSL211-3	0.8	MSG301-9	Jacqueline Lee		
MSL183-AY	0.8	Boulder	Tollocan		
MSP408-10Y	1.0	MSG004-3	Jacqueline Lee		
MSM137-2	1.0	Eramosa	Jacqueline Lee		
MSN199-B	1.1	MSJ319-1	MSJ461-1		
MSP464-4	1.2	Torridon	MSJ060-2		
MSP497-1	1.8	MSJ456-4	NY120		
$LSD_{0.05}$	10.1				

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

[2] 104 potato varieties and advanced breeding lines were tested in all. For brevity purposes, only selected varieties and breeding lines are listed.

Phytopthora infestans isolates US-1 (Pi 95-3); US-6 (Pi 95-2, Pi 96-2); US-8 (Pi 02-007, Pi 95-7, Pi 02-006, Pi 00-003); US-10 (SR83-84); US-11 (Pi 96-1); US-14 (Pi 94-2, Pi 98-1, Pi 99-2, Pi 00-001) were inoculated 7/26/2005.
Planted as a randomized complete block design consisting of 3 replications of 4 hill plots on 6/2/2005.

Table 12

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2005 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

ENTRY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
DATE OF HARVEST: LATE HARVEST								
FL1922	22	3					88	0.1
MSM051-3	21	4					84	0.2
MSH228-6	20	5					80	0.2
MSK009-B	21	3		1			84	0.2
MSJ036-A	17	6	2				68	0.4
MSL211-3	16	8	1				64	0.4
MSK061-4	16	6	3				64	0.5
MSK498-1Y	15	8	2				60	0.5
Pike	**17**	**6**		**2**			**68**	**0.5**
FL1879	14	8	2	1			56	0.6
MSJ316-A	16	4	4	1			64	0.6
W2128-8	12	11	2				48	0.6
MSG227-2	14	7	3	1			56	0.6
MSJ461-1	12	9	4				48	0.7
MSE221-1	12	9	3	1			48	0.7
MSK049-A	11	8	5		1		44	0.9
Atlantic	**12**	**6**	**4**	**2**	**1**		**48**	**1.0**
MSJ147-1	12	6	4	1	2		48	1.0
FL1833	7	7	6	4	1		28	1.4
A91814-2	10	3	4	7	1		40	1.4
Snowden	**7**	**5**	**7**	**6**			**28**	**1.5**
MSK128-A	7	6	7	3	1	1	28	1.5
Beacon Chipper	3	5	7	6	4		12	2.1
NY132	4	6	3	8	3	1	16	2.1
ADAPTATION TRIAL, CHIP-PROCESSING LINES								
MSJ126-9Y	21	4					84	0.2
MSN073-2	23	1		1			92	0.2
MSL007-B	21	3	1				84	0.2
MSL292-A	20	3	1	1			80	0.3
MSK409-1	17	7	1				68	0.4
MSM182-1	17	6	2				68	0.4
MSM058-A	16	7	2				64	0.4
MSL603-319Y	17	5	2	1			68	0.5
MSL766-1	17	4	1	3			68	0.6

2005 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

	NUMBER OF SPOTS PER TUBER						PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
ENTRY	0	1	2	3	4	5+		
MSN046-3	14	7	4				56	0.6
MSN191-2Y	17	4	3			1	68	0.6
MSN184-2	14	7	3	1			56	0.6
MSN143-3	13	5	6		1		52	0.8
Atlantic	**12**	**2**	**5**	**4**	**2**		**48**	**1.3**
Snowden	**9**	**8**	**3**	**3**	**1**	**1**	**36**	**1.3**
MSM053-4	5	10	4	5	1		20	1.5
MSN180-3	3	4	4	7	4	3	12	2.6
ADAPTATION TRIAL, TABLESTOCK LINES								
MSM171-A	22	3					88	0.1
MSN105-1	21	3	1				84	0.2
MSI049-A	20	4	1				80	0.2
MSM037-3	20	4		1			80	0.3
Onaway	**18**	**6**	**1**				**72**	**0.3**
MSM224-1	14	8	3				56	0.6
MSN159-4	15	8	1		1		60	0.6
MSN076-1	12	9	2	2			48	0.8
MSL228-1	11	8	4	2			44	0.9
MSL183-AY	13	4	5	3			52	0.9
MSM183-1	16	3	1	1	2	2	64	1.0
MSN106-2	8	7	9	1			32	1.1
MSL045-AY	8	8	7		2		32	1.2
PRELIMINARY TRIAL, CHIP-PROCESSING LINES								
MSP270-1	21	4					84	0.2
MSP292-7	20	5					80	0.2
Pike	**20**	**5**					**80**	**0.2**
MSM060-3	19	6					76	0.2
MSP542-04	19	6					76	0.2
MSP542-11	19	6					76	0.2
MSM108-A	17	7	1				68	0.4
MSN123-B	19	3	3				76	0.4
MSP238-1	18	5	2				72	0.4
MSN236-A	17	6	2				68	0.4
MSP327-6	18	5	1	1			72	0.4
MSN085-2Y	17	5	3				68	0.4
MSN170-A	15	9	1				60	0.4

2005 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

ENTRY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSN238-A	16	6	2	1			64	0.5
MSP262-4	15	7	3				60	0.5
MSM070-1	15	7	2	1			60	0.6
MSM246-B	17	6			2		68	0.6
MSP459-5	14	9	1	1			56	0.6
MSN190-2	17	4	2	1	1		68	0.6
MSP382-13	14	8	1	2			56	0.6
MSP365-1	12	9	4				48	0.7
MSL268-D	13	7	4	1			52	0.7
MSN148-A	14	5	5	1			56	0.7
MSP368-1	11	9	5				44	0.8
MSP497-1	12	6	6	1			48	0.8
MSP450-2	9	12	2	2			36	0.9
MSN252-HY	11	7	5	2			44	0.9
MSM102-A	11	8	3	2	1		44	1.0
MSP252-3	6	13	5	1			24	1.0
MSN313-A	8	8	4	5			32	1.2
MSP515-2	8	6	6	3	2		32	1.4
Snowden	**7**	**5**	**9**	**4**			**28**	**1.4**
Atlantic	**5**	**5**	**7**	**4**	**4**		**20**	**1.9**

PRELIMINARY TRIAL, TABLESTOCK LINES

ENTRY	0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSP197-1	23	2					92	0.1
MSP216-1R	23	2					92	0.1
MSN084-3	22	3					88	0.1
Onaway	**22**	**3**					**88**	**0.1**
MSN224-AR	21	4					84	0.2
MSI201-2PYSPORT	21	3	1				84	0.2
MSL072-C	21	3	1				84	0.2
MSN199-B	22	2			1		88	0.2
MSN205-A	20	2	3				80	0.3
MSP408-10Y	18	5	2				72	0.4
A93157-6LS	19	3	2	1			76	0.4
MSL082-A	18	5	1	1			72	0.4
MSP420-7Y	16	7	2				64	0.4
MSN222-ARUS	17	4	1	3			68	0.6
A95109-1	13	10	1		1		52	0.6
MSM148-A	12	10	3				48	0.6

2005 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

ENTRY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSN099-B	16	4	3	1	1		64	0.7
MSP403-2	15	4	5	1			60	0.7
MSP445-2P	9	9	6	1			36	1.0
MSM231-CY	8	6	10	1			32	1.2
A9045-7	8	10	2	3	1	1	32	1.3
MSP408-14Y	9	3	9	4			36	1.3
MSP464-4	8	7	5	3	1	1	32	1.4
ROUND-WHITE TRIAL (+NCR-84)								
MSI005-20Y	22	1	2				88	0.2
MN99144-1	18	3	4				72	0.4
MN99380-1	17	5	3				68	0.4
W2309-7	18	3	3	1			72	0.5
W2717-5	17	6		1	1		68	0.5
Liberator	16	7		1	1		64	0.6
MSJ461-1	13	9	3				52	0.6
NY126	10	12	3				40	0.7
MSI152-A	13	8	1	3			52	0.8
B0766-3	8	11	6				32	0.9
W2128-8	11	4	8	2			44	1.0
MSH095-4	11	5	3	3	2	1	44	1.3
W4013-1	9	6	6	2	1	1	36	1.3
MegaChip	10	3	5	6	1		40	1.4
Atlantic	**5**	**5**	**11**	**3**		**1**	**20**	**1.6**
Snowden	**6**	**6**	**6**	**4**	**3**		**24**	**1.7**
CO95051-7W	7	3	9	3	1	2	28	1.8
W2310-3	6	3	6	5	4	1	24	2.0
W2133-1	5	4	5	5	4	2	20	2.2
Monticello	1	2	4	5	6	7	4	3.4
RUSSET TRIAL (+NCR-84)								
GoldRush	**22**	**3**					**88**	**0.1**
Russet Norkotah	**20**	**5**					**80**	**0.2**
A8893-1	18	7					72	0.3
CO904035-15RU	20	3	2				80	0.3
TXNS287	17	8					68	0.3
Silverton Russet	18	3	3	1			72	0.5
TXA549-1RU	16	5	4				64	0.5

2005 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

ENTRY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
CO93001-11RU	17	4	3		1		68	0.6
GemStar	18	2	4		1		72	0.6
MN99460-21	16	4	4	1			64	0.6
MSA8254-2BRUS	15	3	6	1			60	0.7
Stampede Russet	13	8	2	2			52	0.7
W1879-1RUS	15	7		1	1	1	60	0.8
TXDH99-1RU	12	8	2	2		1	48	0.9
MSL794-BRUS	11	6	4	2		2	44	1.2
MWTX2609-2RU	8	6	8	2		1	32	1.3
AC92009-4RU	5	9	3	5	2	1	20	1.7
W2683-2RUS	9	3	2	5	4	2	36	1.9
RED TRIAL (+NCR-84)								
MSN109-6RR	24	1					96	0.0
ND5281-2R	24	1					96	0.0
NDTX4304-1R	24	1					96	0.0
NDTX731-1R	24	1					96	0.0
MN96013-1R	23	2					92	0.1
MSN109-7PP	23	2					92	0.1
Villetta Rose	22	3					88	0.1
CO89097-2R	21	4					84	0.2
MI PURPLE	21	3	1				84	0.2
MSN215-2P	20	5					80	0.2
NDTX4271-5R	20	4	1				80	0.2
MSN230-1RY	16	9					64	0.4
QUAD STATE TRIAL (+NCR-84)								
Red Norland	**24**	**1**					**96**	**0.0**
V0319-1	21	4					84	0.2
Red Pontiac	**19**	**6**					**76**	**0.2**
FV12486-2	18	7					72	0.3
NorValley	**17**	**5**	**3**				**68**	**0.4**
Russet Norkotah	**15**	**4**	**5**	**1**			**60**	**0.7**
Russet Burbank	**11**	**9**	**4**		**1**		**44**	**0.8**
V1102-1	7	10	3	2	3		28	1.4

2005 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

	NUMBER OF SPOTS PER TUBER						PERCENT (%) BRUISE	AVERAGE
ENTRY	0	1	2	3	4	5+	FREE	SPOTS/TUBER
SFA TRIAL CHECK SAMPLES								
A91814-5	25						100	0.0
AF2211-9	25						100	0.0
Atlantic	**25**						**100**	**0.0**
MegaChip	25						100	0.0
MSJ316-A	25						100	0.0
MSJ461-1	25						100	0.0
Snowden	**25**						**100**	**0.0**
NDC5822C-7	24	1					96	0.0
NY132	22	3					88	0.1
W2133-1	20	5					80	0.2
SFA TRIAL BRUISE SAMPLES								
MegaChip	19	6					76	0.2
A91814-5	20	3	1	1			80	0.3
Atlantic	**17**	**8**					**68**	**0.3**
MSJ316-A	19	5		1			76	0.3
MSJ461-1	15	9	1				60	0.4
ND5822C-7	17	5	2	1			68	0.5
AF2211-9	12	12	1				48	0.6
W2133-1	16	5	2	1		1	64	0.7
Snowden	**10**	**12**	**2**	**1**			**40**	**0.8**
NY132	5	11	1	5	3		20	1.6

* 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.
The table is presented in ascending order of average number of spots per tuber.

Funding: Federal Grant, MPIC and USPB/SFA

2005 On-Farm Potato Variety Trials

Chris Long, Dr. Dave Douches, Dave Glenn (Presque Isle), Dr. Doo-Hong Min and Chris Kapp (Upper Peninsula)

Introduction

On-farm potato variety trials were conducted with 12 growers in 2005 at a total of 14 locations. Nine of the locations evaluated processing entries and five evaluated fresh market entries. The processing cooperators were Crooks Farms, Inc. (St. Joseph / Montcalm), Walther Farms, Inc. (St. Joseph), Lennard Ag. Co. (Monroe), 4-L Farms, Inc. (Allegan), and Main Farms (Montcalm). The United States Potato Board/Snack Food Association (USPB / SFA) chip trial was at V & G Farms (Montcalm). Fresh market trial cooperators were Crawford Farms, Inc. (Montcalm), DuRussel's Potato Farms, Inc. (Washtenaw), Wilk Farms (Presque Isle), Horkey Bros. (Monroe), M.J. Van Damme Farms (Marquette) and Elmaple Farm LLC (Kalkaska).

Procedure

There were two types of processing trials conducted this year. The first type contained 16 entries which were compared with check varieties Atlantic, Snowden, Pike and FL1879. This trial type was conducted at Main Farms, Lennard Ag. Co., 4-L Farms, and Walthers Farms, Inc. Varieties in these trials were planted in 100' strip plots. Seed spacing was grower dependent, but in general ranged from 8 to 11 inches. The Walther trial was harvested at two harvest dates of 117 and 135 days after planting. Plot size was 34" wide by 20 hills long. Seed spacing was 9".

The second type of processing trial, referred to as a "Select" trial, contained from five to eight 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 was 10" and 34", respectively. On Crooks farm, a small common scab trial was also planted to screen the scab tolerance of the varieties being tested in the Select trials. The plots were seven feet long and total yield, specific gravity, scab rating and vine maturity was recorded. Seed spacing was also ten inches in these plots.

Within the fresh market trials, there were 32 entries evaluated. There were 12-24 lines planted at each of the following locations: Marquette, Monroe, Montcalm, Presque Isle, and Washtenaw counties. The varieties in each trial ranged from mostly round white varieties to mostly russet varieties. These varieties were planted in 100' strip plots. Again, spacing varied from 8 to 12 inches depending upon grower production practices and variety. At Elmaple Farms, larger 4 row by 500 feet block planting were evaluated. MSE221-1 and Stampede Russet were planted and their commercial potential was evaluated.

For procedural details on the USPB / SFA trial reference the 2005 annual report published by the United States Potato Board.

Results

A. Processing and "Select" Processing Variety Trial Results

A description of the processing varieties, their pedigree and scab ratings are listed in Table 1. The overall averages of the three locations of Allegan, Montcalm and Monroe counties are shown in Table 2. The data from Walther Farms, Inc. in St. Joseph County is shown separately in Table 3 (first harvest, 117 days) and Table 4 (second harvest, 135 days). The overall averages of the "Select" processing trial, which are averaged across two locations, are in Table 5 and Crooks Farm "Scab Trial" is in Table 6.

Processing Variety Highlights

Beacon Chipper (UEC), is in the process of being jointly released by Michigan and Maine in early 2006. This variety had a strong performance at Walther Farms, St. Joseph County location (Tables 3 and 4). In the other On-farm locations Beacon Chipper averaged 379 cwt/A US#1 yield. Internal raw tuber and finished chip quality continue to be good, but specific gravity is generally in the mid 1.070 range.

MSJ147-1, a Michigan State clone, is a strong yielding line with good internal quality and excellent chip quality (Table 2). This variety continues to exhibit excellent chip quality into May and June. Yield and specific gravity appear to be in the acceptable range.

MSJ036-A, another Michigan State University clone has good chip quality, very nice uniform type and excellent common scab resistance. This variety was a top yielding line at 472 cwt/A US#1 at the Allegan, Monroe and Montcalm locations (Table 2).

B. USPB / SFA Chip Trial Results

The Michigan location of the USPB / SFA chip trial was on the V & G Farm in Montcalm county in 2005. Table 7 shows the yield, size distribution and specific gravity of the entries when compared with Atlantic and Snowden. Table 8 shows the at harvest raw tuber quality results. Table 9 shows the out of the field chip quality evaluations from samples processed and scored by Herr Foods, Inc., Nottingham, PA and Table 10 provides the blackspot bruise susceptibility of each entry.

USPB / SFA Chip Trial Highlights

The varieties in the 2005 trial that displayed the greatest potential for commercialization were ND5822C-7 and MSJ316-A. Yield potential and specific gravity were excellent for ND5822C-7 (Table 7), but the recorded number of hollow heart was quite high (Table 8). MSJ316-A was also a strong yielding line at 380 cwt/A US#1 yield (Table 7). This variety has good internal quality (Table 8) and excellent tolerance to blackspot bruise (Table 10).

C. Fresh Market and Variety Trial Results

A description of the fresh pack varieties, their pedigree and scab ratings are listed in Table 11. Table 12 shows the overall average of five locations: Marquette, Monroe, Montcalm, Presque Isle and Washtenaw counties.

Fresh Market Variety Highlights

Two round white and four russet lines are worthy of mention from the 2005 variety trials. They are Boulder (MSF373-8) and MSE221-1 (the round whites) and the russets; MSA8254-2BRus, A93157-6LS, CO95172-3Rus and CO95086-8Rus.

Boulder (MSF373-8), a Michigan State University (MSU) release, was the second highest yielding line in the 2005 On-farm variety trials. This variety had a 487 US#1 yield with excellent internal quality (Table 12). At an eight inch seed spacing 33 percent of the marketable yield of Boulder was in the oversize category. The variety can have some deep eyes as the tubers get large. This variety can be grown on dry land and consequently produces a nice crop of round white potatoes.

MSE221-1 is an MSU release with scab resistance. This round white variety is much like Superior in type with a stronger yield and shallow eyes. MSE221-1 yielded 381 cwt/A US#1 in 2005 (Table 12).

MSA8254-2BRus has an unknown pedigree with excellent scab resistance (Table 11). MSA8254-2BRus had a 252 cwt./A US#1 yield with a 1.067 specific gravity. This variety has a nice long type and good marketable appearance.

A93157-6LS, is a USDA Aberdeen release with processing potential. In Michigan, this variety had a 284 cwt/A US#1 yield with a 1.073 and a nice russet long type. Some hollow heart was observed (Table 12). The overall type and appearance of this variety make it a candidate for further testing.

CO95172-3Rus, a Colorado release, has a good general appearance. The US#1 yield was 333 cwt/A with excellent internals and a 1.079 specific gravity (Table 12).

CO95086-8Rus is another Colorado selection with good type and a strong marketable yield at 271 cwt/A (Table 12). This variety also has good internal quality and a good general appearance.

Table 1

2005 MSU Processing Potato Variety Trials

Entry	Pedigree	2005 Scab Rating*	Characteristics
Atlantic (B6987-56)	Wauseon X Lenape	1.6	Early maturing, high yield check variety.
Beacon Chipper (UEC)	Unknown	1.0	Mid-season maturity, high yield, some heat stress and scab tolerance.
FL1879	Snowden X FL1207	2.3	Late maturing, late season storage check variety
FL1922	FL1533 X FL1207	1.0	Oval to oblong tubers, medium to low specific gravity, good chip quality out of late storage.
Megachip (W1201)	Wischip X FYF 85	1.0	Late maturing, high yield, cold chipper 45 °F, slight deep eyes, early bulking.
Monticello (NY102 or K9-29)	Steuben X Kanona	1.0	Mid-season maturity, average yield, medium specific gravity, good long term storability, low internal defects, black spot susceptible.
Pike (NYE55-35)	Allegany X Atlantic	1.0	Early maturing, early storage check variety.
Snowden (W855)	B5141-6 X Wischip	2.0	Late maturing, late season storage check variety.
A91814-5	NDA2031-2 X Ivory Crisp	1.3	Mid-season maturity, medium high specific gravity, round to oblong tuber type, high yield potential, low internal defects, scab tolerance similar to Atlantic.
AF2211-9	Atlantic X Maine Chip	2.3	Mid-season maturity, high specific gravity, good tuber appearance, cold chipping potential, high yield.

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible.

Entry	Pedigree	2005 Scab Rating*	Characteristics
B0766-3	B0243-18 X B9792-157 (Coastal Chip)	2.8	Mid-season maturity, high yield, uniform size, scab tolerant, round to oval shape, good chip quality until early March from 50 ºF.
CO9505-7W	AC88456-6W X BC0894-2W	0.5	Medium to late maturity, medium high yielding, high percent of US#1 tubers, low internal defects, high specific gravity.
MSG227-2	Prestile X MSC127-3	1.0	Average yield potential: flattened round shape, shallow eyes, low internal defects, medium specific gravity.
MSH095-4	MSE266-2 OP	1.8	Mid-season maturity, bruise susceptibility equal to Snowden, long term storage profile, average yield, acceptable specific gravity.
MSH228-6	MSC127-3 OP	1.0	Mid-season maturity, slightly flatted tubers, shallow eyes, intermediate specific gravity, average yield.
MSJ036-A	A7961-1 X Zarevo	0.8	Mid-season maturity, high yield, nice round uniform tuber type, medium high specific gravity, scab resistant.
MSJ126-9Y	Penta OP	1.0	Average yield, cold chipper from 45 ºF, Uniform A-size tubers, attractive appearance, good internal quality.
MSJ147-1	Norvalley X S440	2.0	Mid-season maturity, good internal quality, very good chip quality late in storage, medium specific gravity.
MSJ316-A	Pike X B0718-3	1.0	Late maturing, medium specific gravity, round tubers, high yield, scab tolerant, good type.
MSJ461-1	Tollocan X NY88	1.3	Maturity slightly earlier than Snowden, round tubers with bright skin, low defects, strong foliar late blight resistance, intermediate specific gravity.

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible.

Entry	Pedigree	2005 Scab Rating*	Characteristics
MSK061-4	MSC148-A X Dakota Pearl	0.8	Medium to late season maturity, high specific gravity, good chip color.
ND5822C-7	ND4103-2 X Dakota Pearl	0.8	Late maturing, high yield, CPB repelling, hollow heart in oversize tubers, bright appearance, masks PVY.
NY132	Eva X Pike	1.3	Late maturity, medium low specific gravity, medium yield of uniformly round tubers, scab resistance, bright appearance.
W2133-1	Snowden X RHL 167	1.0	Late maturity, scab resistant, good internal quality, high yield, nice tuber type, medium to low specific gravity, 42-45 ºF cold chipper.
W2128-8	W845 X CT80-1	0.9	Medium late maturity, slight deep eye, good size, high specific gravity, cold chipper, moderate scab tolerance.
W2309-7	ND2471-8 X W1242	1.3	Full season maturity, high specific gravity, high yielding, chipping from 42 ºF after 5 months.

*Scab rating based on 0-5 scale; 0 = most resistant and 5 = most susceptible.

Table 2

2005 Processing Potato Variety Trial
Overall Average - Three Locations
Allegan, Monroe, Montcalm Counties

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL		3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	COMMENTS	CWT/A
Snowden	**501**	**532**	**94**	**5**	**85**	**10**	**0**	**1.077**	**1.3**	**1**	**2**	**2**	**0**	**10**	**nice type, tr scab**	**501**
MSJ036-A	472	518	91	9	88	2	0	1.077	1.8	0	0	2	0	10	small uniform round type	-
MSJ316-A	462	500	93	6	84	9	2	1.074	1.7	0	0	1	1	10	heat necrosis	-
W2128-8	451	485	93	7	87	5	1	1.090	1.3	0	0	2	0	10	air checking	-
MSH228-6	440	470	94	5	77	17	2	1.070	1.2	1	2	1	0	10	flattened, tr surface scab	440*
MSK061-4	431	533	82	7	79	3	10	1.078	1.2	0	3	0	0	10	plot variability	-
NY132	427	462	92	6	86	6	2	1.076	2.0	0	0	3	0	10	plot variability, tr surface scab	-
MSJ147-1	424	484	87	11	86	2	2	1.072	1.7	0	1	1	0	10	sl scab	424*
Atlantic	**418**	**454**	**92**	**6**	**78**	**14**	**3**	**1.079**	**1.3**	**4**	**0**	**2**	**1**	**10**	**scab**	**418**
B0766-3	395	461	85	11	77	8	4	1.072	1.7	1	0	0	0	10	irregular type	395*
Beacon Chipper	379	455	84	7	75	9	9	1.069	1.5	0	3	0	0	10	sl misshapen, sl surface scab	-
Pike	**369**	**409**	**90**	**9**	**86**	**5**	**1**	**1.076**	**1.5**	**1**	**0**	**1**	**0**	**10**	**heat necrosis**	**369**
Monticello	342	399	84	16	84	0	0	1.073	1.5	0	1	0	0	10	tr points, tr surface scab, small size	-
MSJ461-1	339	470	73	24	71	2	2	1.070	1.7	0	0	0	0	10	small tubers	339
FL1879	**317**	**341**	**92**	**5**	**80**	**12**	**3**	**1.068**	**1.5**	**1**	**0**	**0**	**0**	**10**	**plot variability**	**317***
FL1922	195	234	84	14	82	2	2	1.068	1.0	0	0	0	0	10	small set	195*
MEAN	397	451	88					1.074								

[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 Assoc. Scale
(Out of the field)
Ratings: 1 - 5
1: Excellent
5: Poor

* Two-Year Average

sl = (slight)
tr = (trace)

Table 3

2005 Processing Potato Variety Trial
Walther Farms - St. Joseph County
First Harvest 2-Sept-05 117 Days

	CWT/A		PERCENT OF TOTAL[1]				
			US#1				Total Chip
LINE	US#1	TOTAL	As	Bs	SP GR	HH[2]	Defects[3]
Atlantic	**489**	**527**	**93**	**7**	**1.090**	**-**	**57.6**
FL1879	**482**	**511**	**94**	**6**	**1.080**	**-**	**6.1**
Snowden	**444**	**569**	**78**	**22**	**1.095**	**-**	**21.8**
Beacon Chipper	443	470	94	6	1.087	-	7.8
NY132	431	515	84	16	1.099	-	42.4
B0766-3	416	469	89	11	1.089	-	23.3
W2128-8	416	496	84	16	1.106	-	78.2
MSJ461-1	413	510	81	19	1.086	-	37.5
Megachip	391	434	90	10	1.093	-	43.3
MSJ316-A	336	430	78	22	1.089	-	47.3
MSH228-6	330	393	84	16	1.087	-	33.6
MSJ147-1	322	404	80	20	1.086	-	6.4
MSK061-4	296	385	77	23	1.091	-	21.3
Monticello	291	401	72	28	1.086	-	0.0
FL1922	289	364	79	21	1.074	-	6.0
MSJ036-A	285	385	74	26	1.089	-	52.9
MEAN	380	454	83	17	1.089		30.3

[1]Percent of Total (Size)
US#1: ≥2 in.
Bs: < 2 in.

[2]Based on a 10 tuber raw sample

[3]Total Chip Defects is a percentage comprised of; undesirable color, greening, internal defects and external defects present in a chip sample.

Planted May 9, 2005

9" seed spacing

Vine kill data: None

Table 4

2005 Processing Potato Variety Trial
Walther Farms - St. Joseph County
Second Harvest 20-Sept-05 135 Days

	CWT/A		PERCENT OF TOTAL[1]						Total
			US#1		Small	Large			Chip
LINE	US#1	TOTAL	As	Bs	As	As	SP GR	HH[2]	Defects[3]
Snowden	**554**	**615**	**90**	**10**	**89**	**1**	**1.083**	**0.0**	**24.0**
FL1879	**552**	**584**	**94**	**6**	**84**	**10**	**1.078**	**4.0**	**14.2**
Atlantic	**550**	**589**	**93**	**7**	**83**	**10**	**1.081**	**1.0**	**27.1**
NY132	499	564	89	11	87	2	1.091	0.0	51.5
MSJ461-1	496	564	88	12	84	4	1.081	0.0	29.4
Beacon Chipper	495	521	95	5	78	17	1.076	0.0	25.5
B0766-3	485	528	92	8	86	6	1.085	0.0	24.7
Megachip	467	509	92	8	88	4	1.090	0.0	16.8
MSH228-6	451	493	91	9	81	10	1.080	0.5	35.1
MSK061-4	398	450	88	12	87	1	1.083	0.0	32.9
MSJ036-A	390	456	85	15	84	1	1.079	0.0	31.7
MSJ147-1	385	442	87	13	85	2	1.081	0.0	12.5
FL1922	353	405	87	13	87	0	1.068	0.0	38.4
W2128-8	351	402	87	13	82	5	1.094	0.0	38.3
MSJ316-A	328	369	89	11	83	6	1.076	0.0	26.4
Monticello	322	393	82	18	81	1	1.076	0.5	30.1
MEAN	442	493	89	11			1.081		28.7

[1]Percent of Total (Size)
US#1: ≥2 in.
Large As: >4 in.
Small As: 2 - 4 in.
Bs: < 2 in.

[2]Based on a 10 tuber raw sample

[3]Total Chip Defects is a percentage comprised of; undesirable color, greening, internal defects and external defects present in a chip sample.

Vine kill data: September 9, 2005
Days from planting to vine kill: 124

Planted May 9, 2005

9" seed spacing

Table 5

2005 "Select" Processing Potato Variety Trial
Overall Average - Crooks Farms, Inc., Two Counties
Montcalm & St. Joseph Counties

NUMBER OF		CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL	
LOCATIONS	LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	COMMENTS
2	Megachip	471	502	84	15	83	1	1	1.089	0	0	0	0	10	tr of surface scab and deep eyes (Montcalm)
2	MSJ036-A	318	363	87	13	85	2	0	1.069	1	1	0	1	10	heat runners (St. Joseph)
2	W2128-8	313	360	87	11	86	1	2	1.090	1	0	1	0	10	growth cracks (Montcalm)
2	MSJ147-1	240	284	84	16	84	0	0	1.000	0	0	0	0	10	
2	W2309-8	200	238	82	15	82	0	3	1.080	2	1	2	0	10	4 tubers with soft rot (Montcalm)
	MEAN	308	349	85					1.065						

[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
BC: Brown Center
VD: Vascular Discoloration
IBS: Internal Brown Spot

sl = (slight)
tr = (trace)

Table 6

2005 "SCAB"
Processing Potato Variety Trial
Crooks Farms - Montcalm County
September 6, 2005 Harvest / 104 Days

LINE	TOTAL YIELD CWT/A	SP GR	SCAB[1] SCORE	VINE[2] MATURITY
Megachip	611	1.093	1.0	4
W2128-8	529	1.095	3.0	4
Monticello	461	1.083	0.5	2
Snowden	433	1.078	3.0	2
W2309-7	417	1.089	2.0	1
MSJ036-A	404	1.086	0.5	3
Pike	389	1.083	1.0	3
MSJ147-1	293	1.084	2.5	3
MEAN	442	1.086		

[1] Common Scab
0: No Infection
3: Intermediate
5: Highly Susceptible

[2] Vine Maturity
1: Early (Dead Vines)
5: Late (Vigorous Vines)

Planted: May 25, 2005
Vines Killed: None
Days After Vine Kill: 0
Seed Spacing : 10"

Table 7. USPB / SFA Chip Trial: Yield ,Size Distribution*, Specific Gravity								
	Yield (cwt/A)		**Percent Size Distribution**					
Entry	**US#1**	**TOTAL**	**US#1**	**Small**	**Mid-Size**	**Large**	**Culls**	**Specific Gravity**
ND5822C-7	621	648	95	3	72	23	2	1.089
MSJ461-1	404	474	85	15	84	1	0	1.073
MSJ316-A	380	420	91	7	82	9	2	1.079
Snowden	**375**	**403**	**94**	**6**	**89**	**5**	**0**	**1.082**
Megachip	368	399	92	6	83	9	2	1.083
W2133-1	304	336	91	8	83	8	1	1.084
A91814-5	301	407	74	21	72	2	5	1.067
Atlantic	**275**	**318**	**87**	**9**	**85**	**2**	**4**	**1.081**
NY132	260	300	87	11	81	6	2	1.080
AF2211-9	184	226	83	12	75	7	5	1.070
Average	380	413	88					1.079

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

Table 8. USPB / SFA Chip Trial: At Harvest Tuber Quality. V & G Farms, Michigan.						
	Internal Defects[1]					
Entry	**HH**	**VD**	**IBS**	**BC**	**Total Cut**	**Scab[2] Tolerance**
ND5822C-7	7	0	0	0	30	0.5
MSJ461-1	1	0	0	0	30	2.0
MSJ316-A	2	0	0	0	30	1.5
Snowden	**2**	**1**	**0**	**0**	**30**	**3.5**
Megachip	4	1	0	0	30	2.0
W2133-1	2	0	0	0	30	3.0
A91814-5	0	0	0	0	30	3.5
Atlantic	**1**	**0**	**0**	**0**	**30**	**3.5**
NY132	2	0	0	0	30	1.5
AF2211-9	5	0	0	0	30	3.5

[1]Internal Defects. HH = hollow heart, VD = vascular discoloration, IBS = internal brown spot, BC = brown center.
[2]Scab reading October 10, 2005. 0 = no infection, 1 = low infection < 5%, 3 = intermediate, 5 = highly susceptible.

Table 9. USPB / SFA Chip Trial: 2005 Post-Harvest Chip Quality[1].

Entry	Agtron Color	SFA[2] Color	Specific Gravity	Percent Chip Defects[3] Internal	External	Total
ND5822C-7	64.1	2.0	1.085	21	1	22
MSJ461-1	61.7	2.0	1.063	19	17	36
MSJ316-A	59.5	3.0	1.079	50	2	52
Snowden	**67.8**	**2.0**	**1.075**	**14**	**22**	**36**
Megachip	61.7	2.0	1.078	32	12	44
W2133-1	59.1	2.0	1.076	23	10	33
A91814-5	58.2	4.0	1.073	28	37	65
Atlantic	**63.1**	**3.0**	**1.075**	**20**	**27**	**47**
NY132	64.1	3.0	1.075	28	12	40
AF2211-9	57.2	4.0	1.066	37	16	53

[1] Samples collected at harvest October 10th and processed by Herr Foods Inc., Nottingham, PA on October 18, 2005 (9 days).

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 10. USPB / SFA Chip Trial: Black spot Bruise Test

	A. Check Samples[1]									B. Simulated Bruise Samples[2]								
Entry	0	1	2	3	4	5	Total Tubers	Percent Bruise Free	Average Bruises Per Tuber	0	1	2	3	4	5	Total Tubers	Percent Bruise Free	Average Bruises Per Tuber
ND5822C-7	24	1					25	96	0.0	17	5	2	1			25	68	0.5
MSJ461-1	25						25	100	0.0	15	9	1				25	60	0.4
MSJ316-A	25						25	100	0.0	19	5		1			25	76	0.3
Snowden	25						25	100	0.0	**10**	**12**	**2**	**1**			**25**	**40**	**0.8**
Megachip	25						25	100	0.0	19	6					25	76	0.2
W2133-1	20	5					25	80	0.2	16	5	2	1		1	25	64	0.7
A91814-5	25						25	100	0.0	20	3	1	1			25	80	0.3
Atlantic	25						25	100	0.0	**17**	**8**					**25**	**68**	**0.3**
NY132	22	3					25	88	0.1	5	11	1	5	3		25	20	1.6
AF2211-9	25						25	100	0.0	12	12	1				25	48	0.6

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

[2]Tuber samples collected at harvest, held at 50ºF for 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 11

2005 MSU Fresh Pack Potato Variety Trials

Entry	Pedigree	2005 Scab Rating*	Characteristics
Boulder (MSF373-8)	MS702-80 X NY88	2.0	High yield, large tubers, low internal defects, med. deep eyes.
Dakota Jewel (ND3196-1R)	ND2223-8R X ND649-4R	1.0	Early maturity, average yield, smooth round tubers, white flesh, shallow eyes, stores well, some brown center noted, nice red color out of the field.
Dakota Pearl (ND2676-10)	ND1118-1 X ND944-6	1.0	Early maturing, low internal defects, average yield, cold chipping potential at 42 °F.
Eramose	F52047 X F60019	-	High yielding, resistance to skinning and hollow heart, medium dormancy, medium specific gravity, smooth white skin, oval tubers, moderate resistance to common scab.
Eva (NY103)	Steuben X OP	2.8	Mid-season maturity, above average yield, round to oval appearance, resistant to PVX and PVY.
Goldrush (ND1538-1 Rus)	ND450-3 Rus X Lemhi Russet	0.3	Long to oval tubers, heavy russet, check variety.
Katahdin (USDA 42667)	USDA 40568 X USDA 24642	-	Mid-season maturity, high yielding check variety.
Liberator (MSA091-1)	MS702-80 X Norchip	0.8	Full season maturity, average yield, tubers round with some tendency to form Norchip off-types, medium high specific gravity, internal pigmentation noted, scab resistant, bright appearance.

*Scab rating based on a 0-5 rating; 0 = most resistant and 5 = most susceptible.

Entry	Pedigree	2005 Scab Rating*	Characteristics
Michigan Purple	W870 X Maris Piper	1.5	Mid-season, attractive purple skin, white flesh, high yield potential, low incidence of internal defects.
Onaway	USDA X96-56 X Katahdin	1.0	Early maturing, high yielding check variety.
Reba (NY 87)	Monona X Allegany	2.5	High yield, bright tubers, low incidence of internal defects, mid to late season maturity.
Russet Norkotah (ND534-4 Rus)	ND9526-4 Rus X ND9687-5 Rus	1.3	Mid-season maturity, average yield, long to oval tubers, heavy russet skin, check variety.
Salem (NY 84)	-	-	Medium maturity, tablestock variety, high yielding, low to medium specific gravity, scab resistant, large tubers with a bright appearance.
Silverton Russet (A083064-6)	A76147-2 X A7875-5	1.3	Oblong to long, medium russet skin, medium yield, masks PVY.
Stampede Russet (TXAV657-27Rus)	BR7091-1 X Lemhi Russet	1.0	Early season maturity, oblong to long, heavy russeting, average yield potential, fresh market.
A8893-1 (Blazer Russet)	A7816-14 X NorKing Russet	0.3	Early maturing, high yielding, good processing quality, A possible replacement for Shepody.
A9045-7	Ranger Russet X Russet Legend	1.3	Medium late maturity, light russet skin, high yielding, uniform tuber type, dual purpose usage.
A93157-6LS	A87149-4 X A88108-7	0.8	Maintains low levels of reducing sugars even after extended storage, Med to late maturity, dual purpose usage, PVY resistant, high specific gravity.

*Scab rating based on a 0-5 rating; 0 = most resistant and 5 = most susceptible.

Entry	Pedigree	2005 Scab Rating*	Characteristics
A95109-1	Blazer Russet X Summit Russet	0.0	Early maturity, attractive appearance, fresh market use.
CO93001-11Rus	A79141-3 X Silverton Russet	1.0	Early maturity, medium specific gravity, medium to high yielding, dual purpose russet, good storage fry color, good size profile.
CO94035-15Rus	AO80432-1 X Silverton Russet	1.0	Medium maturity and specific gravity profile, dual purpose russet, medium to high yielding, average tuber size is large, some hollow heart has been noted.
CO95086-8Rus	CO87009-4Rus X Silverton Russet	1.0	Early maturity, medium high specific gravity, resistant to black spot bruise, no internal defects, good size profile, medium yield potential, dual purpose russet, good processing from storage.
CO95172-3Rus	Russet Nugget X AC88165-3RUS	-	Medium maturity, medium to high specific gravity, high yield potential, few external defects, resistant to hollow heart, fresh market russet.
MSA8254-2BRus	Unknown	0.0	Late season maturity, dual purpose, medium specific gravity, good yield.
MSE221-1	Superior X Spartan Pearl	1.0	Medium maturity, medium yield, scab tolerant, netted round tubers, low internal defects.
MSH031-5	MSB110-3 X MSC108-3	2.7	Mid-season maturity, average yield, nice appearance, res. To black spot.
MSH228-6	MSC127-3 OP	1.0	Mid-season maturity, slightly flatted tubers, shallow eyes, intermediate specific gravity, average yield
MSI005-20Y	MSA097-1Y X Penta	1.3	Early to mid-season maturity, high yielding, low internal defects, strong yellow flesh color.
MSJ033-10Y	MSA097-1Y X Penta	1.0	Mid-season maturity, strong yellow flesh color, good size profile, nice round type.

*Scab rating based on a 0-5 rating; 0 = most resistant and 5 = most susceptible.

Entry	Pedigree	2005 Scab Rating*	Characteristics
MSJ461-1	Tollocan X NY88	1.3	Maturity slightly earlier than Snowden, round, bright skin, low defects, strong foliar late blight resistance, nice flavor, intermediate specific gravity.
MSK498-1Y	Saginaw Gold X Brodick	1.8	Late maturity, uniform sizing, moderate scab resistance, light yellow flesh.
MSL757-1	AWN86514 X A84180-8	2.5	Mid-season maturity, oval tuber type, strong foliar resistance to Late Blight, high yield, medium specific gravity, tablestock usage.
RN278	Line Selection	1.5	Medium maturity, fresh market utilization, oblong russeted tubers, reduced nitrogen usage, medium tuber dormancy, high yielding.
W2683-2Rus	ND4093-4 X CO80011-5	0.3	Late maturity, tablestock gravity, golden russet type, high yield,

*Scab rating based on a 0-5 rating; 0 = most resistant and 5 = most susceptible.

Table 12

2005 Freshpack Potato Variety Trial
Overall Averages - Five Locations
Marquette, Monroe, Montcalm, Presque Isle, Washtenaw Counties

NUMBER OF 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	TOTAL CUT	COMMENTS	3-YR AVG US#1 CWT/A
3	**Onaway**	**527**	**588**	**90**	**3**	**69**	**21**	**7**	**1.064**	**0**	**0**	**0**	**0**	**10**	**sheep nose, surface scab, misshapen**	**441**
2	Boulder	487	498	97	3	64	33	0	1.077	0	1	0	0	10	tr surface scab, sheep nose	-
5	**Reba**	**429**	**453**	**92**	**8**	**83**	**10**	**0**	**1.067**	**2**	**0**	**0**	**0**	**10**	**deep eyes, sl sheep nose, tr scab**	**440**
2	**Katahdin**	**403**	**431**	**93**	**6**	**76**	**18**	**1**	**1.064**	**0**	**1**	**1**	**0**	**10**	**bright appearance, tr scab**	**-**
4	MSE221-1	381	434	87	6	73	14	7	1.068	1	0	0	0	10	nice type, netted skin, tr scab	-
3	Silverton Russet	360	403	89	10	69	20	1	1.067	1	0	0	0	10	nice type	327
3	MSI005-20Y	359	419	86	12	80	6	2	1.069	0	0	0	0	10	nice tuber flesh and trace of scab	371
2	MSH228-6	356	386	92	7	87	5	0	1.069	4	2	0	0	10	tr scab	-
2	MSK498-1Y	340	410	80	18	79	1	2	1.076	0	0	0	0	10	tr surface scab	-
3	CO95172-3Rus	333	431	74	22	69	5	4	1.079	0	0	0	0	10	misshapen	-
2	Salem	322	397	76	19	69	6	5	1.067	1	0	0	0	10	scab, growth cracks	-
5	MSJ461-1	316	399	77	23	76	1	0	1.070	0	0	1	0	10	bright appearance small size, scab	401
5	Liberator	307	352	87	11	80	6	3	1.075	0	0	0	0	10	deep eyes	-
3	A93157-6LS	284	354	76	21	63	13	3	1.073	5	0	0	0	10	nice type	-
2	CO95086-8Rus	271	347	75	21	63	13	3	1.069	0	1	0	0	10	growth cracks and misshapen	-
2	Eramosa	266	306	86	10	74	12	4	1.055	4	2	1	0	10	nice type	-
4	MSA8254-2BRUS	252	392	61	26	55	7	13	1.067	3	0	0	0	10	misshapen	-
5	Eva	248	273	91	8	88	3	1	1.069	0	1	0	0	10	tr scab	293
3	**R. Norkotah**	**245**	**342**	**69**	**26**	**65**	**5**	**5**	**1.066**	**1**	**0**	**0**	**0**	**10**	**plot variability**	**268**
3	A95109-1	245	296	81	15	78	4	4	1.071	0	1	0	0	10	uniform type	-
3	CO94035-15Rus	241	332	67	22	55	13	10	1.070	4	0	0	0	10	growth cracks and misshapen	-
5	MSL757-1	236	354	63	35	62	0	2	1.079	0	0	1	0	10	long type light russet and scab	-
3	Dakota Jewel	227	262	83	16	73	10	1	1.062	1	0	0	0	10	small size	258
3	**Goldrush**	**211**	**308**	**68**	**23**	**65**	**4**	**8**	**1.064**	**0**	**0**	**0**	**0**	**10**	**misshapen**	**-**
3	W2683-2	196	340	56	28	51	5	16	1.068	2	0	0	0	10	misshapen and points	-
3	A9045-7	194	288	65	28	59	5	7	1.075	0	1	0	0	10	tr scab	-
1	MSE192-8Rus	185	301	61	34	61	0	5	1.067	0	0	0	0	10	heavy russet skin, long type	188
3	C093001-11Rus	175	294	56	41	54	2	2	1.068	0	0	1	0	10	misshapen	-
3	Stampede Russet	175	280	61	34	59	2	5	1.061	0	0	1	0	10	small size and misshapen	-
1	Dakota Pearl	171	259	66	33	66	0	0	1.070	0	2	0	1	10	bright appearance, small size	229
3	RN278	164	287	55	32	52	3	13	1.071	1	0	0	0	10	small set and misshapen	-
3	A8893-1	140	247	56	27	56	0	17	1.071	1	1	0	0	10	lots of misshapen tubers	-
	MEAN	283	358	76					1.069							

[1]SIZE
Bs: < 1 7/8" or < 4 oz.
As: 1 7/8" - 3.25" or 4 - 10 oz.
OV: > 3.25" or > 10 oz.
PO: Pickouts

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

sl = (slight)
tr = (trace)

Funding: MPIC / Industry

Potato Seed Piece and Variety Response to Variable Rates of Gibberellic Acid 2005

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Introduction

This report is a short communication and follow-up to similar work conducted in 2003 and 2004 results of which are reported in the 2004 Michigan Research Report. In 2005 a follow-up experiment was conducted on three Frito-Lay, Inc. varieties, FL1879, FL1833 and FL1922. In addition, a Michigan State University (MSU) developed clone, Michigan Purple was added to the study. Our goal was to continue to investigate the possibility of increasing tuber set by hormonally influencing the tuber eyes' ability to produce an increased number of stems. It has been documented that stem number directly influences tuber set (Toosey 1958). Wilkins (1958) indicates that gibberellic acid (GA) is implicated in increasing the number of stems emerging from each tuber eye. Gibberellic acid, although believed to increase the number of stems, ultimately influences tuber size and yield (Smeltzer and MacKay 1963). The objectives of this study are to: (1) establish the effectiveness of GA in inducing greater stem numbers arising from a given potato seed piece and (2) establish whether the increase in stem numbers per plant will increase tuber set and decrease tuber size of four commercially available varieties.

Procedure

In 2005 four varieties, FL1833, FL1879, FL1922 and Michigan Purple were evaluated for their response to three levels of GA. In 2005, seed was obtained and cut into approximately two ounce seed pieces on May 16, 2005. The cut seed was immediately treated with GA at 0, 1, 2 and 4 mg of active ingredient per 100 lbs. (mg a.i./cwt). Pro Gibb 4% which was used in this study is a trademark product of VALENT U.S.A. Corporation. Each treatment required 55 lbs of seed to plant the 3 replication randomized block design. The treatments were applied by producing an 8 ppm solution and varying the volume of this solution that was applied per cwt. of cut seed. For example, to obtain 1 mg of a.i. per cwt, 125 ml of an 8 ppm GA solution was applied per 100 pounds of cut seed. For 2 mg of GA, 250 ml of the 8 ppm solution would be applied and for 4 mg, 500 ml would be applied. The 55 lbs of cut seed was placed into a light industrial cement mixer and the treatment solution was added. Once the seed pieces appeared uniformly wet an arbitrary amount of bark flour was added to absorb any free water. The seed was placed into plastic ventilated trays and allowed to dry. The plot was planted two days after the seed treatment was applied at the Michigan State University, Montcalm Research Farm, Entrican, Michigan on May 18, 2005. On June 16, 2005 stand counts and stem numbers per plant were also recorded. Harvest was conducted on September 14, 2005 and total tuber yield, US#1 yield, and total tuber number for four size categories were recorded (< 1 7/8", Pick-outs, >3 1/4" and 1 7/8" to 3 1/4"), specific gravity, and hollow heart were recorded for each replication.

Results

In 2005, the 1 and 4 mg a.i. treatment for FL1833 showed a reduction in the US#1 yield when compared to the control (Table 1). There was no observed change in average number of stems per hill recorded across the treatments for FL1833. The 2 mg treatment displayed an increase in US#1 and Total yield as well as an increase in the number of "A" sized tubers and total tuber number.

Gibberellic acid increased the number of "B" sized tubers across the FL1879 treatments (Table 1). The 1 and 4 mg treatments exhibited higher numbers of "B" size tubers than the control with the 2 mg treatment exhibiting the highest at 69 tubers when compared to 34 in the control.

GA levels had no influence on yield or tuber number for FL1922. The data in table 1 would appear to indicate that increasing GA levels did increase the average number of stems per hill.

For Michigan Purple, the 1 and 4 mg GA levels most significantly reduced the US#1 and Total yield while increasing the number of "B" sized tubers. The 2 mg a.i./cwt treatment was the most effective at reducing oversize tubers, increasing the number of "A" size tubers (1 7/8" – 3 ¼") and increasing total tuber numbers when compared to the control.

Discussion

In general, gibberellic acid when used as a seed piece treatment results in some degree of variability as to its overall effect. The trend shows that GA does decrease US#1 and Total yield while increasing the number of "A" and "B" sized tubers. Oversize tuber numbers are generally degreased and total tuber numbers increase. The repeatability of these results are not always consistent and the predictability of the effect of GA can not always be controlled. Weather conditions and seed piece age are likely factors to seeing consistent responses to GA. In general, a two mg application of GA (approximately 250 ml of an 8 ppm solution per cwt cut seed) was the optimal treatment to increase the number of stems per hill, increase the number of "A" and "B" size tubers, while not effecting the specific gravity or number of "pick-out" tubers. This treatment was also effective in reducing the number of oversize tubers. The effect of GA on FL1922 appeared to be insignificant, but the reason for this is not understood.

Literature Cited

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Table 1.

Gibberellic Acid Plot Averages for 2005 Field Data

Line	GA Level mg a.i./cwt	US# 1 Yield in CWT/A	Total Yield in CWT/A	Specific Gravity	Tuber Count <1 7/8"	P.O.	> 3 1/4"	1 7/8" - 3 1/4"	Total Tuber Number	Internal* Tuber Defects HH	Average # Stems/Hill
FL1833	0	379 ab	393 ab	1.086	20	0	8 a	146 b	174 b	4.0	2.3
	1	353 b	369 b	1.086	25	0	2 b	163 ab	190 b	2.7	2.6
	2	400 a	422 a	1.086	33	0	6 ab	169 a	208 a	4.7	2.4
	4	354 b	372 ab	1.085	24	1	4 ab	145 b	174 ab	5.0	2.3
LSD		46	51	0.005	15	1	5	23	22	2.9	
FL1879	0	320	347	1.077 b	37 b	0	7	141	185	5.3	3.2
	1	269	303	1.079 a	48 ab	0	0	149	198	4.0	4.3
	2	261	309	1.081 a	69 a	1	0	157	226	2.0	6.1
	4	237	290	1.080 a	65 ab	3	2	137	207	4.0	4.0
LSD		141	148	0.002	30	3	7	72	88	4.0	
FL1922	0	245	279	1.081	44	1	0	129	174	0.0	2.9
	1	224	257	1.082	47	0	0	126	173	0.0	3.2
	2	235	280	1.081	62	0	0	127	189	0.0	3.0
	4	201	248	1.080	62	1	0	121	185	0.0	4.0
LSD		62	73	0.004	28	2	0	1	58	0.0	
MI Purple	0	359 a	388 a	1.071	23 c	5	8 a	145 ab	181 b	0.3	3.5
	1	252 b	293 b	1.070	43 b	5	5 ab	128 b	181 b	0.3	3.7
	2	294 ab	349 ab	1.073	64 a	4	1 b	166 a	236 a	0.0	3.5
	4	253 b	302 b	1.071	47 b	6	4 ab	127 b	185 b	0.0	3.3
LSD		72	71	0.003	13	4	6	29	28	0.9	

* 30 tubers per treatment were evaluated for hollow heart (HH).

Potato Systems Research at MRF and SWMREC

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Summary

A 6-year study of potato systems and soil quality improvement in a sandy soil was implemented in 2001 at 2 locations in Michigan, at the Montcalm Research Farm near Entrican, MI, and at the Southwest Michigan Research Extension Center near Benton Harbor, MI. The crops tested include potatoes grown in rotation with snap beans, sweet corn or wheat with or without one of 3 different cover crops. The three potato-snapbean rotation systems are also split for a poultry manure comparison of soil amendment effects. Objectives of the experiment are to evaluate sustainability, in terms of environmental impact, profitability and biological resilience in the face of a highly variable climate. We are monitoring yield, tuber product quality, fertilizer requirements, nutrient efficiency and soil quality characteristics over time.

Four years of results are providing strong evidence that the use of poultry compost/dried manure in combination with a winter cover crop is a technology that produces consistently higher crop yields, at lower levels of fertilizer (Table 5, Figure 3 and 4). By contrast, crop yield after a winter fallow is generally in decline, and soil is becoming degraded in this bare winter treatment. In three of the four years (2002, 2003 and 2005) winter cover crop treatments were associated with increased yields compared to a bare winter (10 to 18%). Red clover was the most beneficial cover crop, improving soil quality parameters and potato yields, although not in all cases (Figure 3 and 4).

Over four years of our research manure application has not consistently influenced incidence of common scab but we recommend vigilance against any potential disease issues with organic amendments, and the use of scab-resistant varieties. In the disease suppression experiment, the BOKS, there was some evidence that conventional fumigation is similar in potato tuber yield compared to an ultra-biofumigant treatment of sorghum-sudangrass summer cover crop followed by oriental mustard and a winter rye cover crop (e.g., one year of multiple mixtures of biofumigant types of cover crops, to rehabilitate the soil, followed by a potato crop). The yield data and scab rating is shown in Figures 5 and 6. The long-term nature of our trial provides insights into the benefits of a three year rotation compared to a two year. Disease is suppressed after legume cover crops, and in three year rotation systems, compared to two year. Potato tuber yields and sweet corn yields were always highest in three-year rotation sequences compared to any of the two-year potato rotations tested.

In 2004 all cover crop treatments tended to be associated with tuber yield reductions compared to a bare winter fallow. This may be related to a cold, wet spring which could have reduced nitrogen availability from organic sources at a critical point in time. Over the long-term we are testing if this immobilization of nitrogen in cold springs can be minimized by enhancing soil biology. Our research in 2006 will continue (funded by other sources) and we hope to provide insights for the industry regarding which practices of combining cover crops, manure and reduced fertilizer rates provide the maximum nutrient synchrony while supporting crop demand and high quality tuber yields. A top priority of Snapp's program in 2006 is to develop practical tools and nitrogen prediction methods that can be used by private and public labs as well as directly by farmers and advisors to improve management of organic nutrient sources.

Methods

Field Experiments: A 6-year trial was initiated in 2001 at the Montcalm Research Farm (MRF) in Entrican, MI and at the Southwest Michigan Research and Extension Center (SWMREC) near Benton Harbor, MI. Both sites have well-drained, loamy sand to sandy loam soils that are common soil types used to produce a wide range of vegetable crops in Michigan. At MRF, the soil is a Montcalm/McBride loamy sand and at SWMREC the soil is an Oakville series fine sand transition to loamy sand (Table 1.). The two sites provide information about performance under a vegetable and potato production environment at a southern Michigan location with a warmer spring, and a cooler central Michigan location.

Table 1. Soil texture and chemical properties for 0-8" depth at the Montcalm Research Farm plot

Organic C, %	Average	1.5
	Range	0.4 – 3.6
Texture, % sand	Average	78
	Range	63 - 89
Calcium, ppm	Average	388
	Range	200 - 1000

The trial includes seven 2-year potato rotations and one 3-year rotation system with 3 cover crop options (see Table 2).

Table 2. Rotation, cover crop and compost treatments used in long-term potato rotation experiment at Montcalm Research Farm and SWMREC

		Rotation	Cover Crop	Manure
1.	2Y	Potato / Snap Bean	Bare (no cover crop)	+ or - manure
2.	2Y	Potato / Snap Bean	Rye	+ or - manure
3.	2Y	Potato / Snap Bean	Rye + Hairy Vetch	+ or - manure
4.	2Y	Potato / Corn	Rye after Potatoes, Bare after Corn	
5.	2Y	Potato / Corn	Rye + Hairy Vetch	
6.	2Y	Potato / Wheat	Wheat after Potatoes, Rye after Wheat	
7.	2Y	Potato / Wheat	Wheat + Red Clover (frost seeded clover)	
8.	3Y	Potato / Corn / Wheat	Rye+Hairy Vetch or Wheat+Clover	

Rotation treatment 1 represents a worst-case system where soil is left bare after potato harvest. Treatment 8 is included as a best-case option with a 3 year rotation using less tillage and cereal+legume cover crops. Rotation treatments 2, 4 and 6 represent commonly used rotations and winter cover crops or winter cash crop for Michigan potato growers, whereas rotations 3, 5 and 7 represent alternative systems which evaluate the effect of legume cover crops.

Three snap bean rotation treatments 1,2 and 3 were split for a poultry manure treatment comparison. Dry, partially composted poultry manure is applied annually to split plots at 2.5 T / acre in the spring before planting. Principle crops and cover crops were planted with standard commercial equipment. Varieties used are listed in Table 3. Fertilizer was applied to potato plots at the recommended rate of 180 lb N/acre, reduced in the case of manured and cover crop treatments as N fertilizers were adjusted to compensate for nitrogen applied with organic amendments, following recommended practice. Fertilizer was reduced by 50 lbs. N/acre in manured treatments due to a credit based on nitrogen availability for manure application, 10 lbs. N/acre was credited for a rye cover crop, and 30 lbs. N/acre was credited for a rye+vetch cover crop. Plots were irrigated as needed. Cover crops were planted after principle crops were harvested in the fall except for red clover which was frost-seeded into wheat in the spring. Standard pest and weed control measures were used throughout the growing season.

Table 3. Varieties of cash crops and cover crops used in long-term rotation experiment at SWMREC

Crop	Variety
Potato	Snowden
Snap Bean	HiStyle
Sweet Corn	Jackpot
Wheat	Caledonia
Rye	Wheeler
Hairy Vetch	Common
Red Clover	Mammoth

Soil Results

Soil nitrogen supply capacity has increased in treatments with added organic amendments, as shown in Table 4 below.

Table 4. The influence of cover crop systems and manure on soil characteristics

Winter Cover crop		NO_3 (0-20cm) Mean (mg/g dry soil)	SD	NO_3 (20-50cm) Mean (mg/g dry soil)	SD	30d NMP (0-20cm) Mean (mg/g dry soil/d)	SD
Bare	- Manure	7.24	2.81	3.54	0.50	0.13	0.05
	+ Manure	7.59	1.89	3.40	0.61	0.21	0.04
Rye	- Manure	7.28	2.13	4.16	1.20	0.20	0.04
	+ Manure	7.16	1.25	3.99	1.03	0.23	0.15
Rye+Vetch	- Manure	6.40	2.54	3.54	0.51	0.25	0.08
	+ Manure	9.30	3.71	4.31	1.23	0.23	0.05
Clover	- Manure	7.57	1.55	3.51	0.83	0.30	0.11

Table 5. Average total potato tuber yields in 2004 at MRF and SWMREC.			
System	*US#1 Yield*	*B Yield*	*% Scab*
S bean – bare – potato	238	21	31
S bean – rye - potato	205	13	49
S corn – rye - potato	197	20	42
Wheat – rye - potato	228	21	55
Wheat/red clv - potato	187	17	41
S bean – MIX - potato	178	16	43
S corn – MIX - potato	204	16	38
Three year rotation	236	15	17
P-value	0.04	0.13	0.005

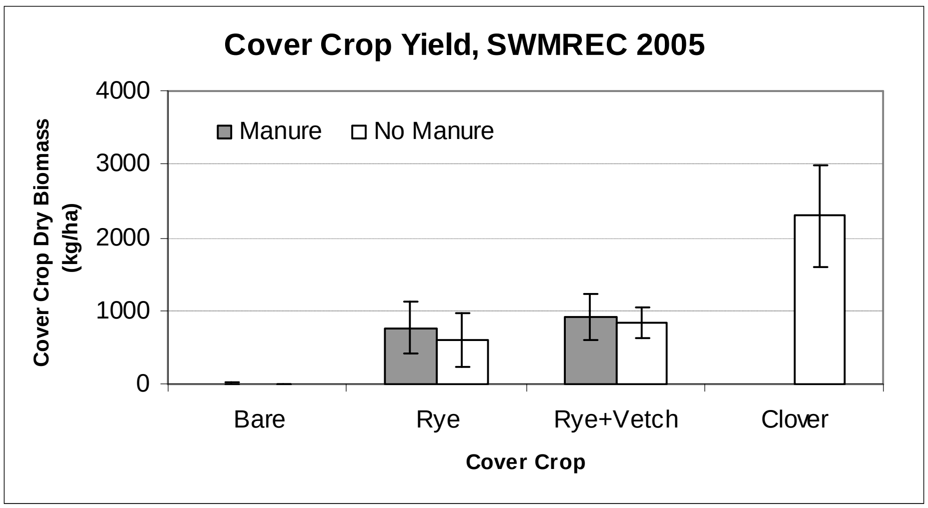

Figure 1. Cover crop biomass yield (kg/ha) by system, SWMREC site.

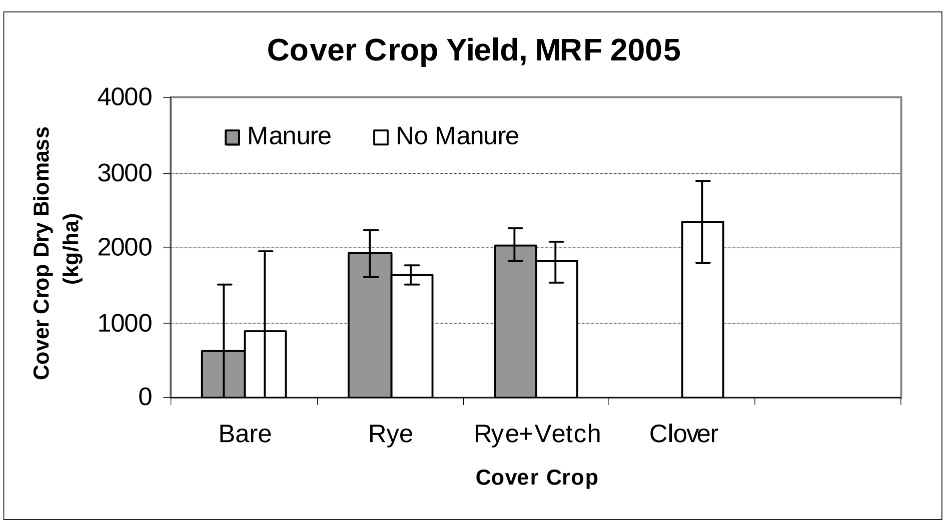

Figure 2. Cover crop biomass yield (kg/ha) by system, MRF site.

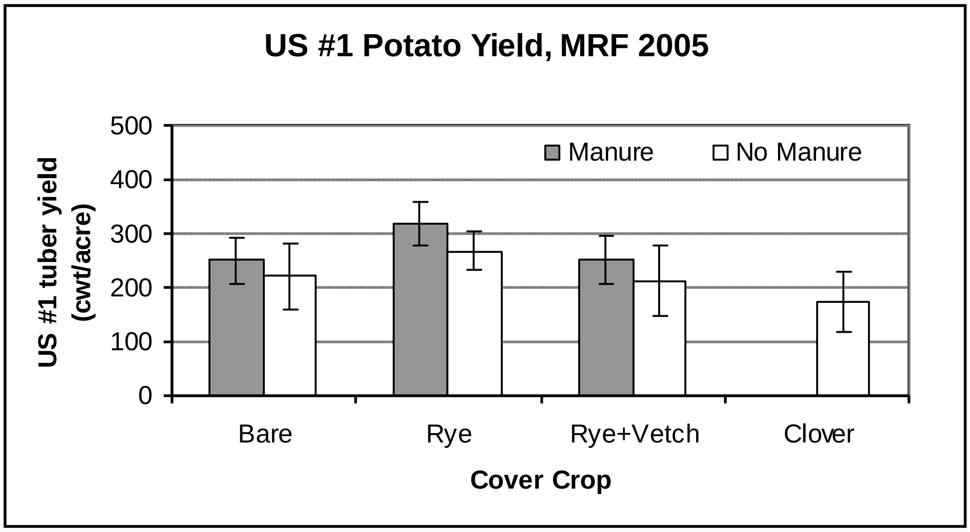

Figure 3. US No. 1 tuber yield (cwt/acre) at MRF in 2005 by poultry manure and cover crop treatment from long-term soil quality rotation trial.

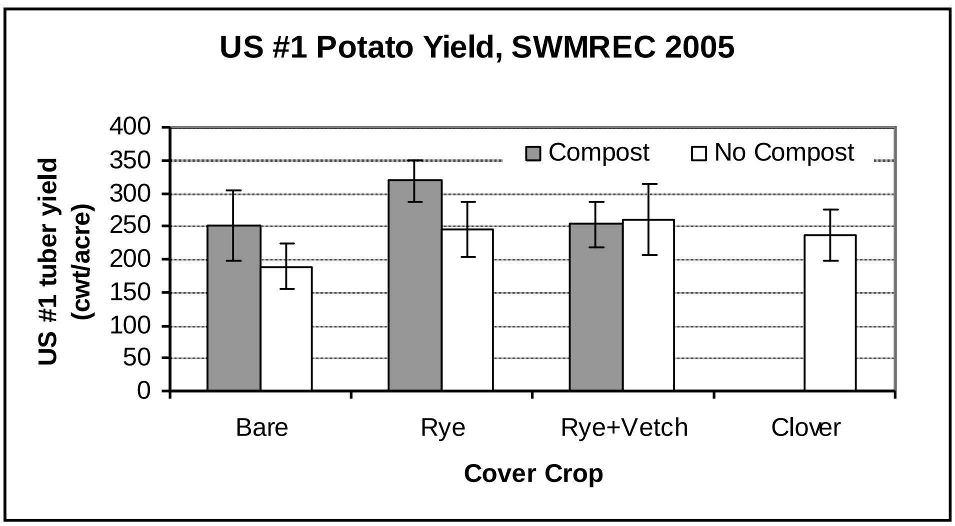

Figure 4. US No. 1 tuber yield (cwt/acre) at SWMREC in 2005 by poultry compost and cover crop treatment from long-term soil quality rotation trial.

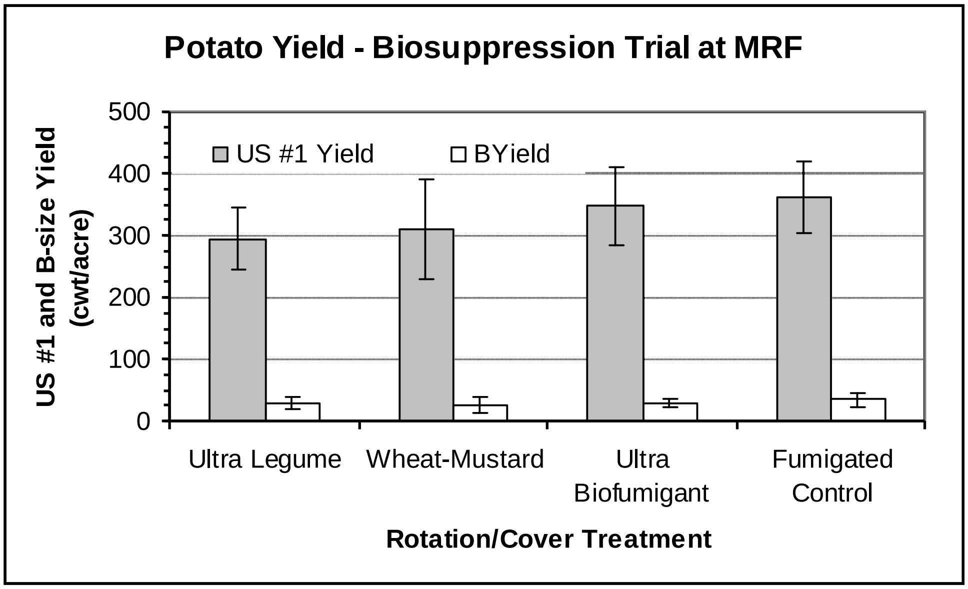

Figure 5. Potato yield of Atlantic variety in the BOKS biosuppression trial at MRF, 2005. The comparison is between a fumigated wheat potato rotation and a wheat followed by oriental mustard fall-rye winter cover crop, a sudex summer cover crop followed by oriental mustard/rye winter cover crop (ultrabiofumigant), and a forage soybean followed by a hairy vetch/rye winter cover crop.

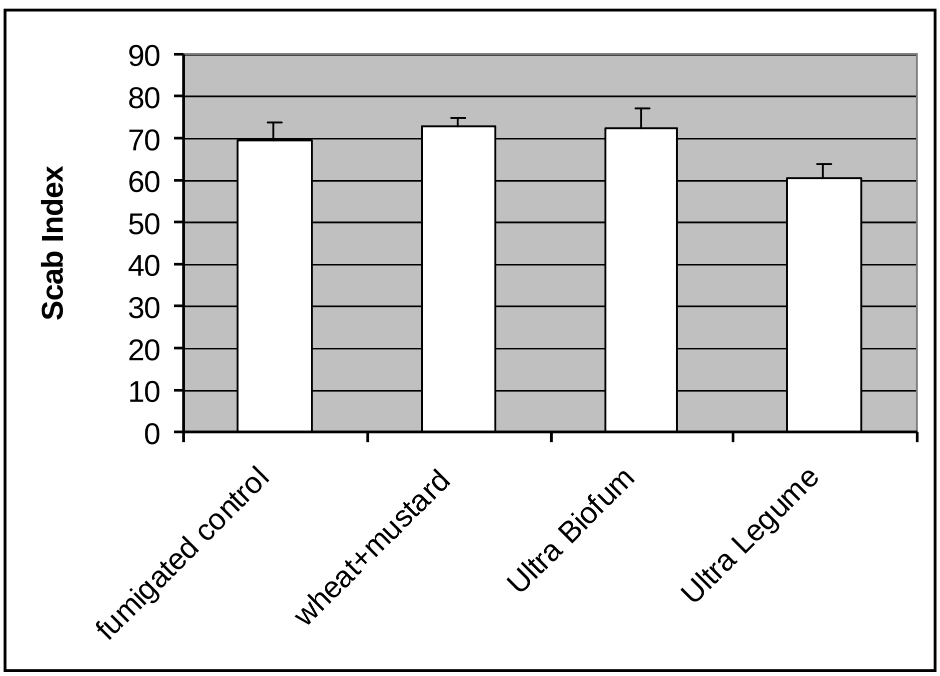

Figure 6. Scab rating of Atlantic tubers in the BOKS biosuppression trial at MRF, 2005. The comparison is between a fumigated wheat potato rotation and a wheat followed by oriental mustard fall-rye winter cover crop, a sudex summer cover crop followed by oriental mustard/rye winter cover crop (ultrabiofumigant), and a forage soybean followed by a hairy vetch/rye winter cover crop.

Funding: MPIC

Evaluation of seed piece fungicides for control of seed-transmitted *Fusarium* dry rot of potatoes

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INTRODUCTION

Fusarium dry rot is one of the most important diseases of potato, affecting tubers in storage and seed tubers after planting. *Fusarium sambucinum* is the most common pathogen causing dry rot of stored tubers in North America. *Fusarium* dry rot of seed can reduce crop establishment through its ability to destroy developing potato sprouts, and crop losses can be up to 25%, while greater than 60% of tubers can be infected in storage. All the commonly grown potato varieties in North America are susceptible to the pathogen, although some are more tolerant than others.

There are two main opportunities in the potato crop cycle for the control of Fusarium dry rot. The first is the post-harvest control of seed piece decay in the seed crop in the fall and the second is the control of seed piece decay and sprout infection prior to planting of the commercial crop in the spring. In crops intended to be used as seed for the following season, the dry rot pathogen enters tubers mainly through wounds produced during harvest and transportation. The first symptoms of dry rot are usually dark depressions on the surface of the tuber and as lesions increase in size, the skin becomes wrinkled in concentric rings as the underlying dead tissue desiccates. Clumps of fungal mycelium and white or pink pustules containing spores may emerge through the dead skin. Potato seed tubers are maintained at 37^{o}F in storage which is approximately the temperature at which *F. sambucinum* is dormant and consequently there is minimal development of dry rot in storage. During the pre-planting phase of potato production seed tubers are warmed to about 54^{o}F then cut into seed-pieces prior to planting. Tubers infected with *F. sambucinum* are particularly susceptible to the development of seed piece decay during this phase and in severe disease cases seed pieces may completely rot before planting. Alternatively after planting, over 50% of sprouts developing on infected tubers may become diseased and may be killed outright before emergence. Damage at this stage results in delayed emergence and is usually expressed as poor and uneven stands with weakened plants. Reduction in crop vigor then results from expenditure of seed energy used to produce secondary or tertiary sprouts to compensate for damage to primary sprouts. During recent seasons in the potato growing regions of the mid-western states of the US, three factors have enhanced dry rot problems; 1) lack of information on effective fungicides for both post-harvest and pre-planting use against *F. sambucinum*; 2) an increase in the area of potatoes grown by fewer growers leading to management issues such as timing of pre-cutting of seed; 3) climatic factors such as increased frequencies of precipitation events during the planting phase of the season. In combination, these factors can delay planting and increase the impact of dry rot during the early portion of the growing season and subsequently may effect yield and quality of the crop.

There is little information on the use and effectiveness of seed treatments for control of Fusarium seed piece decay, the pre-planting phase of dry rot, and sprout rot, the post-planting phase of the disease. Much of the research that has been carried out on the use of seed treatments for control of seed-borne *Fusarium* was conducted in Europe during the latter part of the 20th century. Thus, the objectives of this investigation were two-fold. First, to evaluate *in vitro* the effectiveness of fungicidal seed treatments applied at various times prior to planting for controlling *Fusarium* seed piece decay and sprout rot. Second, *in vivo* field experiments to evaluate the agronomical effects of fungicidal seed treatments applied at various times prior to planting on crop health.

MATERIALS AND METHODS

Chip processing potato varieties “Pike” and “FL1879” were used in all experiments. Whole tubers were harvested from certified seed crops grown in northern Michigan. Tubers free from signs and symptoms of Fusarium dry rot (and other diseases) were selected for the experiments. The tubers were stored in the dark at 37^{o}F and 95% RH until used in the spring of the following year. For each treatment timing, tubers were removed from storage and warmed to 46^{o}F in the dark in controlled environment chambers with forced air ventilation at 5950 l min^{-1} for 10 days prior to the treatment. Whole tubers were cut in half with a sterile knife and the cut surfaces of the pieces (160 per treatment) were spray inoculated with 7 fl. oz. of a *F. sambucinum* conidial suspension to give a final dosage of about 1 ml per tuber. Fungicidal seed treatments were applied about 30 minutes after inoculation (described below). Tubers were inoculated and treated (as described below) 10, 5 and 2 days prior to planting. After inoculation and treatment, the seed pieces were placed in sterilized plastic crates and returned to controlled environment chambers set at 46^{o}F (in the dark), with forced air ventilation at 210 ft^{3} min^{-1} until planting.

Potato seed pieces were inoculated as described above and treated 30 minutes later with fungicidal seed treatments 10, 5 or 2 days prior to planting. Controls included 1) non-inoculated/ non-treated tubers (negative control) and 2) inoculated/non-treated tubers (positive control). Seed was treated with Maxim® MZ (fludioxonil 0.08 oz lb^{-1} + mancozeb 0.9 oz lb^{-1}) at the manufacturers recommended rate (0.5 lbs per 100 lbs. potato seed). Dust formulations of seed treatments were measured and added to cut seed pieces in a Gustafson revolving drum seed treater and mixed for two minutes to ensure even spread of the fungicide.

To evaluate the effect of seed treatment on the development of dry rot on the seed pieces and its effect on sprout health, samples from each treatment were incubated at 46^{o}F (95% RH) in controlled environment chambers for 14 days after the scheduled time of planting. The total number of healthy and dry rot affected sprouts was calculated. Development of dry rot on the seed piece was subjectively estimated as percent decay by comparing depth of penetration of darkening through the tuber after cutting four transverse sections through the seed piece. The treated seed tuber samples were held in storage post-treatment for 24, 19 and 16 days (10, 5 and 2 days pre-planting treatments, respectively). The experiment was carried out in 2002 and repeated in 2003.

In both years, the treated seed-pieces were planted at the Michigan State University Montcalm Potato Research Farm, Edmore, MI into single-row by 30 ft plots (ca. 9 in between plants to give a target population of 40 plants at 34 in row spacing) replicated four times in a randomized complete block design. Fertilizer was formulated according to results of soil tests and drilled into plots before planting. Additional nitrogen was applied to the growing crop with irrigation 45 days after planting (DAP). The fungicide Bravo WS 6SC® (active ingredient: chlorothalonil) was applied at manufacturers recommended rates on a seven-day interval (eight applications), starting when the canopy was about 50% closed. A permanent irrigation system was established prior to the commencement of fungicide sprays and the fields were maintained at soil moisture capacity throughout the season by frequent (minimum 5 day) irrigations. Weeds were controlled by hilling and with the herbicides metolachlor (Dual 8E®) 10 DAP, and sethoxydim (Poast®) 40 DAP. Insects were controlled with the insecticides imidacloprid (Admire 2F®) at planting, carbaryl (Sevin 80S®) at 31 and 55 DAP, endosulfan (Thiodan 3

EC®) at 65 and 87 DAP, and permethrin (Pounce 3.2EC®) 48 DAP. The experiment was carried out in 2002 and repeated in 2003.

Data from the experiments carried out in 2002 were analyzed separately from those carried out in 2003. Four way analyses of variance were run for all combinations of treatments common to the two varieties, i.e. variety, presence of seed treatment, timing of treatment and presence of inoculum. Emergence was rated as the cumulative number of plants breaking the soil surface or fully emerged after planting. The rate of emergence was estimated as the area under the plant emergence curve (RAUEPC; max=100). The number of emerged plants was recorded over a 22 day period after planting and the relative area under the emergence progress curve (RAUEPC) was calculated. The relative area under the emergence progress curve (RAUEPC) was calculated by modification of the method used to calculate the relative area under the disease progress curve RAUDPC. As plant emergence was assessed at various time intervals, the area under emergence progress curve (AUEPC) was calculated by adding the area under the linear progression of the number of emerged plants between consecutive estimations of emergence from planting to full emergence. The RAUEPC was calculated by dividing the sum of individual AUEPC values by the maximum AUEPC (100 × duration of emergence period, from planting to full emergence). The rate of canopy development was measured as the relative area under the canopy closure curve (RAUCCC), calculated from day of planting to a key reference point taken as 58 DAP (about 100% canopy closure; max = 100). RAUCCC was calculated by modification of the method used to calculate RAUEPC as described above. Treatment means were compared using the Tukey Multiple Comparison test in JMP ($P = 0.05$).

RESULTS AND DISCUSSION

In the current study, overall there was no significant effect of dry rot on the mean number of sprouts per tuber even though inoculation of seed pieces with *F. sambucinum* caused disease in up to 60% of sprouts on untreated infected tubers (Fig 1). Treatment of infected seed pieces with Maxim MZ at 10, 5 or 2 days before planting significantly reduced the percentage of diseased sprouts per tuber (Fig. 2). This effect was much more pronounced in 2003 than in 2002 even though there was more disease pressure in 2003. Levels of seed piece decay were also almost twice as high in 2003 than in 2002 and again seed treatment with Maxim MZ provided very effective control of the disease (Fig. 3). On the whole, there was no appreciable difference among seed treatment timings in both years although in 2002, seed treatment with Maxim MZ appeared to provide slightly better control of dry rot of sprouts in “Pike” than in “FL1879”.

The application of seed treatments to infected seed appreciably enhanced emergence of sprouts, rate of canopy closure and the final plant stand in 2003. The fact that dry rot in general did not have an effect on the mean number of sprouts per tuber, the high numbers of diseased sprouts and decreased rate of emergence in the positive control suggests that sprouts were becoming infected and killed prior to emerging from the soil. This indicates that the seed treatment not only prevented seed piece decay but also protected the developing sprouts from infection. In 2002, there were no significant differences in the rate of emergence, rate of canopy closure or the final plant stand among treatments. This suggests that the seed pieces were able to compensate for the loss of sprouts by stimulating the development of dormant sprouts. The slower rate of emergence in 2003 may have enabled the fungus to become better established and kill more developing sprouts in the positive controls. A reduction in the rate of emergence would then have a negative effect on the rate of canopy control and final plant stand.

Some level of *Fusarium* dry rot is almost always present in commercially available seed. Even though it is not possible at present to be 100% sure that a seed lot is completely free of dry rot, it is sensible to plant seed that meets established seed certification standards. Although it may not seem cost effective to apply seed treatments to healthy seed, these results suggest that applying a seed treatment up to 10 days prior to planting can provide effective control of dry rot and increase rate of emergence, rate of canopy closure and final plant stand.

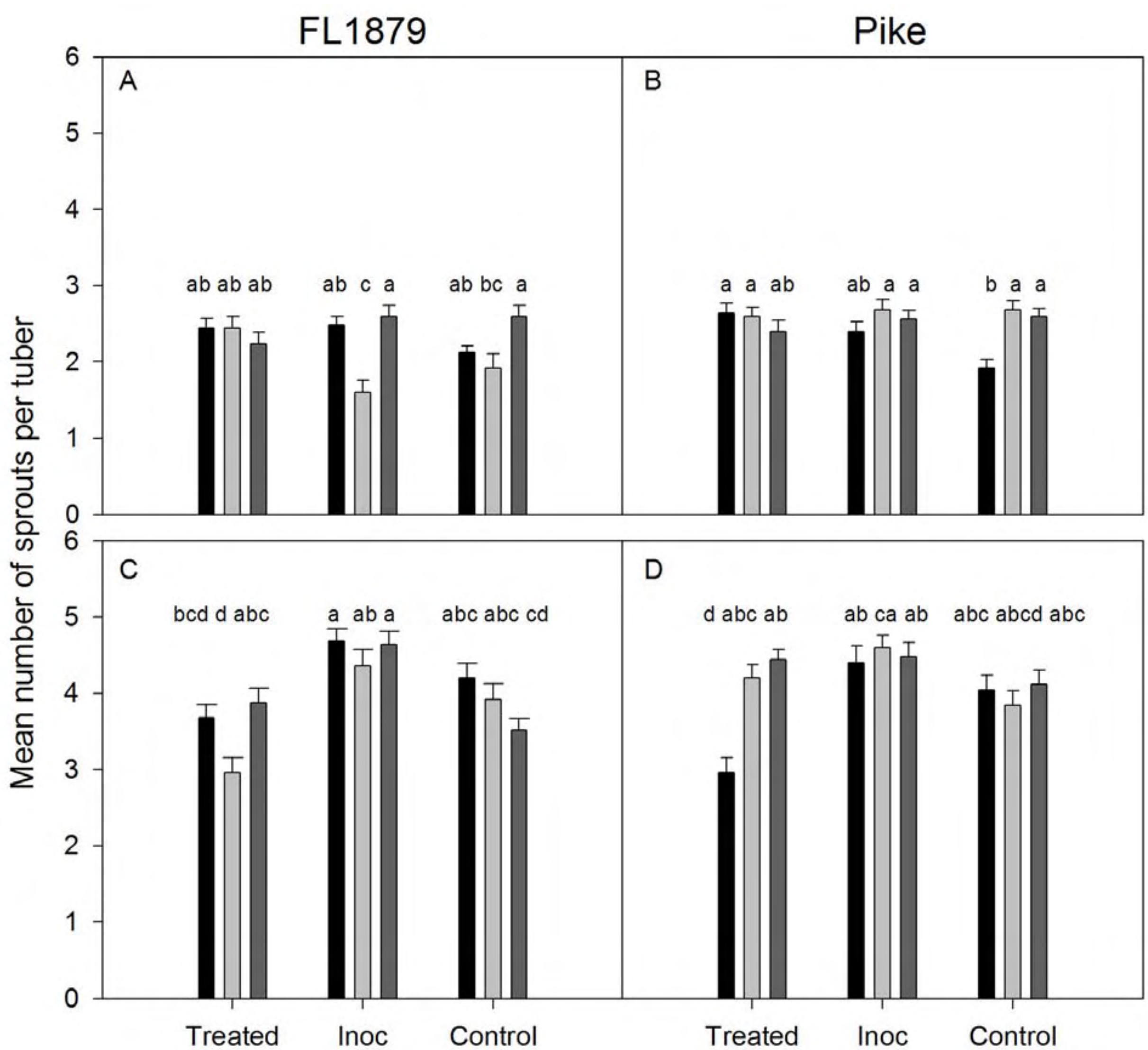

Figure 1. Mean number of developing sprouts per seed tuber from *in vitro* dry rot experiments carried out in 2002 (A and B) and 2003 (C and D). In each year, columns with the same letter are NSD $\alpha = 0.05$ (Tukey). Bars represent the standard error of the mean. ■ Treatment applied 2 days before planting. ■ Treatment applied 5 days before planting. ■ Treatment applied 10 days before planting. Treated: fungicide treated seed; Inoc: seed inoculated but not treated; Control: seed non-inoculated, non-treated.

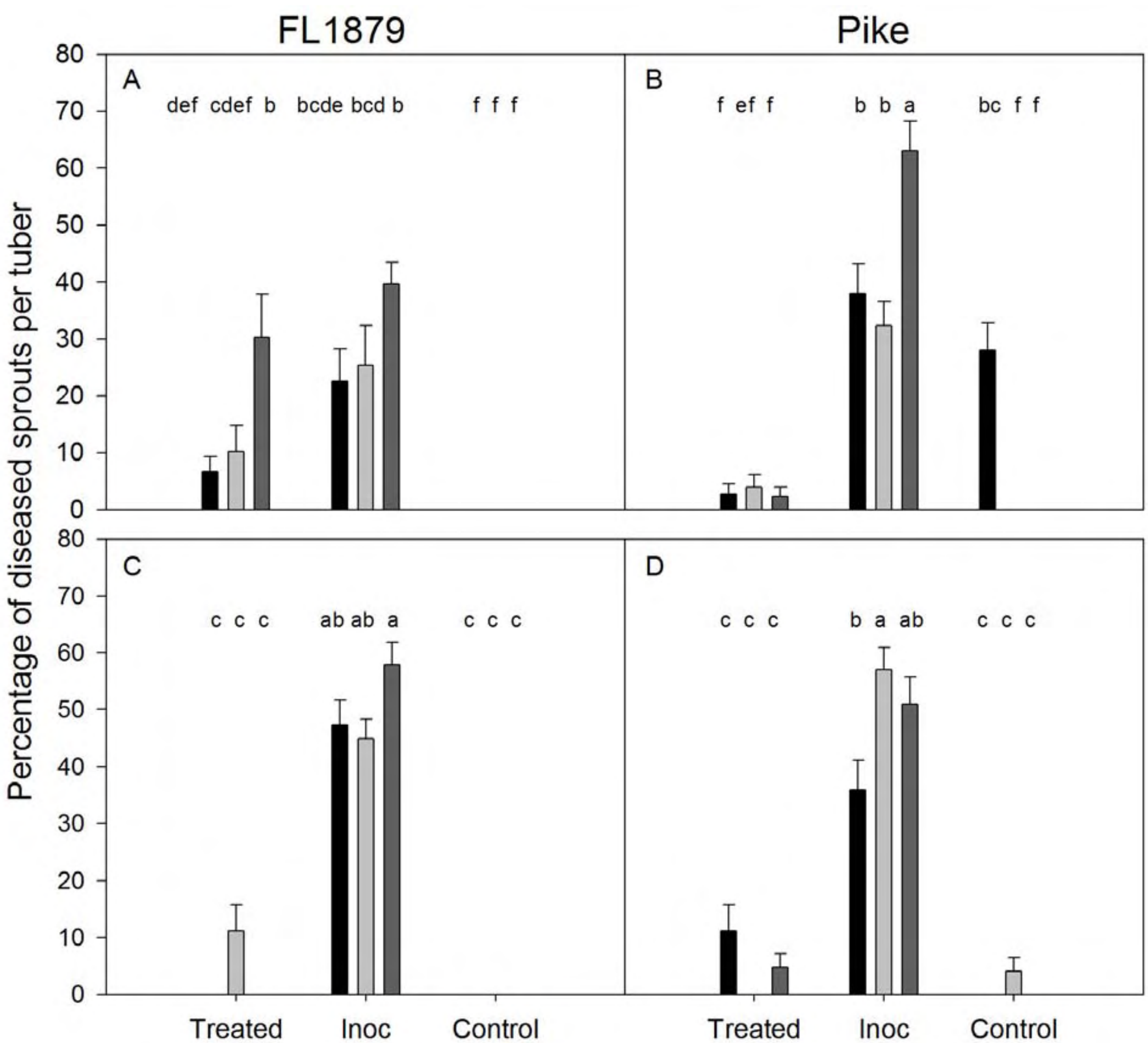

Figure 2. The percentage of diseased sprouts per seed tuber from *in vitro* dry rot experiments carried out in 2002 (A and B) and 2003 (C and D). In each year, columns with the same letter are NSD $\alpha = 0.05$ (Tukey). Bars represent the standard error of the mean. ■ Treatment applied 2 days before planting. ■ Treatment applied 5 days before planting. ■ Treatment applied 10 days before planting. Treated: fungicide treated seed; Inoc: seed inoculated but not treated; Control: seed non-inoculated, non-treated.

Funding: MPIC

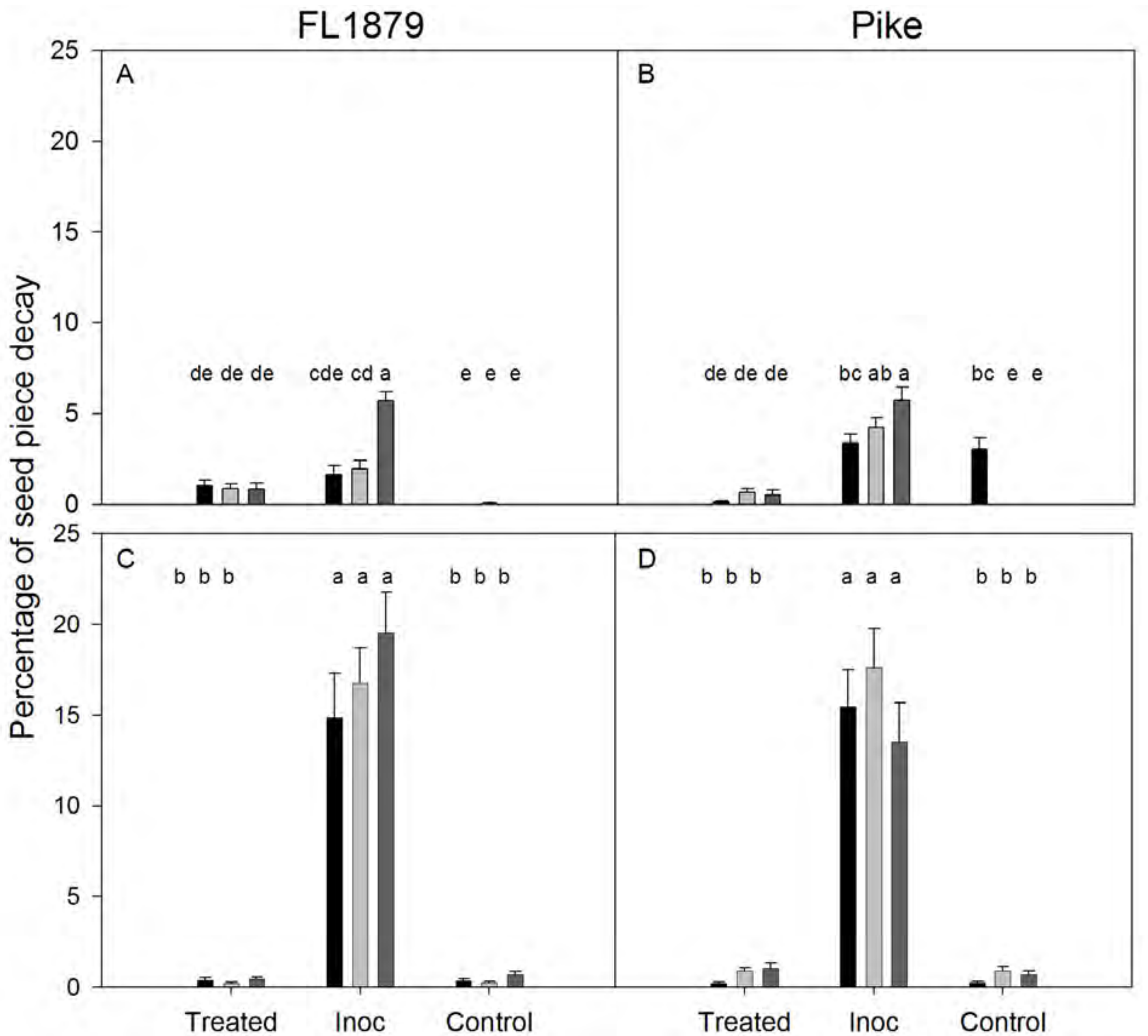

Figure 3. The percentage of seed piece decay in tubers from *in vitro* dry rot experiments carried out in 2002 (A and B) and 2003 (C and D). In each year, columns with the same letter are NSD α = 0.05 (Tukey). Bars represent the standard error of the mean. ■ Treatment applied 2 days before planting. ■ Treatment applied 5 days before planting. ■ Treatment applied 10 days before planting. Treated: fungicide treated seed; Inoc: seed inoculated but not treated; Control: seed non-inoculated, non-treated.

Funding; MPIC

In-furrow at planting treatments for control of common scab in potato, 2005.

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Potato seed, 'Michigan Purple' and "FL1879" was prepared for planting by cutting seven days prior to planting. Seed were planted at the Michigan State University Crop and Soil Science Farm, East Lansing, MI on 29 Jun 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. The two-row beds were separated by a five-foot unplanted row. In-furrow applications were made immediately ahead of seed at planting, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 p.s.i.) and using one XR11003VS nozzle 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 was applied at 1.5 pt/A on a seven day interval, total of 8 applications, starting after the canopy was about 50% closed. No supplemental irrigation was applied to the trial. Weeds were controlled by hilling 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. Emergence was rated as the number of plants breaking the soil surface or fully emerged after planting. The rate of emergence was estimated as the area under the plant emergence curve (max=100) from the day of planting until 29 days after planting. The rate of canopy development was measured as the RAUCPC, relative area under the canopy development curve, calculated from day of planting to a key reference point taken as 49 DAP (about 100% canopy closure), (max = 100). Vines were killed with Reglone 2EC (1 pt/A on 2 Sep). Plots (25-ft row) were harvested on 29 Oct and individual treatments were weighed and graded. Samples of 200 tubers per plot were harvested 14 days after desiccation (approximately 135 DAP). Tubers were washed and assessed for common scab (*S. scabies*) incidence (%) and severity 40 days after harvest. Severity of common scab was measured as an index calculated by counting the number of tubers (n = 200) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >16% surface area of tuber covered with tuber lesions (surface and pitted). The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with lesions.

The analysis of the main effects indicated that Michigan Purple and FL1879 were significantly different in incidence and severity of common scab and yield. There was a significant difference among treatments on incidence of common scab and yield but not on severity of common scab (Table 1). The varieties were analyzed separately (Table 2). In FL1879, both rates of Blocker significantly reduced the incidence and but not the severity of common scab (Table 2). There were no differences among treatments in terms of incidence or severity of common scab in Michigan Purple (Table 2). Blocker 10 pt/A significantly increased marketable (US1) yield in comparison with Blocker 5 pt/A and the non-treated control which were not significantly different in FL1879 (Table 2). Both rates of Blocker increased marketable and total yield in comparison with the non-treated control but there were no differences between the two rates of Blocker (Table 2). No phytotoxicity was observed in this trial.

Funding; MPIC

Table 1. Main effects of variety and fungicide in-furrow at-planting application on incidence and severity of common scab and yield in two potato cultivars.

Source of variation		Prob > F			
	DF	% scab free	scab index	US1	total
Variety	1	<.0001	0.0224	<.0001	<.0001
Fungicide treatment	2	<.0001	0.5868	0.0002	0.0002
Interaction	2	0.0306	0.2445	0.0672	0.0413

Table 2. Efficacy of in-furrow at-planting fungicide application of Blocker on incidence and severity of common scab and yield in two potato cultivars.

		Common scab incidence and severity						Yield (cwt/A)					
Variety	treatment rate/A	% scab free			scab index			US1			total		
		mean	se		mean	se		mean	se		mean	se	
FL1879	Blocker 10 pt (A)	34.7	3.5	a[y]	45.4	10.2	a	374.4	3.3	a	381.3	2.8	a
	Blocker 5 pt(A)	33.3	3.5	a	53.0	7.3	a	332.8	8.1	b	340.3	9.1	b
	Untreated	2.7	2.7	b	36.2	1.8	a	316.8	13.9	b	330.1	9.8	b
HSDp=0.05					31.8								
Michigan Purple	Blocker 10 pt(A)	50.0	1.2	a	28.8	2.4	a	232.0	26.3	a	241.1	25.5	a
	Blocker 5 pt(A)	41.3	5.3	a	30.8	4.4	a	201.1	7.9	a	207.5	6.6	a
	Untreated	33.3	4.8	a	35.3	6.7	a	115.7	14.2	b	125.9	14.8	b
HSDp=0.05[x]		18.21				20.95							

[z] Application dates: A= 15 May.

[y] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

[x] $HSD_{p=0.05}$ included if no significant difference among mean values.

Funding: Industry and MPIC

Pre-planting application of chloropicrin and in-furrow at planting treatments of Blocker for control of common scab in potato, 2005.

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Potato seed, FL1879 and Snowden was planted at the Michigan State University Montcalm Potato Research Farm, Edmore, MI on 15 May into eight-row by 50-ft plots (ca. 9-in. between plants at 34-in. row spacing) replicated four times in a randomized complete block design. 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). Plots were irrigated to supplement precipitation to about 0.5 in. /A/7 day period with overhead pivot irrigation. Bravo WS 6SC was applied at 1.5 pt/A, 25 gal/A (80 p.s.i.) using three XR11003VS nozzles per row on a seven-day interval (eight applications), starting after the canopy was about 50% closed. Chloropicrin was applied as Pic Plus Fumigant 85.5% active ingredient into pre-made rows 30 days prior to planting when soil temperature reached 45^{o}F. In-furrow applications of Blocker were made immediately ahead of seed at planting, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 p.s.i.) and using one XR11003VS nozzle per row. Bravo WS 6SC was applied at 1.5 pt/A on a seven day interval, total of 8 applications, starting after the canopy was about 50% closed. Weeds were controlled by hilling and with Dual 8E at 2 pt/A 10 DAP, and Poast at 1.5 pt/A 40 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Pounce 3.2EC at 8 oz/A 48 DAP, Sevin 80S at 1.25 lb/A 55 DAP and Thiodan 3 EC at 2.33 pt/A 65 DAP. Emergence was rated as the number of plants breaking the soil surface or fully emerged after planting. The rate of emergence was estimated as the area under the plant emergence curve (max=100) from the day of planting until 29 days after planting. The rate of canopy development was measured as the RAUCPC, relative area under the canopy development curve, calculated from day of planting to a key reference point taken as 49 DAP (about 100% canopy closure), (max = 100). Vines were killed with Reglone 2EC (1 pt/A on 2 Sep). Plots (8 x 50-ft row) were harvested on 29 Sep and individual treatments were weighed and graded. Samples of 200 tubers per plot were harvested 14 days after desiccation (approximately 135 DAP). Tubers were washed and assessed for common scab (*S. scabies*) incidence (%) and severity 40 days after harvest. Severity of common scab was measured as an index calculated by counting the number of tubers (n = 200) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >16% surface area of tuber covered with tuber lesions (surface and pitted). The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with lesions. Maximum and minimum air temperature (^{o}F) were 82.6 and 24.0 (May), 91.2 and 46.1 (Jun), 89.7 and 43.4 (Jul), 90.3 and 47.5 (Aug), 89.9 and 41.0 (Sep) and 84.1 and 23.6 (Oct). Maximum and minimum relative humidity (%) was 100 and 18.4 (May), 99.1 and 13.8 (Jun), 99.4 and 24.2 (Jul), 99.5 and 31.2 (Aug), 99.7 and 23.2 (Sep) and 99.7 and 33.9 (Oct). Maximum and minimum soil temperature (^{o}F) were 76.0 and 38.3 (May), 87.3 and 58.2 (Jun), 83.1 and 58.6 (Jul), 83.0 and 59.5 (Aug), 76.3 and 52.4 (Sep) and 70.3 and 42.3 (Oct). Maximum and minimum soil moisture (% of field capacity) was 17.5 and 11.1 (May), 22.5 and 8.4 (Jun); 26.0 and 13.1 (Jul), 19.1 and 12.8 (Aug), 24.0 and 8.4 (Sep) and 16.2 and 10.3 (Oct). Precipitation was 1.39 in. (May), 3.57 in. (Jun), 3.65 in. (Jul), 1.85 in. (Aug), 3.90 in. (Sep) and 0.33 in. (Oct).

There was no significant difference among treatments on emergence or rate of canopy closure. The analysis of the main effects indicated that there was no significant difference among varieties tested on incidence and severity of common scab and yield but that there was a significant difference caused by the soil applied treatments on incidence and severity of common scab but not yield (Table 1). All treatments had significantly lower incidence of common scab in comparison with the non-treated control in both varieties in both varieties (Table 2). Treatments with scab indices from 6.3 to 10.6, 9.1 to 15.6 and 15,6 to 20.1 were not significantly different. There was no significant difference among treatments on marketable or total yield (Table 2). No phytotoxicity was observed in this trial.

Funding: Industry and MPIC

Table 1. Main effects of variety and fungicide in-furrow at-planting application on incidence and severity of common scab and yield in two potato cultivars.

Source of variation	Prob > F			
	% scab free	scab index[z]	US1	total
Variety	0.7183	0.1364	0.2829	0.0728
Fungicide treatment	<.0001	<.0001	0.2868	0.2543
Interaction	0.6544	0.2654	0.3493	0.3307

[z] Severity of common scab was measured as an index calculated by counting the number of tubers (n = 200) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >16% surface area of tuber covered with tuber lesions (surface and pitted). The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with lesions.

Table 2. Efficacy of in-furrow at-planting fungicide application of Blocker on incidence and severity of common scab and yield in two potato cultivars.

		Common scab incidence and severity						Yield (cwt/A)					
Variety	treatment rate/A	% scab free			scab index[z]			US1			total		
		mean	se		mean	se		mean	se		mean	se	
FL1879	Blocker 10 pt (B[y])	78.8	2.50	a[x]	9.3	1.05	bc	297.4	28.18	a	336.2	27.23	a
	Chloropicrin 100 lb (A)	84.0	5.10	a	6.4	2.42	c	221.7	47.61	a	256.9	52.87	a
	Chloropicrin 80 lb (A)	81.8	4.01	a	8.1	1.73	c	298.3	41.45	a	332.6	40.18	a
	Untreated	60.4	2.41	b	15.6	0.56	ab	271.3	30.07	a	307.3	26.05	a
Snowden	Blocker 10 pt (B)	77.0	1.29	a	10.6	1.18	bc	300.1	27.39	a	368.6	26.22	a
	Chloropicrin 100 lb (A)	80.5	1.26	a	9.2	0.62	bc	315.4	28.71	a	371.3	30.27	a
	Chloropicrin 80 lb (A)	86.3	2.10	a	6.3	0.87	c	340.7	41.54	a	390.2	42.99	a
	Untreated	57.5	6.08	b	20.1	2.59	a	241.5	29.54	a	290.2	26.43	a
HSDp=0.05[w]								147.8			148.1		

[z] Severity of common scab was measured as an index calculated by counting the number of tubers (n = 200) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >16% surface area of tuber covered with tuber lesions (surface and pitted). The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with lesions.

[y] Application dates: A= 16 Apr; B= 15 May.

[x] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison). Varieties were analyzed together as there was no significant difference between varieties in incidence or severity of common scab.

[w] $HSD_{p=0.05}$ included if no significant difference among mean values.

Funding: MPIC and Bayer UK

The importance of competition and host plant resistance on selection of *Phytophthora infestans* populations in Michigan and Northern Ireland

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Introduction

Late blight caused by the oomycete *Phytophthora infestans* remains a major threat to potato production worldwide. Since the 1970s separate migrations, presumably from Mexico, have led to the spread of 'new' strains or genotypes of *P. infestans* throughout Europe and the US. These genotypes have rapidly displaced the 'old' US-1 clonal lineage which previously dominated pan-globally (Kato *et. al*., 1997, Goodwin *et. al*., 1995b). It has been suggested that higher aggressiveness of these 'new' genotypes gave a competitive advantage which led to their rapid increase in frequency (Goodwin, 1997).

Comparison of the competitive ability of multiple genotypes has to date been limited to tuber infection, detached leaflet experiments and whole plants in growth chambers, with few studies testing fitness and competition in the field environment. The current investigation uses multiple cultivars and genotypes to study the isolate-cultivar interaction, and thus determine the potential influence of variety on selection of the surrounding late blight population.

Methodology

Field trials were planted in the early summer of 2003, 2004 and 2005 in NI and Michigan. Cultivars with differing resistance ratings to foliar late blight were selected. These ratings were taken from National Institute of Agricultural Botany (NIAB) ratings or breeder's estimates for foliar resistance, on a 1-9 scale where 9 is maximum resistance. Four cultivars were planted at both sites in 2003 and 2004. This was increased to eight for the US field trial of 2005. The commercial varieties Atlantic (NIAB rating 3) and Stirling (NIAB rating 8) were included as common varieties in both trials. Pike (breeder's estimate 3) and Jacqueline Lee (breeder's estimate 8) were planted in the US, and Sante (NIAB rating 7) and Milagro (breeder's estimate 8) in the NI field trial. Milagro was bred at the NI Horticultural and Plant Breeding Station while Jacqueline Lee was bred at Michigan State University. MS1I52-A, MS1049-A, MSJ461-1 and Dakota Crisp were included in the US in 2005.

Six representative groups were chosen from each of the local *P. infestans* populations of NI and Michigan based on phenotypic and genotypic differences (Table 1). In NI four isolates were included for each group and these same isolates were used for each trial. In the US one isolate was used for each group in 2003. These were increased to four (where available) for each group in 2004 and 2005. All isolates were tested on detached leaves of each cultivar before being used for field inoculation to rule out, as far as possible, effects of major gene resistance. Isolates were distinguished by mating type (Cooke *et al*., 1995), glucose-6-phosphate isomerase (*Gpi*) and peptidase (*Pep*) allozyme genotyping (Goodwin *et al.*, 1995a), mitochondrial haplotype (Griffith and Shaw, 1998) and sensitivity to the fungicide metalaxyl (leaf disc method of Cooke, 1986).

Each cultivar was replicated four times in a randomised complete block design. Six rows of susceptible infector plants (cv. FL1979 in the US and Desiree in NI) were planted, surrounding the trial plots (each containing four rows of 10 tubers), two on both sides and two in the centre. Each infector row was inoculated with equal amounts of standardized inoculum from each of the six groups. Every third plant was inoculated with an individual group of isolates chosen at random. An epidemic was established and allowed to spread to test cultivars (data not reported). Forty single-lesions were removed from each cultivar when infection had reached approximately 1%. These isolates were then characterised and re-assigned to their respective groupings. The significance of association between cultivar and group found was compared using the chi-squared test (Statsoft Statistica for Windows). Each genotype was compared in its distribution of infection over the four cultivars. Results from the 2003 NI field trial and all three US field trials are presented.

Funding: MPIC and Bayer UK

Table 1 Groups chosen to represent *P. infestans* populations of N. Ireland and the US

Site	Group Number	Metalaxyl Sensitivity[a]	*Pep* genotype	Haplotype
N. Ireland	1	R	*100/100*	IIa
	2	S	*100/100*	IIa
	3	R	*100/100*	Ia
	4	S	*100/100*	Ia
	5	R	*96/100*	Ia
	6	R	*83/100*	Ia
Site	**Group Number**	**Mating Type**	***Gpi* genotype**	**Genotype[b]**
US	1	A1	*86/100*	US-1
	2	A1	*100/100*	US-6
	3	A2	*100/111/122*	US-8
	4	A2	*111/111/122*	US-10
	5	A1	*100/100/111*	US-11
	6	A2	*100/122*	US-14

[a] Sensitivity to the fungicide metalaxyl, R = resistant. S = sensitive.
[b] Genotype grouping as designated by Goodwin *et. al*., 1995a.

Results

In the 2003 NI field trial the distribution of infection by the six isolate groups, as indicated by characterisation of isolates recovered from each plot, differed significantly between cultivars. Group 1 (X^2 = 11.08, p<0.01), Group 2 (X^2=7.85, p<0.05), Group 4 (X^2=11.733, p<0.001) and Group 6 (X^2=16, p<0.001) isolates infected the four cultivars to significantly different degrees. There was no significant difference between the numbers of isolates from Group 3 and Group 5 recovered from the four cultivars. A greater number of groups were able to infect the susceptible Atlantic than the other more resistant cultivars. Whereas isolates from all six groups were recovered from Atlantic, only *Pep 100/100* mtDNA Ia genotypes (Groups 4 and 5) were recovered from the resistant Stirling and only *Pep 83/100* genotype isolates (Group 6) from the resistant Stirling (Figure 1).

In the 2003 and 2004 US field trials there was no significant difference between the infection distribution of the six isolate groups on any of the four cultivars. Out of 160 isolates characterised from the 2003 trial, all but one proved to be US-8 (Figure 2). A single US-14 isolate was recovered from the susceptible Pike, but only US-8 isolates from the other three cultivars. In the 2004 trial, isolates from three genotypes were detected but as in 2003 the vast majority were US-8 (Figure 3). One US-10 isolate and one US-14 isolate were found among those from the susceptible Atlantic, but only US-8 on Pike, Stirling and Jacqueline Lee. The data from the 2005 trial remains to be analysed. Of 137 isolates tested 128 were US-8 (Figure 4). Only nine were US-14. Of these three were detected in the spreader rows, four from Pike and two from MS1049-A.

In all US field trials, the US-8 clonal lineage was by far the most aggressive with few other genotypes being detected. It is likely that the US-8 isolate out-competed all others through higher aggressiveness independently of any isolate x cultivar interaction. In contrast the NI field trial of 2003 clearly showed that cultivars were selecting certain genotypes or isolates when competition was imposed. This was particularly obvious in the resistant Stirling where only the Pep *100/100*, haplotype Ia genotype was recovered and the resistant Milagro where only the Pep *83/100*, a rare genotype in the NI population, successfully infected. These findings illustrate the importance of the host in population selection and of exposing new cultivars to a wide range of genotypes in the field before marketing as blight-resistant.

Funding: MPIC and Bayer UK

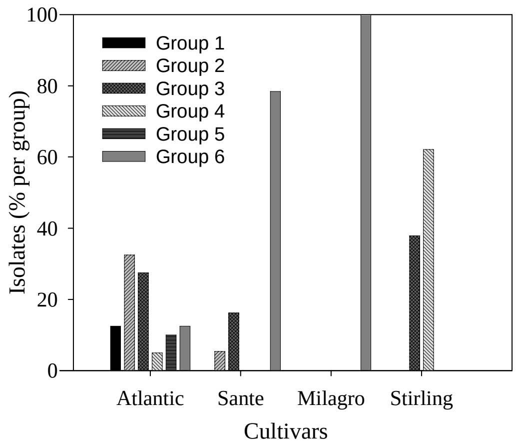

Figure 1. Percentage of isolates from each group obtained from each cultivar in the 2003 NI field.

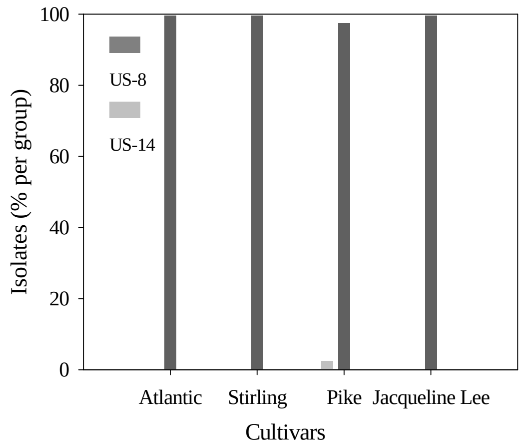

Figure 2. Percentage of isolates from each group obtained from each cultivar in the 2003 US trial.

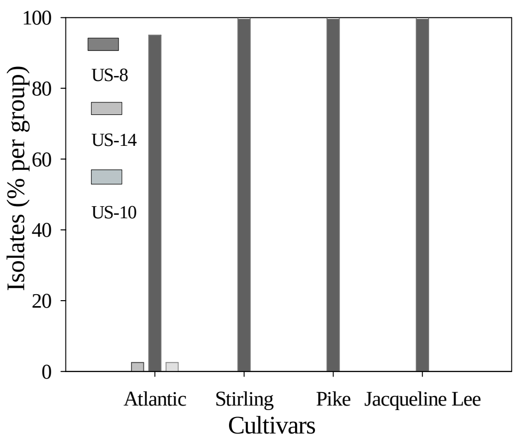

Figure 3. Percentage of isolates from each group obtained from each cultivar in the 2004 US trial.

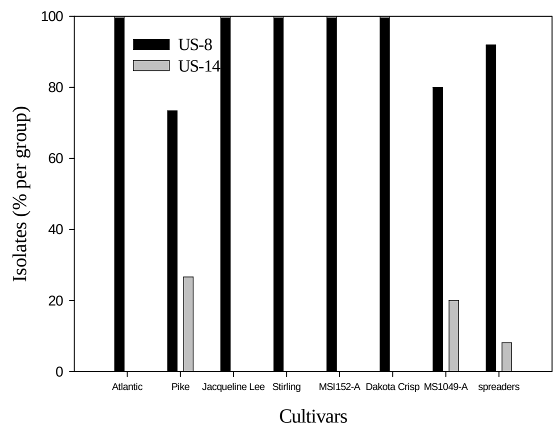

Figure 4. Percentage of isolates from each group obtained from each cultivar in the 2005 US trial. No isolates were recovered for MSJ46-1-1.

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Funding; Industry and MPIC

Evaluation of fungicide programs for potato early blight control, 2005.

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Potatoes [Russet Norkotah; cut seed, treated with Maxim MZ 0.5D (0.5 lb/cwt)] were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 4 Jun into two-row by 25-ft plots (34-in row spacing), separated by a five-foot unplanted row and 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 21 Jul to 8 Sep (8 applications) with an ATV rear-mounted R&D spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Foliar late blight was prevented by applications of Previcur Flex (1.2 pt/A) applied on a 7-day interval from 27 Jul. Weeds were controlled by hilling and with Dual 8E (2 pt/A on 28 Jun), Basagran (2 pt/A on 28 Jun and 25 Jul) and Poast (1.5 pt/A on 25 Jul). Insects were controlled with Admire 2F (20 fl oz/A at planting on 28 Jun), Sevin 80S (1.25 lb/A on 11 and 25 Jul), Thiodan 3EC (2.33 pt/A on 1 and 21 Aug) and Pounce 3.2EC (8 oz/A on 25 Jul). Plots were rated visually for percentage foliar area affected by early blight on 22, 29 Aug, and 8 Sep [80, 87 and 97 days after planting] when there was about 36.3% foliar early blight in the untreated plots. Vines were killed with Reglone 2EC (1 pt/A on 13 Sep). Plots (2 x 25-ft row) were harvested on 5 Oct and individual treatments were weighed and graded. Maximum and minimum air temperature (^{o}F) were 91.8 and 42.3 and 6 days with maximum temperature >90^{o}F (Jun), 91.8 and 46.1 and 1 day with maximum temperature >90^{o}F (Jul), 90.2 and 41.8 and 1 day with maximum temperature >90^{o}F (Aug) and 89.0 and 32.9 (Sep). Maximum and minimum soil temperature (^{o}F) were 77.4 and 59.1 (Jun), 82.3 and 64.1 (Jul), 78.6 and 61.9 (Aug) and 76.3 and 52.3 (Sep). Maximum and minimum soil moisture (% of field capacity) was 77.4 and 59.1 (Jun); 82.3 and 64.1 (Jul), 78.6 and 61.9 (Aug) and 76.3 and 52.3 (Sep). Precipitation was 2.34 in. (Jun), 3.71 in. (Jul), 3.19 in. (Aug) and 4.25 in. (Sep). The total number of early blight disease severity values (P-values) over the growing season was 2042 (45^{o}F base for accumulation). Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

Early blight developed slowly then steadily during Aug and untreated controls reached 36.3% foliar infection by 8 Sep (97 DAP). On 22 Aug, 80 days after planting (DAP), no programs were significantly different from the non-treated check with 0.2% early blight. On 29 Aug, 87 DAP, programs with 0.3 0 to 2.1, and 2.1 to 4.0% early blight (non-treated check) were not significantly different. On 8 Sep, 97 DAP, programs with 3.5 to 12.0, and 36.3% early blight (non-treated check) were not significantly different. Programs with 161.3 (non-treated check) 198.8 and 187.5 to 220.0 cwt/A marketable yield were not significantly different. There were no significant differences among treatments in total yield. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/A	Foliar early blight (%)					Yield (cwt/A)		
	80 dap	87 dap		97 dap		US1		Total
1 Serenade ASO (QRD143) 8.0 pt + Biotune 1.5 pt (A,B,C,D,E,F,G,H[z]).....................	0.3	1.2	b	7.3	b	191.3	ab	316.3
2 Sonata ASO (QST 2808) 8.0 pt + Biotune 1.5 pt (A,B,C,D,E,F,G,H)......................	0.3	1.2	b	4.0	b	187.5	ab	306.3
3 HeadsUp 7.0 oz (A,B,C,D,E,F,G,H)..................	0.1	0.3	b	12.0	b	198.8	ab	318.8
4 Headline 2.08SC 0.56 pt (A,B,C,D,E,F,G,H)....	0.6	2.1	ab	4.0	b	197.5	ab	308.8
5 Endura 250WG 4.5 oz (A,B,C,D,E,F,G,H).........	0.1	0.4	b	3.5	b	220.0	a	333.8
6 Untreated..	0.2	4.0	a	36.3	a	161.3	b	271.3
HSD p=0.05[x]	0.62							70.69

[w] Application dates: A= 21 Jul; B= 28 Jul; C= 4 Aug; D= 11 Aug; E= 18 Aug; F= 25 Aug; G= 1 Sep; H= 8 Sep.

[v] Values followed by the same letter are not significantly different at $p = 0.05$ (Tukey Multiple Comparison).

[x] Tukey HSD p = 0.05 given if there were no significant differences among treatments.

Funding; Industry and MPIC

Evaluation of fungicide programs for potato late blight control, 2005.

W. W. Kirk, R. L Schafer, D. Berry, P. Tumbalam and P. Wharton. Department of Plant Pathology, Michigan State University, East Lansing, MI 48824

Potatoes [cv FL1879; cut seed, treated with Maxim MZ 0.5D (0.5 lb/cwt)] were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 4 Jun into two-row by 25-ft plots (34-in row spacing), separated by a five-foot unplanted row and 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* [US8 biotype (insensitive to mefenoxam, A2 mating type)] at 10^4 spores/fl oz on 30 Jul. All fungicides in this trial were applied on a 7-day interval from 5 Jul to 31 Aug (9 applications) with an ATV rear-mounted R&D spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Weeds were controlled by hilling and with Dual 8E (2 pt/A on 4 Jun), Basagran 2E (2 pt/A on 28 Jun and 25 Jul) and Poast 1E (1.5 pt/A on 25 Jul). Insects were controlled with Admire 2F (20 fl oz/A at planting on 4 Jun), Sevin 80S (1.25 lb/A on 11 and 25 Jul), Thiodan 3EC (2.33 pt/A on 1 and 21 Aug) and Pounce 3.2EC (8 oz/A on 25 Jul). Plots were rated visually for percentage foliar area affected by late blight on 30 Jul; 11, 17, 24 Aug and 2 and 13 Sep [13 days after final application (DAFA), 42 days after inoculation (DAI)] when there was about 100% foliar infection in the untreated plots. The relative area under the disease progress curve was calculated for each treatment from date of inoculation, 30 Jul to 13 Sep, a period of 45 days. Vines were killed with Reglone 2EC (1 pt/A on 13 Sep). Plots (2 x 25-ft row) were harvested on 5 Oct and individual treatments were weighed and graded. Maximum and minimum air temperature (^{o}F) were 91.8 and 42.3 and 6 days with maximum temperature >90^{o}F (Jun), 91.8 and 46.1 and 1 day with maximum temperature >90^{o}F (Jul), 90.2 and 41.8 and 1 day with maximum temperature >90^{o}F (Aug) and 89.0 and 32.9 (Sep). Maximum and minimum soil temperature (^{o}F) were 77.4 and 59.1 (Jun), 82.3 and 64.1 (Jul), 78.6 and 61.9 (Aug) and 76.3 and 52.3 (Sep). Maximum and minimum soil moisture (% of field capacity) was 77.4 and 59.1 (Jun); 82.3 and 64.1 (Jul), 78.6 and 61.9 (Aug) and 76.3 and 52.3 (Sep). Precipitation was 2.34 in. (Jun), 3.71 in. (Jul), 3.19 in. (Aug) and 4.25 in. (Sep). The total number of late blight disease severity values (DSV) over the inoculation period was 104 and 22 (using 80% and 90% ambient %RH as bases for DSV accumulation), respectively. Plots were irrigated to supplement precipitation to about 0.1 in. /A/4 day period with overhead sprinkle irrigation.

Trial A; Table 1.

Late blight developed slowly after inoculation then steadily during Aug and untreated controls reached 95% foliar infection by 7 Sep. Taking 36 DAI as a key reference point, all fungicide programs reduced the foliar late blight significantly compared to the untreated control. Programs with 0.4 to 9.2% foliar late blight were not significantly different. Taking 42 DAI as a key reference point, there was about 95% defoliation of the untreated control due to late blight and all fungicide programs had significantly less foliar late blight than the untreated. Programs with 1.5 – 25.0% foliar late blight were not significantly different. All fungicide programs significantly reduced the average amount of foliar late blight over the season (RAUDPC, 0 to 42 DAI) compared to the untreated. Application programs with RAUDPC values between 0.2 and 2.9 were not significantly different. There were no significant differences in marketable or total yield among treatments. Phytotoxicity was not noted in any of the treatments.

Trial B; Table 2.

Thirty-six DAI all fungicide programs significantly reduced foliar late blight compared to the untreated. Fungicide programs with 0.4 to 3.3% foliar late blight were not significantly different. Forty-two DAI there was complete defoliation of the untreated plots due to late blight and all fungicide programs had significantly less foliar late blight than the untreated. Fungicide programs with 1.0 – 7.5% foliar late blight were not significantly different. All fungicide programs significantly reduced the average amount of foliar late blight over the season (RAUDPC, 0 to 42 DAI) compared to the untreated. Application programs with RAUDPC values between 0.14 and 0.8 were not significantly different. Only three treatments had marketable yields (greater than or equal to 385 cwt/A) significantly greater than the untreated (257 cwt/A). Two treatments had significantly greater total yields (greater than or equal to 457 cwt/A) than the untreated (325 cwt/A). Phytotoxicity was not observed in any of the treatments.

Table 1. Trial A; Ranman-based fungicide programs.

Treatment, rate/A	Foliar late blight (%)				RAUDPC[x] Max (100)		Yield (cwt/A)			
	36 DAI[z]		42 DAI 13 DAFA[y]		0 - 42 DAI		US1		Total	
1 Bravo, WS 6SC 1.5 pt (A,B,C,D,E,F,G,H,I[w]).........................	2.0	b[v]	6.3	b	0.9	b	340.4	a	392.9	a
2 Quilt, LF 200SC 0.875 pt (A,C,E,G) Bravo, WS 6SC 1.5 pt (B,D,F,H,I)……………………...…..	9.2	b	22.0	b	2.6	b	312.4	a	361.4	a
3 Ranman, 3.3SC 0.17 pt + Silwet, 0.125 pt (A,B,C) Bravo, WS 6SC 1.0 pt (D,E,F,G,H,I).....................................	2.0	b	6.8	b	0.8	b	357.0	a	409.5	a
4 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Ranman, 3.3SC 0.17 pt + Silwet, 0.125 pt (D,E,F)……….....	1.8	b	5.5	b	0.7	b	357.9	a	407.8	a
5 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Ranman, 3.3SC 0.17 pt + Silwet, 0.125 pt (B.D.F)…………	1.4	b	5.8	b	0.8	b	374.5	a	415.6	a
6 Ranman, 3.3SC 0.09 pt + Penncozeb, 75DF 1.8 lb + Silwet, 0.125 pt (A,B,C) Bravo, WS 6SC 1.0 pt (D,E,F,G,H,I).....................................	2.8	b	10.0	b	1.2	b	371.0	a	428.8	a
7 Ranman, 3.3SC 0.13 pt + Penncozeb, 75DF 1.8 lb + Silwet, 0.125 pt (A,B,C) Bravo, WS 6SC 1.0 pt (D,E,F,G,H,I).....................................	1.8	b	8.0	b	0.9	b	343.0	a	405.1	a
8 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Ranman, 3.3SC 0.09 pt + Penncozeb, 75DF 1.8 lb + Silwet, 0.125 pt (D,E,F)..	0.4	b	1.5	b	0.2	b	348.3	a	391.1	a
9 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Ranman, 3.3SC 0.13 pt + Penncozeb, 75DF 1.8 lb + Silwet, 0.125 pt (D,E,F)..	2.3	b	7.5	b	0.9	b	364.0	a	407.8	a
10 Bravo, WS 6SC 1.0 pt (A,C,E,G,H,I) Ranman, 3.3SC 0.09 pt + Penncozeb, 75DF 1.8 lb + Silwet, 0.125 pt (B,D,F)………………………………..……	0.6	b	1.5	b	0.2	b	374.5	a	436.6	a
11 Bravo, WS 6SC 1.0 pt (A,C,E,G,H,I) Ranman, 3.3SC 0.13 pt + Penncozeb, 75DF 1.8 lb + Silwet, 0.125 pt (B,D,F)………………………...…………	0.7	b	3.3	b	0.3	b	328.1	a	396.4	a
12 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Gavel, 75DF 1.5 lb (D,E,F)...	0.9	b	2.3	b	0.4	b	368.4	a	421.8	a
13 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Acrobat, 50WP 0.4 lb (D,E,F)..	5.5	b	21.3	b	2.3	b	360.5	a	422.6	a
14 Ranman, 3.3SC 0.17 pt + NIS, 1 pt (A,B,C) Bravo, WS 6SC 1.0 pt (D,E,F,G,H,I).....................................	3.3	b	19.5	b	1.8	b	369.3	a	434.0	a
15 Bravo, WS 6SC 1.0 pt (A,B,C,G,H,I) Ranman, 3.3SC 0.17 pt + NIS, 1 pt (D,E,F)………………	1.8	b	9.5	b	0.9	b	295.8	a	339.5	a
16 Bravo, WS 6SC 1.0 pt (A,C,E,G,H,I) Ranman, 3.3SC 0.17 pt + NIS, 1 pt (B,D,F)………………	8.5	b	25.0	b	2.9	b	319.4	a	390.3	a
17 Untreated...	50.0	a	95.0	a	14.1	a	258.1	a	324.6	a

[z] Days after inoculation with *Phytophthora infestans*, US8, A2.
[y] Days after final application of fungicide.
[x] RAUDPB, relative area under the disease progress curve calculated from day of inoculation to last evaluation of late blight.
[w] Application dates: A= 5 Jul; B= 12 Jul; B= 20 Aug; D= 28 Aug; E= 3 Aug; F= 10 Aug; G= 17 Aug; H= 24 Aug; I = 31 Aug.
[v] Values followed by the same letter are not significantly different at $p = 0.05$ (Tukey Multiple Comparison).

Table 2. Trial B; miscellaneous fungicide programs.

Treatment and rate/A	Foliar late blight (%) 34 DAI[z]		42 DAI 13 DAFA[y]		RAUDPC[x] Max (100) 0 - 42 DAI		Yield (cwt/A) US1		Total	
1 Dithane, 75DF 2.0 lb (A,C,E[w]); Gavel, 75D 1.5 lb (D,E,F,G,H,I)...	0.8	b[v]	1.5	b	0.2	b	336.0	ab	377.1	ab
2 Penncozeb, 75DF 2.0 lb (A,B,C,D,E,F,G,H,I)........................	1.0	b	2.3	b	0.4	b	385.0	a	434.0	ab
3 Echo ZN, 6SC 2.15 pt (A,B,C,D,E,F,G,H,I)...........................	0.4	b	1.3	b	0.2	b	344.8	ab	386.8	ab
4 Tanos, 50WDG 0.5 lb + Manzate, 1.5 lb (A,C,E,G); Bravo, WS 6SC 1.5 pt (B,D,F,H,I)..	0.6	b	3.3	b	0.3	b	310.6	ab	378.9	ab
5 Reason, 500SC 0.25 pt + Polyram, 80WG 1.5 lb + NIS, 100SL 0.125 pt (A,C,E,G); Polyram, 80WG 2.0 lb (B,D,F,H,I)..	0.5	b	1.0	b	0.1	b	410.4	a	461.1	a
6 Reason, 500SC 0.25 pt + Dithane, 75DF 1.5 lb + NIS, 100SL 0.125 pt (A,C,E,G); Dithane, 75DF 2.0 lb (B,D,F,H,I)...	0.7	b	2.8	b	0.4	b	330.8	ab	376.3	ab
7 Reason, 500SC 0.25 pt + Echo, 6SC 1.0 pt + NIS, 100SL 0.125 pt (A,C,E,G); Echo, 6SC 1.5 pt + (B,D,F,H,I)..	1.6	b	4.8	b	0.6	b	344.8	ab	406.0	ab
8 Penncozeb, 75DF 1.6 lb + (A,B,C,G,H,I); Ranman, 3.3SC 0.01 pt + Penncozeb, 75DF 1.6 lb + Organosilicone, 100SL 4 pt (D,E,F)………………….……	1.3	b	1.5	b	0.3	b	339.5	ab	380.6	ab
9 Penncozeb, 75DF 1.6 lb + (A,B,C,G,H,I); Ranman, 3.3SC 0.01 pt + Penncozeb, 75DF 1.6 lb (D,E,F)...	0.6	b	1.4	b	0.2	b	334.3	ab	384.1	ab
10 Endura, 250WG 0.62 lb (A,B,C,G,H,I); Ranman, 3.3SC 0.01 pt + Endura 0.62 lb + Organosilicone, 100SL 4 pt (D,E,F).......................................	0.9	b	7.5	b	0.7	b	326.4	ab	369.3	ab
11 Bravo, WS 6SC 1,5 pt (A,B,D,E,F,H,I); Omega, 500F 0.5 pt (C); Quadris Opti, 1.6 pt (G,I); Ridomil Gold Bravo, 76.5WP 2 lb (J)....................................	1.5	b	5.5	b	0.6	b	401.6	a	457.6	a
12 Gem, 25DG 0.38 lb (A,C,G,I); Bravo, WS 6SC 1.5 pt (B,D,F); Previcur Flex, 1.2 pt (E,H); Gavel, 75DF 2.0 lb (J)...	0.9	b	1.8	b	0.3	b	351.8	ab	409.5	ab
13 Bravo, WS 6SC 1.0 pt (A,B,C); 1.5 pt (E) Manzate, 75DF 1.5 lb (D,F,H); 2.0 lb (E,G,I)……………….	0.7	b	2.3	b	0.3	b	363.1	ab	410.4	ab
14 Gem, 25DG 0.38 lb (C,E); Bravo, WS 6SC 1.5 pt (D,H); Previcur Flex, 1.2 pt (E,H); Reason, 500SC 0.25 pt (G,I).......	0.7	b	1.8	b	0.3	b	310.6	ab	364.9	ab
15 Bravo, WS 6SC 1.5 pt (A,B,D,H,); Polyram, 80WG 2.0 lb (C,E); Acrobat, 50WP 0.2 lb (F,I); Pristine, 38WP 1.16 lb (G,J)..	3.3	b	5.3	b	0.8	b	300.1	ab	360.5	ab
16 Untreated..	46.3	a	100.0	a	13.6	a	257.3	b	325.5	b

[z] Days after inoculation with *Phytophthora infestans*, US8, A2.
[y] Days after final application of fungicide.
[x] RAUDPC, relative area under the disease progress curve calculated from day of inoculation to last evaluation of late blight.
[w] Application dates: A= 5 Jul; B= 12 Jul; C= 20 Aug; D= 28 Aug; E= 3 Aug; F= 10 Aug; G= 17 Aug; H= 24 Aug; I = 31 Aug; J = 8 Sep.
[v] Values followed by the same letter are not significantly different at $p = 0.05$ (Tukey Multiple Comparison).

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Host Plant Resistance and Reduced Rates and Frequencies of Fungicide Application to Control Potato Late Blight (Co-operative trial Quad State Group 2005).

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Late blight of potato caused by *Phytophthora infestans* (Mont de Bary), is a major threat to the production of high quality potatoes. Unchecked, *P. infestans* can rapidly defoliate plants in the field and can infect potato tubers when spores are washed into the soil. Potato late blight control strategies changed following the migration of mefenoxam/metalaxyl-resistant populations of *P. infestans* from Mexico to North America and necessitate cultural control methods and crop protection strategies that rely primarily on protectant foliar fungicide applications. There are several potential methods for reducing fungicide inputs in potato crop management. These include the use of fungicides with less active ingredient, reduced application rates, longer application intervals and a combination of any of these strategies. There are currently few late blight resistant potato cultivars that meet commercial standards in the United States. Typical fungicide application programs use a 5-7 day spray interval depending on environmental conditions and grower preference. The frequent fungicide spray intervals and rates currently used by growers to control late blight are expensive and more economical control measures are needed.

Therefore, the objective of this research was to determine if acceptable control of foliar late blight can be achieved by using increased fungicide spray intervals and reduced application rates of residual contact fungicides on potato germplasm with a range of susceptibility to late blight developed at each of the four potato breeding programs in Michigan, Minnesota, North Dakota and Wisconsin.

MATERIALS AND METHODS

Potato Germplasm, agronomy and experimental design

Previous experiments from the co-operating breeding programs have identified potato cultivars and advanced breeding lines (ABL) with different responses to foliar late blight.

All experiments were conducted at the Michigan State University Muck Soils Research Station, Bath, MI (90% organic muck soil). Soils were plowed to 9” cm depth during Oct following harvest of preceding crops. Soils were prepared for planting with a mechanical cultivator in early May and fertilizer applied during final bed preparation on the day of planting. Cultivars/ABL were planted on 4 Jun, 2005 in two-row by 50 ft plots (34” row spacing). The experimental design for the fungicide application interval and reduced dose rate trials was a randomized complete block design with four replications. Fertilizers were applied in accordance with results from soil testing carried out in the spring of each year and about 200 cwt N/A (total N) was applied in two equal doses at planting and hilling. Additional micronutrients were applied according to petiole sampling recommendations and in all years. Approximately 0.2, 0.3 and 0.2 cwt/A boron, manganese and magnesium, respectively were applied as chelated formulations. Cut and whole seed pieces (2.5 -5.0 oz) of selected cultivars and ABL were used in all experiments.

When relative humidity (RH) dipped below 80% (measured with RH sensors mounted within the canopy, described below), a mist irrigation system (described below) was turned on to maintain RH at >95% within the plant canopy. Plots were irrigated as necessary to maintain canopy and soil moisture conditions conducive for development of foliar late blight with turbine rotary garden sprinklers (Gilmour Group, Somerset, PA, U.S.A.) at 112 gal H_2O A/hr and managed under standard potato agronomic practices. Weeds were controlled by hilling and with Dual 8E (2 pt/A on 28 Jun), Basagran (2 pt/A on 28 Jun and 25 Jul) and Poast (1.5 pt/A on 25 Jul). Insects were controlled with

Admire 2F (20 fl oz/A at planting on 28 Jun), Sevin 80S (1.25 lb/A on 11 and 25 Jul), Thiodan 3EC (2.33 pt/A on 1 and 21 Aug) and Pounce 3.2EC (8 oz/A on 25 Jul).

Residual Contact Fungicides

Omega 5SC (Syngenta) was used for this experiment. Fungicides were applied with an ATV rear-mounted spray boom (R&D Sprayers, Opelousas, LA) 20 gal H_2O/A (80 psi pressure) with three XR11003VS nozzles per row positioned 12" apart and 18" above the canopy. In the fungicide application interval and reduced dose rates trial, Omega 5SC was applied at 5, 10 and 15 day intervals at 0, 50 and 100% MRAR to the ABL and cultivars described in Figure 1. The first fungicide application occurred at 32 days after planting (DAP; 5 Jul, 2005) when potato plants were approximately 6" tall. Fungicides were applied until non-treated plots of susceptible controls reached about 100% diseased foliar area (4 Sep). The 5, 7, 10 and 15-day interval treatments received nine, seven, five and three applications in 2005, respectively.

Pathogen Preparation and Inoculation.

Zoospore suspensions were made from *P. infestans* cultures of several isolates from different genetic backgrounds, including (US8 and US14 genotypes, insensitive to mefenoxam/metalaxyl, A2 mating types) grown on rye agar plates for 14 days in the dark at 15^{o}C. Sporangia were harvested from the rye agar plates by rinsing the mycelial/sporangial mat in cold (4^{o}C) sterile, distilled water and scraping the mycelial/sporangial mat from the agar surface with a rubber policeman. The mycelial/sporangial suspension was stirred with a magnetic stirrer for 1 hour. The suspension was strained through four layers of cheesecloth and the concentration of sporangia was adjusted to about 1 x 10^2 sporangia/fl oz using a hemacytometer. Sporangial cultures were incubated for 2-3 hours at 40^{o}F to stimulate zoospore release. All plots were inoculated simultaneously through an overhead sprinkler irrigation system, on 27 Jul, 2005; by injecting the zoospore suspension of *P. infestans* into the irrigation water feed pipeline at 20 psi CO_2 pressure and applied at a rate of about at 10^4 spores/fl oz over the whole trial area. The amount and rate of inoculum applied was estimated from prior calibration of the irrigation system (described above) and was intended to expose all potato foliage to inoculum of *P. infestans*.

Disease Evaluation and Data Analysis

As soon as late blight symptoms were detected (about 10 days after inoculation, DAI), each plant within each plot was visually rated at 3 to 5 day intervals for percent leaf and stem (foliar) area with late blight lesions on 30 Jul; 11, 17, 24 Aug and 2 and 13 Sep [13 days after final application (DAFA), 42 DAI in 2005] when there was about 100% foliar infection in the untreated plots. The mean percent blighted foliar area per treatment was calculated. In the present study, any cultivar/ABL with foliar late blight severity measured as the Relative Area Under the Disease Progress Curve [RAUDPC] value that was not significantly higher than that of Torridon was classified as late blight resistant (R). Any cultivar/ABL with a RAUDPC value significantly higher than that of Snowden or with a RAUDPC value that was not statistically different from that of Atlantic was classified as late blight susceptible (S). Cultivars/ABLs were classified as moderately resistant (I) if the RAUDPC value was significantly higher than that of Torridon but significantly lower than that of Snowden. The cultivars/ABLs included in the trials from 2005 are shown in Table 1.

Fungicide treatments were classified into three groups within each cultivar; non-effective if the RAUDPC was not significantly different from the non-treated control (NE); partially effective if significantly less than the non-treated control and significantly greater than the 100% MRAR, 5-day frequency application (PE); and effective if the RAUDPC was not significantly different from 100% MRAR, 5-day frequency application (E).

Microclimate Measurement

Climatic variables were measured with a Campbell Weather Station equipped with air

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temperature and humidity sensors located within the potato canopy on site. Microclimate within the potato canopy was monitored beginning when 50% of the potato plants had emerged and ending when canopies of healthy plants reached 100% senescence. The Wallin Late Blight Prediction Model was developed in the Eastern United States under conditions similar to those in Michigan and was adapted to local conditions. Late blight disease severity values (DSV) were estimated from the Wallin Late Blight Prediction Model and accumulated from inoculation to final evaluation to estimate the conduciveness of the environment for late blight development.

RESULTS

Microclimate conditions

Late blight developed slowly during August due to high temperatures; non-treated susceptible controls reached about 100% diseased foliar area 42 DAI. Maximum and minimum air temperature (^{o}F) were 91.8 and 42.3 and 6 days with maximum temperature >90^{o}F (Jun), 91.8 and 46.1 and 1 day with maximum temperature >90^{o}F (Jul), 90.2 and 41.8 and 1 day with maximum temperature >90^{o}F (Aug) and 89.0 and 32.9 (Sep). Maximum and minimum soil temperature (^{o}F) were 77.4 and 59.1 (Jun), 82.3 and 64.1 (Jul), 78.6 and 61.9 (Aug) and 76.3 and 52.3 (Sep). Maximum and minimum soil moisture (% of field capacity) was 77.4 and 59.1 (Jun); 82.3 and 64.1 (Jul), 78.6 and 61.9 (Aug) and 76.3 and 52.3 (Sep). Precipitation was 2.34 in. (Jun), 3.71 in. (Jul), 3.19 in. (Aug) and 4.25 in. (Sep). The total number of late blight disease severity values (DSV) over the inoculation period was 104 and 22 (using 80% and 90% ambient %RH as bases for DSV accumulation), respectively. Plots were irrigated to supplement precipitation to about 0.1”/A/4 day period with overhead sprinkle irrigation. This indicated that environmental conditions were conducive to late blight development (DSV > 18).

The susceptibility of the different cvs/ABLs is shown in Table 1. The RAUDPC of the susceptible cultivars ranged from 8.6 to 12.7 mean RAUDPC and included Russet Norkotah, Dakota Crisp, Snowden, MN 99144-1 and FL1879. Very little late blight developed on any other cv or ABL and they were classified as resistant (Table 1). There were no moderately resistant cvs/ABLs in the study in 2005.

Application of Omega 5SC at full rate of application at 5, 7, 10 or 14-day intervals resulted in effective control of late blight in all varieties (Figure 1). Application of Omega 5SC at 50% rate of application at 5, 7, 10 or 14-day intervals resulted in effective control of late blight in Dakota Crisp (Figure 1). Application of Omega 5SC at 50% rate of application at 5, or 7-day intervals resulted in effective control of late blight in FL1879, and Snowden (Figure 1). Application of Omega 5SC at 50% rate of application at 10, or 14-day intervals resulted in partially effective control of late blight in FL1879 and Snowden (Figure 1). Application of Omega 5SC at 50% rate of application at 5, or 7-day intervals resulted in partially effective control of late blight in Russet Norkotah and at 5, 7 or 10-day intervals in MN 99144-1 (Figure 1). Application of Omega 5SC at 50% rate of application at 10, or 14-day intervals resulted in non-effective control of late blight in Russet Norkotah and at 14-day intervals in MN 99144-1 (Figure 1). The mean RAUDPC for non-treated and fungicide treated Jacqueline-Lee, MSJ461-1, MSK136-2, Stirling and Torridon ranged from 0.0 to 0.05, which were classified as resistant. Fungicide treatments did not significantly effect late blight development in either MSJ461-1 or Torridon.

DISCUSSION

The results of this study were consistent with previous studies and indicate that a combination of cultivar/ABL resistance and managed application of protective fungicides will reduce foliar late blight to acceptable levels in most situations. When conditions were less conducive to late blight development (as in 2005), reduced amounts of fluazinam were either fully or partially effective at most application rates tested on all cultivars/ABL compared to the non-treated controls. However, in some cultivars/ABL, 50% of the MRAR of fungicide was sufficient to achieve acceptable control, whereas other cultivars/ABL required 100% MRAR to control late blight. On late blight susceptible cultivars, applications of fluazinam at either 10 or 14-day intervals were usually partially effective for controlling late blight at the doses tested. However, in the resistant cultivars the fungicides did not reduce the RAUDPC in comparison with untreated plots of these cultivars and fungicides are not required for late blight control in these entries.

The opportunity to manage late blight by applying reduced rates of fungicides at increased spray intervals to cultivars less susceptible to late blight was demonstrated in this study. In addition, the efficacy of reduced rates and increased application intervals of fungicides against other potato pathogens such as early blight has not been established and may prove to be a major constraint in the adoption of managed fungicide applications. As new cultivars with enhanced late blight resistance are developed and released it will be important to provide growers with recommendations for the most effective and economical chemical control of late blight in these new cultivars. In the future, the type of information gathered in this study will be used to develop models, based on cultivar resistance and response to fungicide application, to advise and guide growers as to which fungicide, rate and frequency of application is required to provide protection against late blight. Climatic conditions within the canopy will also impact choice of fungicide and rate and frequency of application. Therefore, new cultivars will need to be carefully screened in the manner described in this study, over several seasons in order to develop accurate models for fungicide application.

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Table 1. Susceptibility of potato cultivars and advanced breeding lines from North Central US potato breeding programs to potato late blight, MSU 2005.

Cv/ABL[1]	RAUDPC[2] (0 – 42 DAI)		Susceptibility[3]
Russet Norkotah	12.7	a[4]	S
Dakota Crisp	11.4	ab	S
Snowden	10.3	ab	S
MN 99144-1	10.0	ab	S
FL1879	8.6	b	S
Jacqueline-Lee	0.05	c	R
MSJ 461-1	0.01	c	R
MSK136-2	0	c	R
Stirling	0	c	R
Torridon	0	c	R

[1] Varieties and advanced breeding lines from the Quad State potato breeding programs.
[2] Relative area under the disease progress curve from inoculation to 100% late blight (max = 100).
[3] Susceptibility of non-treated control to late blight; R = Resistant, not significantly different from Torridon (non-treated); S = Susceptible, not significantly different from Snowden (non-treated); I = Intermediate, significantly different from both Torridon and Snowden (non-treated).
[4] Means followed by the same letter were not significantly different at $p = 0.05$.

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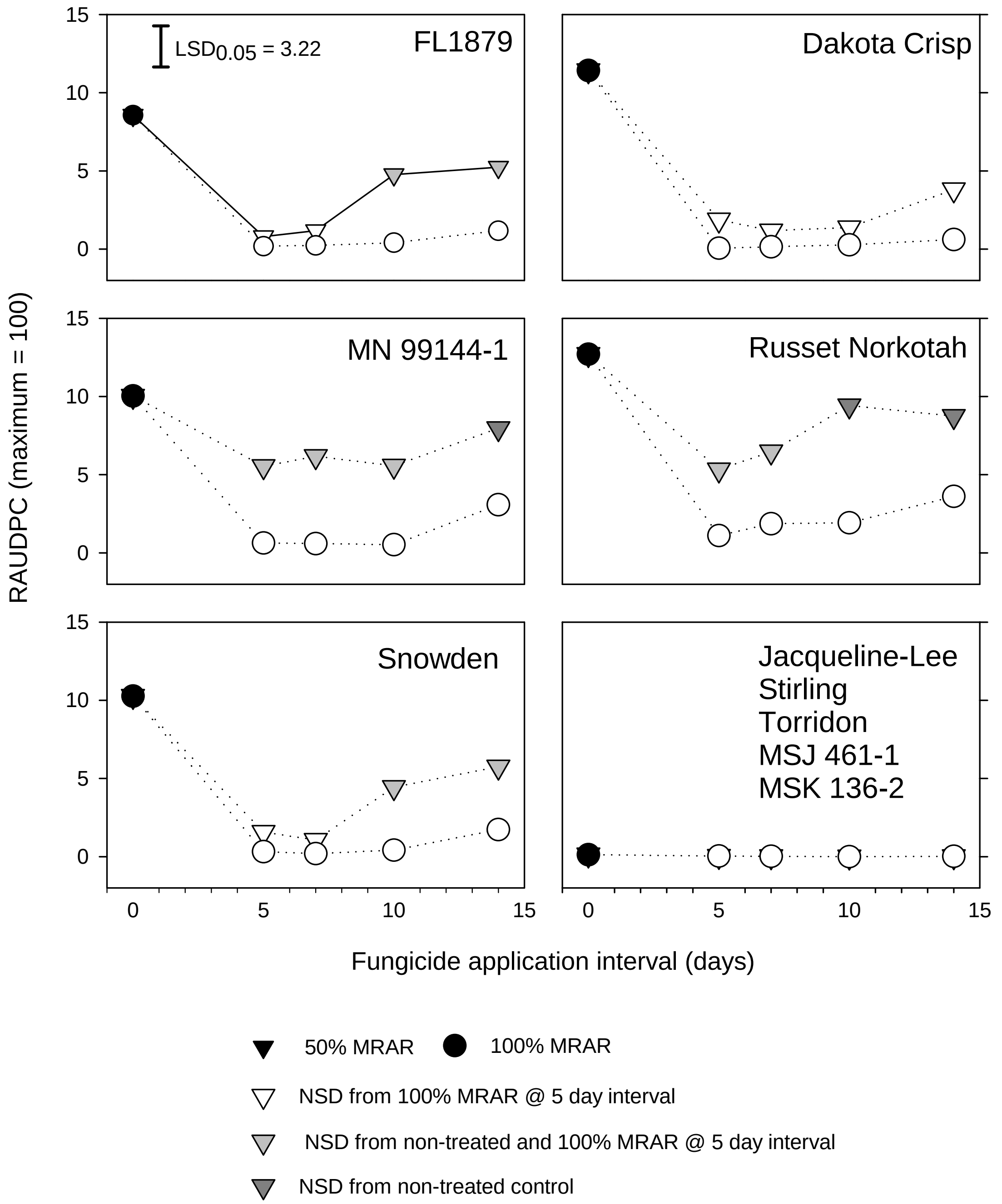

Figure 1. Figure 1. Mean RAUDPC (max = 100) in potato cultivars and ABL inoculated with *Phytophthora infestans* (US8, A2) and protected with reduced rates of fluazinam applied at 50 or 100% manufacturers recommended application rate. The least significant difference was RAUDPC = 3.22, for comparisons among all cultivars at all fungicide application rates and frequencies. All comparisons were tested at p = 0.05

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Managing Rhizoctonia Diseases of Potato with Optimized Fungicide Applications and Varietal Susceptibility; Results from the 2005 Field Experiments.

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Introduction

The pathogen *Rhizoctonia solani* (AG-3) causes stem canker and black scurf of potatoes. Rhizoctonia diseases are initiated by seedborne or soilborne inoculum. Seedborne inoculum is carried on seed tubers in the form of sclerotia (black scurf) or as mycelium from the previous season. When contaminated seed is planted the fungus grows from the seed surface to the developing sprout and infection of root primordia, stolon primordia and leaf primordia can occur. The sprouts can be killed at this stage and emergence may be prevented or delayed. Mycelia and sclerotia of *R. solani* also survive in soil and on plant debris and can cause disease independently of seedborne inoculum. Soilborne inoculum can infect potato tissue at anytime when plant organs develop in the proximity of inoculum, however the plant is most severely impacted when immature sprouts, stolons and roots are infected early in the season. During early potato development in April in MI soil temperature is well within the optimal range (average about 10^{o}C) for infection by *R. solani*.

High temperature tends to minimize the impact of *R. solani* even when inoculum is abundant. Some potato varieties appear to be more sensitive than others to but there are none which exhibit high levels of resistance, however information on currently grown varieties is not available. Current recommendations for control of this disease are focused on reducing both seedborne and soilborne inoculum. It is known that minimizing the time between planting and emergence can minimize sprout infection. Crop rotation in warm climates to about three years can also reduce inoculum in the soil. As growers in MI are constrained by season length and rotation requirements it is necessary to include the application of fungicides effective against *R. solani* in a control program. Trials at MSU and elsewhere have indicated that there are several effective fungicides that can be used to manage *R. solani*, either applied as seed treatments or as in-furrow at-planting applications. These fungicides include fludioxonil-based seed treatments (Maxim products), strobilurin-based products applied in-furrow [azoxystrobin (Quadris, Amistar); pyraclostrobin (Headline), trifloxystrobin (Gem)], and flutolonil-based fungicides [Moncoat MZ (seed treatment); Moncut (in-furrow)]. Although products are available, new standards are being developed for avoidance of resistance in pathogen populations (not necessarily *R. solani*) to at-risk fungicide classes such as those in group 11 [QoI-fungicides (Quinone outside Inhibitors)] which includes all the strobilurines currently registered for use on potatoes. The broad spectrum of efficacy reported in strobilurines may lead to excessive use in the future as other products such as B2 carcinogens are at risk of further limitations in usage, and therefore a management plan for their use need to be developed which is compatible with potato production in MI. Currently there are many fungicide options available for control of Rhizoctonia diseases of potato however, to achieve optimal performance and preserve efficacy, a systematic approach of usage needs to be established. This approach also should address the climatic variability on the epidemiology of *R. solani* in potatoes to establish the threshold at which the application of fungicide intervention would have no effect.

The objectives of this project therefore are to A) to identify the efficacy of some fungicides (identified below) applied at different timings during early crop development in combination with and without seed treatments on two table stock cultivars grown in two potentially different soil temperature regimes; and B) evaluate the effect of soil temperature on currently grown varieties at the Plant Pathology Research Farm on a sand/mineral site.

Materials and Methods

A) The seed treatment and fungicide application timing experiment for the control of symptoms of *Rhizoctonia solani* was tested at two locations and on two varieties. The potato cultivar 'Superior' was planted in a grower's field near Mancelona, MI, while the cultivar 'Russet Norkotah' was planted at the

Michigan State University Muck Soils Research farm near Bath, MI. Both cultivars were tested for the control of Rhizoctonia disease symptoms under identical chemical regimes. Within each regime three chemicals, Amistar (a.i. azoxystrobin), Moncut (a.i. flutolonil), Headline (a.i. pyraclostrobin), were examined for efficacy at three application times, at-planting in-furrow, at emergence, and 14 days after emergence. Also, the efficacy of the addition of a seed treatment, Maxim (a.i., fludioxonil), in combination with the fungicides was examined at each application timing (Table 1).

Table 1: Experimental layout for seed treatment and timing of application of fungicides in-furrow at-planting, emergence and 14 days post-emergence

Seed treatment	In-furrow	Emergence	14 day post-emergence	Seed treatment	In-furrow	Emergence	14 day post-emergence
Yes	Amistar			No	Amistar		
Yes		Amistar		No		Amistar	
Yes			Amistar	No			Amistar
Yes	Moncut			No	Moncut		
Yes		Moncut		No		Moncut	
Yes			Moncut	No			Moncut
Yes	Headline			No	Headline		
Yes		Headline		No		Headline	
Yes			Headline	No			Headline
Yes				No			

‘Superior’ seed was cut and treated with the seed treatment one day prior to planting. Seed pieces were planted near Mancelona, MI in sandy loam soil on 26 May, into four- row by 20 ft plots (approximately 13-in. between plants give a target population of 72 at 34-in. row spacing) replicated four times in a randomized complete block design. Whole ‘Russet Norkotah’ seed was also treated with the seed treatment one day prior to planting. Seed pieces were planted in Houghton muck soil at the Michigan State University Muck Soils Research Farm, Bath, MI on 1 June, into four- row by 20 ft plots (approximately 13-in. between plants give a target population of 72 at 34-in. row spacing) replicated four times in a randomized complete block design. The seed treatment was applied, in a water suspension of at a rate of 0.8 fl. oz/cwt in 0.8 fl. oz/cwt of water for a total final solution of 0.16 fl. oz/cwt, onto the entire seed surface. In-furrow applications were made over the seed at-planting, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 psi) and using one XR11003VS nozzle per row.

At the Mancelona site, pesticides were applied by the grower cooperator. Weeds, insects, and pathogenic fungi were managed with the farm manager’s proprietary program.

Fertilizer was drilled into plots before planting, formulated according to results of soil tests at the Bath, MI location. Previcur Flex was applied at 1.2 pt/A on a ten day interval, total of four applications, starting two weeks after the last application of experiment treatments. A permanent irrigation system was established prior to the commencement of fungicide sprays and the fields were maintained at soil moisture capacity throughout the season by frequent (minimum 5-day) irrigations. Weeds were controlled with Dual 8E at 1 pt/A and Sencor 75DF at .6 lbs/A at planting, Basagran at 2 pt/A 27 and 45 DAP (days after planting) and Poast at 1.5 pt/A 63 DAP. Insects were controlled with Platinum at 0.5 pt/A at-planting, Baythroid 2 at .125 pt/A 36 and 60 DAP.

Emergence was rated as the number of plants breaking the soil surface or fully emerged after planting. The rate of emergence was estimated as the area under the plant emergence curve (max=100) from the day of planting until 43 DAP for ‘Superior. Tuber, stem, and stolon numbers, and percentages of stems and stolons with greater than 5% girdling caused by *Rhizoctonia solani* were measured via a destructive mid-season harvest (4 plants per replication) at 67 DAP for ‘Superior’, and 69 DAP for ‘Russet Norkotah.’ Vines were killed with Reglone 2EC (1 pt/A) on 25 August at the Bath location. Plots (20-ft row) were harvested on 15 September (‘Superior’) and 21 September (‘Russet Norkotah’) and individual treatments were weighed and graded. Samples of 20 tubers per plot were washed and assessed for black scurf (*R.. solani*) incidence (%) and severity. Severity of black scurf was measured as an index calculated by counting the number of tubers (n = 20) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 – 15%; 4 = > 15% surface area of tuber covered with sclerotia. The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with sclerotia.

B) The variety experiment was located at the Plant Pathology farm in East Lansing, MI and tested eight potato cultivars (FL1867, FL1879, I152-A, Jacqueline Lee, Michigan Purple, Pike, Russet Norkotah, and Snowden). The eight varieties were planted at three times, which were done once the soil temperature at 4-in. reached a daily average of 8, 14 and 20^{o}C. The soil temperatures were monitored at each planting time with a Cole-Parmer 12 channel scanning thermometer. Each planting took place once the threshold (8, 14, 20^{o}C) was surpassed as a five day average. Timing A was planted 21 April, timing B on 9 May, and timing C on 3 June. Tubers were hand planted into pre-hilled sandy soil in four rows by 10 ft. treatments in a randomized complete block design. Plants were spaced approximately 12-in. apart, with each row having nine plants (36 plants total per replication). Vines were killed with Reglone 2EC (1 pt/A on 8 Sep). All tubers from four plants were harvested from all timings on 27 September. Tubers were washed and assessed for black scurf (*R. solani*) incidence (%) and severity, as described above.

Results and Conclusions

The effect of seed treatment, fungicide application, and timing of the applications in-furrow at-planting, emergence or post-emergence on potato growth and development and yield (See Table 2 A-B)

Fungicide treatments on ‘Russet Norkotah’

- Treatments with no seed treatment had a significant difference for the tuber number. Amistar applied at emergence (2) had a significantly higher tuber number than Amistar applied 14 days post-emergence (3). However, no treatments were significantly different from the untreated control (10).
- Treatments with no seed treatment had no significant difference for the stem number (values between 3.2 and 5.2), stolon number (values between 6.2 and 12.3), or sample yield (values between 17.1 and 23.3 lbs).
- Treatments with the Maxim seed treatment had no significant difference for tuber number (values between 18.0 and 25.9), stem number (values between 3.4 and 4.4), stolon number (values between 6.8 and 10.3), or sample yield (values between 23.0 and 31.0 lbs).

Fungicide treatments on ‘Superior’

- Treatments with no seed treatment had no significant difference for the rate of emergence, RAUEPC, (values between 0.056 and 0.066), tuber number (values between 23.0 and 31.0), stem number (values between 3.8 and 4.3), stolon number (values between 20.8 and 25.2), or sample yield (values between 27.8 and 41.3 lbs).
- Treatments with the Maxim seed treatment had no significant difference for the rate of emergence, RAUEPC, (values between 0.057 and 0.069), tuber number (values between 23.2 and 30.9), stem number (values between 2.9 and 3.9), stolon number (values between 18.3 and 24.2), or sample yield (values between 34.9 and 45.0 lbs).

The effect of seed treatment, fungicide application, and timing of the applications in-furrow at-planting, emergence or post-emergence on disease symptoms caused by *Rhizoctonia solani* growth and development (See Table 3 A – B)

Fungicide treatments on ‘Russet Norkotah’

- Treatments with no seed treatment had no significant difference for the percentage of diseased stems (values between 53.0 and 80.3), percentage of diseased stolons (values between 10.0 and 31.0), the incidence of Rhizoctonia on mature tubers (values between 12.5 and 27.5) and the severity of Rhizoctonia on mature tubers (values between 3.4 and 11.9).

- Treatments with the Maxim seed treatment had no significant difference for the percentage of diseased stems (values between 56.7 and 87.3), percentage of diseased stolons (values between 8.3 and 31.9), the incidence of Rhizoctonia on mature tubers (values between 16.3 and 35.0) and the severity of Rhizoctonia on mature tubers (values between 5.6 and 18.1).

Fungicide treatments on 'Superior'

- Treatments with no seed treatment had a significant difference for the percentage of diseased stolons, although no treatments were significantly different from the untreated (10). Headline applied at emergence (8) had a significantly higher percentage of diseased stolons than either Moncut applied at emergence (5) or Headline applied in-furrow at-planting.
- Treatments with no seed treatment had no significant difference for the percentage of diseased stems (values between 12.6 and 36.8), the incidence of Rhizoctonia on mature tubers (values between 1.3 and 15.0) and the severity of Rhizoctonia on mature tubers (values between 0.6 and 10.3).
- Treatments with the Maxim seed treatment had no significant difference for the percentage of diseased stems (values between 14.1 and 22.3), percentage of diseased stolons (values between 4.1 and 10.9), the incidence of Rhizoctonia on mature tubers (values between 0.0 and 10.0) and the severity of Rhizoctonia on mature tubers (values between 0.0 and 3.8).

The effect of seed treatment on potato growth and development and yield (See Table 4) and on disease symptoms caused by *Rhizoctonia solani* growth and development (See Table 5)

'Russet Norkotah'

- Treatments with the Maxim seed treatment had a significantly higher sample weight than treatments with no seed treatment. There were no significant differences for tuber number, stem number or stolon number.
- Treatments with the Maxim seed treatment had a significantly higher percentage of stems with greater than 5% girdling, incidence of black scurf on mature tubers, and severity of black scurf on mature tubers compared with treatments without the seed treatment. There was no significant difference between Maxim seed treatment and no seed treatment for the percentage of diseased stolons.

'Superior'

- Treatments with the Maxim seed treatment had a significantly higher number of stems than treatments with no seed treatment. There were not significant differences between treatments with and without the seed treatment for the rate of emergence (RAUEPC), the number of tubers, numbers of stolons or sample weight.
- Treatments with the Maxim seed treatment had significantly higher percentage of diseased stolons compared to treatments without the seed treatment. There was no significant difference between treatments with and without the seed treatment for the percentage of diseased stems, or the incidence and severity of black scurf on mature tubers.

The effect of planting time for eight varieties of potato, based upon soil temperature (8, 14, or 20^{o}C), on potato growth and development and yield; East Lansing, MI; 2004 (See Table 6A-C).

Timing 1 (8^{o} C)

- 'Michigan Purple had a significantly higher rate of emergence (RAUEPC) than all other varieties, except 'Frito Lay 1879.' In addition, 'Michigan Purple' had a significantly higher tuber number than 'Frito Lay 1867,' 'Frito Lay 1879,' 'Pike,' and 'Russet Norkotah.' Finally, 'Michigan Purple' had a significantly higher stolon number than all other varieties, except 'Frito Lay 1879.'
- There was no significant difference among cultivars for the sample weight (values between 5.7 and 10.5 lbs).

Timing 2 (14^{o} C)

- 'Snowden' had a significantly higher rate of emergence (RAUEPC) than 'I152-A,' 'Jacqueline Lee,' 'Michigan Purple,' and 'Pike.' Also, 'Snowden' had a significantly higher stem number than all other varieties, except 'Frito Lay 1867' and 'Michigan Purple.'

- 'Michigan Purple' had a significantly higher tuber number than all other varieties, except 'Frito Lay 1879' and 'Snowden.' Also, 'Michigan Purple' had a significantly higher stolon number than all other varieties.
- There was no significant difference for sample weight between varieties.

Timing 3 (20^o C)
- 'Russet Norkotah' had a significantly higher rate of emergence (RAUEPC) compared with all other varieties, except 'Snowden.'
- 'Snowden' had a significantly higher stem number than 'Frito Lay 1867,' 'I152-A,' or 'Pike.'
- 'Jacqueline Lee' had a significantly higher sample weight than either 'Frito Lay 1867,' or 'I152-A.'
- There was no significant difference between varieties for either tuber number or stolon number.

The effect of planting time for eight varieties of potato, based upon soil temperature (8, 14, or 20^oC), on disease symptoms caused by *Rhizoctonia solani* growth and development; East Lansing, MI; 2004 (See Table 7 A-C).

Timing 1 (8^o C)
- 'Frito Lay 1879' had a significantly lower percentage of diseased stems compared to all other varieties, except 'Frito Lay 1867,' 'I152-A,' and 'Jacqueline Lee.'
- There was no significant difference between varieties for either the incidence or severity of black scurf on mature tubers.

Timing 2 (14^o C)
- 'Russet Norkotah' had a significantly higher percentage of diseased stems compared to either 'Jacqueline Lee' or 'Snowden.' Also, 'Russet Norkotah' had a significantly higher percentage of diseased stolons compared to either 'I152-A' or 'Michigan Purple.'
- There was no significant difference between varieties for either incidence or severity of black scurf on mature tubers.

Timing 3 (20^o C)
- 'Jacqueline Lee' had a significantly higher percentage of diseased stolons than all other varieties except 'I152-A' and 'Russet Norkotah.'
- 'Russet Norkotah' had a significantly higher incidence and severity of black scurf on mature tubers than 'Frito Lay 1867,' 'Jacqueline Lee,' or 'Michigan Purple.'
- There was no significant difference between varieties for the percentage of diseased stems.

The effect of planting time on potato growth, development and yield, and disease symptoms caused by *Rhizoctonia solani* growth and development East Lansing, MI, (See Table 8).
- Planting time C (20^oC) had a significantly lower rate of emergence (RAUEPC) and higher stem number than either planting time A (8^oC) or B (14^oC). Also, planting time C (20^oC) had a significantly lower percentage of diseased stems and diseased stolons than either planting time A (8^oC) or B (14^oC).
- Planting time A (8^oC) had a significantly higher tuber number than either planting time B (14^oC) or C (20^oC). Also, planting time A (8^oC) had a significantly higher sample weight than planting time C (20^oC).
  There was no significant difference between planting times for either black scurf incidence or severity on mature tubers.

Funding: MPIC

Table 2 A-B: The effect of seed treatment, fungicide application, and the timing of application; in-furrow at-planting (IF), emergence (Em), or 14 days post-emergence (PE) on potato growth and development and yield. Experiments located at; A) Bath, MI, 'Russet Norkotah'; B) Mancelona, MI, 'Superior'; 2005.

Treatment number		Seed Treatment	Treatment Application (amount per 1000 ft)	Application timing [z]	Tuber number [y]		Stem number [y]		Stolon number [y]		Sample Weight [x]	
A	1	None	Amistar 80WDG 0.25 oz	IF	21.8	ab	3.2	a	8.8	a	21.8	a
	2			Em	31.9	a	5.2	a	12.3	a	19.3	a
	3			PE	16.6	b	2.9	a	6.2	a	14.4	a
	4		Moncut 70DF 1.18 oz	IF	27.2	ab	4.3	a	11.6	a	19.5	a
	5			Em	23.0	ab	3.9	a	9.5	a	19.8	a
	6			PE	23.1	ab	4.0	a	11.1	a	17.1	a
	7		Headline 0.21 fl oz	IF	19.9	ab	3.4	a	8.1	a	19.0	a
	8			Em	21.8	ab	3.6	a	10.3	a	23.3	a
	9			PE	21.8	ab	3.9	a	8.7	a	20.4	a
	10		Non-treated		20.0	ab	3.4	a	9.4	a	18.6	a
	1	Maxim 4FS [w]	Amistar 0.25 oz	IF	25.9	a	4.4	a	10.3	a	27.4	a
	2			Em	20.4	a	3.6	a	7.7	a	31.0	a
	3			PE	24.3	a	3.9	a	8.7	a	28.6	a
	4		Moncut 70 DF 1.18 oz	IF	24.1	a	4.3	a	9.3	a	27.4	a
	5			Em	23.9	a	4.3	a	9.7	a	23.0	a
	6			PE	21.1	a	3.6	a	7.4	a	26.9	a
	7		Headline 0.21 fl oz	IF	24.9	a	4.3	a	8.5	a	29.1	a
	8			Em	18.4	a	3.5	a	9.0	a	26.5	a
	9			PE	19.4	a	3.6	a	7.6	a	27.6	a
	10		Non-treated		18.0	a	3.4	a	6.8	a	28.1	a

[z] Application timings: In-furrow at-planting (IF); at emergence (Em); 14 days post-emergence (PE)

[y] Numbers of tubers, stems, and stolons are the average of 4 plants (per replicate) taken 69 days after planting

[x] Sample weight: all tubers greater than 2.5" in any plane (US1 grade) taken from 20ft of row space, 113 days after planting

[w] Maxim 4FS at Seed treatment at 0.08 fl oz/cwt

[v] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Funding: MPIC

Treatment number		Seed Treatment	Treatment Application (amount per 1000 ft)	Application timing [z]	Rate of Emergence (RAUEPC) [y]		Tuber number [x]		Stem number [x]		Stolon number [x]		Sample Weight [w]	
B	1	None	Amistar 80WDG 0.25 oz	IF	0.060	a [u]	27.1	a	3.9	a	21.9	a	39.6	a
	2			Em	0.061	a	25.2	a	3.9	a	22.4	a	27.8	a
	3			PE	0.059	a	31.0	a	3.8	a	23.1	a	36.8	a
	4		Moncut 70DF 1.18 oz	IF	0.062	a	27.4	a	3.9	a	23.7	a	33.6	a
	5			Em	0.058	a	23.0	a	4.3	a	24.0	a	37.3	a
	6			PE	0.066	a	28.3	a	4.0	a	21.5	a	33.1	a
	7		Headline 0.21 fl oz	IF	0.057	a	29.5	a	3.8	a	24.4	a	36.8	a
	8			Em	0.064	a	27.8	a	3.8	a	25.2	a	41.3	a
	9			PE	0.056	a	25.8	a	4.3	a	20.8	a	35.1	a
	10		Non-treated		0.061	a	28.2	a	3.9	a	24.1	a	31.9	a
	1	Maxim 4FS [v]	Amistar 0.25 oz	IF	0.058	a	30.9	a	3.6	a	23.0	a	36.8	a
	2			Em	0.058	a	30.2	a	3.5	a	21.3	a	37.6	a
	3			PE	0.060	a	26.8	a	3.1	a	21.9	a	34.9	a
	4		Moncut 70 DF 1.18 oz	IF	0.069	a	27.9	a	3.0	a	18.9	a	36.5	a
	5			Em	0.063	a	26.4	a	3.4	a	22.0	a	39.0	a
	6			PE	0.067	a	27.2	a	3.3	a	21.8	a	41.5	a
	7		Headline 0.21 fl oz	IF	0.057	a	24.4	a	2.9	a	18.3	a	37.6	a
	8			Em	0.058	a	23.2	a	3.3	a	20.6	a	45.0	a
	9			PE	0.062	a	30.4	a	3.8	a	23.9	a	36.9	a
	10		Non-treated		0.062	a	30.3	a	3.9	a	24.2	a	37.6	a

[z] Application timings: In-furrow at-planting (IF); at emergence (Em); 14 days post-emergence (PE)
[y] RAUEPC: Relative area under the emergence progress curve (max = 100), calculated from the day of planting to 43 days after planting
[x] Numbers of tubers, stems, and stolons are the average of 4 plants (per replicate) taken 67 days after planting
[w] Sample weight: all tubers greater than 2.5” in any plane (US1 grade) taken from 20ft of row space, 112 days after planting
[v] Maxim 4FS at Seed treatment at 0.08 fl oz/cwt
[u] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Funding: MPIC

Table 3 A-B: The effect of seed treatment, fungicide application, and the timing of application; in-furrow at-planting (IF), emergence (Em), or 14 days post-emergence (PE) on disease symptoms caused by *Rhizoctonia solani* growth and development. Experiments located at A) Bath, MI, 'Russet Norkotah'; B) Mancelona, MI, 'Superior'; 2005.

Treatment number		Seed Treatment	Treatment Application (amount per 1000 ft)	Application timing [z]	Percentage of diseased stems [y]		Percentage of diseased stolons [y]		Black scurf on mature tubers [x]		Black scurf severity on mature tubers [w]	
A	1	None	Amistar 80WDG 0.25 oz	IF	66.9	a [u]	23.9	a	20.0	a	8.1	a
	2			Em	53.0	a	11.3	a	27.5	a	9.7	a
	3			PE	65.6	a	17.4	a	18.8	a	5.6	a
	4		Moncut 70DF 1.18 oz	IF	80.3	a	29.6	a	12.5	a	4.7	a
	5			Em	57.4	a	22.5	a	18.8	a	5.6	a
	6			PE	63.7	a	20.6	a	22.5	a	6.6	a
	7		Headline 0.21 fl oz	IF	76.7	a	10.0	a	12.5	a	3.4	a
	8			Em	59.4	a	12.9	a	21.3	a	7.8	a
	9			PE	69.9	a	31.0	a	21.3	a	6.9	a
	10		Non-treated		74.2	a	11.1	a	26.3	a	11.9	a
	1	Maxim 4FS [v]	Amistar 0.25 oz	IF	87.3	a	31.9	a	15.0	a	5.6	a
	2			Em	81.8	a	11.2	a	31.3	a	14.1	a
	3			PE	63.2	a	8.3	a	35.0	a	15.9	a
	4		Moncut 70 DF 1.18 oz	IF	72.7	a	21.7	a	16.3	a	5.3	a
	5			Em	56.7	a	26.3	a	23.8	a	8.8	a
	6			PE	76.3	a	27.1	a	21.3	a	8.1	a
	7		Headline 0.21 fl oz	IF	71.4	a	10.3	a	27.5	a	11.3	a
	8			Em	79.3	a	17.1	a	31.3	a	14.1	a
	9			PE	76.7	a	27.4	a	47.5	a	18.1	a
	10		Non-treated		73.4	a	25.9	a	23.8	a	9.7	a

[z] Application timings: In-furrow at-planting (IF); at emergence (Em); 14 days post-emergence (PE)

[y] Percentage of diseased stems and stolons had greater than 5% girdling caused by *Rhizoctonia solani* are from an average of 4 plants per replicate

[x] Percent incidence of tubers with sclerotia of R. solani from a sample of 20 tubers per replicate taken 113 days after planting

[w] Severity of black scurf (index calculated by counting the tuber number (n = 20 per replicate) falling into class 0 = 0%; 1 = 1 - 5%; 2 = 6 - 10%; 3 = 11 - 15%; 4 = >16% surface area. Indices of 0 to 25 cover the range 0 - 5%; 25 - 50 cover the range 6 - 10%; 51 - 75 cover the range 11 - 15%; 75 - 100 cover the range >15% surface area of the tuber with sclerotia (Taken 113 days after planting).

[v] Maxim 4FS at Seed treatment at 0.08 fl oz/cwt

[u] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Funding: MPIC

Treatment number	Seed Treatment	Treatment Application (amount per 1000 ft)	Application timing [z]	Percentage of diseased stems [y]		Percentage of diseased stolons [y]		Black scurf incidence on mature tubers [x]		Black scurf severity on mature tubers [w]	
B 1	None	Amistar 80WDG 0.25 oz	IF	14.7	a [u]	10.7	ab	2.5	a	0.6	a
2			Em	12.6	a	9.2	ab	1.3	a	0.3	a
3			PE	24.1	a	10.1	ab	10.0	a	3.1	a
4		Moncut 70DF 1.18 oz	IF	16.5	a	8.7	ab	10.0	a	3.8	a
5			Em	18.9	a	8.3	b	6.3	a	4.7	a
6			PE	16.4	a	10.6	ab	15.0	a	10.3	a
7		Headline 0.21 fl oz	IF	22.1	a	7.3	b	13.3	a	4.6	a
8			Em	20.3	a	11.4	ab	15.0	a	8.4	a
9			PE	35.0	a	30.5	a	7.5	a	2.8	a
10		Non-treated		36.8	a	14.2	ab	5.0	a	2.8	a
1	Maxim 4FS [v]	Amistar 0.25 oz	IF	19.6	a	5.9	a	10.0	a	3.1	a
2			Em	14.7	a	10.9	a	0.0	a	0.0	a
3			PE	21.4	a	5.8	a	0.0	a	0.0	a
4		Moncut 70 DF 1.18 oz	IF	16.7	a	6.6	a	1.7	a	0.4	a
5			Em	14.1	a	4.8	a	1.7	a	0.4	a
6			PE	21.0	a	7.1	a	3.8	a	1.3	a
7		Headline 0.21 fl oz	IF	22.3	a	10.4	a	8.8	a	2.5	a
8			Em	15.6	a	6.3	a	1.3	a	0.3	a
9			PE	19.3	a	6.9	a	10.0	a	3.4	a
10		Non-treated		23.7	a	4.1	a	8.8	a	3.8	a

z Application timings: In-furrow at-planting (IF); at emergence (Em); 14 days post-emergence (PE).

y Percentage of diseased stems and stolons had greater than 5% girdling caused by *R.. solani* are from an average of 4 plants per replicate.

x Percent incidence of tubers with sclerotia of *Rhizoctonia solani* from a sample of 20 tubers per replicate 112 days after planting

w Severity of black scurf (index calculated by counting the tuber number (n = 20 per replicate) falling into class 0 = 0%; 1 = 1 - 5%; 2 = 6 - 10%; 3 = 11 - 15%; 4 = >16% surface area. Indices of 0 to 25 cover the range 0 - 5%; 25 - 50 cover the range 6 - 10%; 51 - 75 cover the range 11 - 15%; 75 - 100 cover the range >15% surface area of the tuber with sclerotia (Taken 112 days after planting).

v Maxim 4FS at Seed treatment at 0.08 fl oz/cwt

u Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Funding: MPIC

Table 4: Effect of seed treatment on potato growth and development and yield; Experiments located at A) Bath, MI, 'Russet Norkotah'; and B) Mancelona, MI, 'Superior'; 2005

Variety and Location		Seed Treatment	Rate of Emergence (RAUEPC) [z]		Tuber number [y]		Stem number [y]		Stolon number [y]		Sample Weight [x]	
A	Russet Norkotah	Maxim 4FS [w]			22.1	a [v]	3.9	a	8.5	a	27.6	a
		None			22.7	a	3.8	a	9.6	a	19.3	b
B	Superior	Maxim 4FS	0.061	a	27.8	a	4.0	a	23.1	a	38.3	a
		None	0.060	a	27.3	a	3.4	b	21.6	a	35.3	a

[z] RAUEPC: Relative area under the emergence progress curve (max = 100), calculated from the day of planting to 43 days after planting for 'Superior.'

[y] Numbers of tubers, stems, and stolons are the average of 4 plants (per replicate) taken 67 days after planting for 'Superior' and 69 days after planting for 'Russet Norkotah'; the average of 4 plants destructively harvested.

[x] Sample weight: all tubers greater than 2.5" in any plane (US1 grade), 112 days after planting for 'Superior' and 113 days after planting for 'Russet Norkotah.'

[w] Maxim 4FS at seed treatment at 0.08 fl oz/cwt.

[v] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison).

Table 5: Effect of seed treatment on disease symptoms caused by *Rhizoctonia solani* growth and development; Experiments located at A) Bath, MI, 'Russet Norkotah'; B) Mancelona, MI, 'Superior' 2005

Variety and Location		Seed Treatment	Percentage of diseased stems [z]		Percentage of diseased stolons [z]		Black scurf incidence on mature tubers [y]		Black scurf severity on mature tubers [x]	
A	Russet Norkotah	Maxim 4FS [w]	73.9	a [v]	20.7	a	27.3	a	11.1	a
		None	66.7	b	19.0	a	20.1	b	7.0	b
B	Superior	Maxim 4FS	21.7	a	12.1	a	8.5	a	4.1	a
		None	18.8	a	6.9	b	4.9	a	1.6	a

[z] Percentage of diseased stems and stolons had greater than 5% girdling caused by *R. solani* are from an average of 4 plants per replicate

[y] Percent incidence of tubers with sclerotia of R. solani from a sample of 20 tubers per replicate taken 112 days after planting for 'Superior' and113 days after planting 'Russet Norkotah'

[x] Severity of black scurf (index calculated by counting the tuber number (n = 20 per replicate) falling into class 0 = 0%; 1 = 1 - 5%; 2 = 6 - 10%; 3 = 11 - 15%; 4 = >16% surface area. Indices of 0 to 25 cover the range 0 - 5%; 25 - 50 cover the range 6 - 10%; 51 - 75 cover the range 11 - 15%; 75 - 100 cover the range >15% surface area of the tuber with sclerotia (Taken 112 days after planting for 'Superior' and 113 days after planting 'Russet Norkotah').

[w] Maxim 4FS at Seed treatment at 0.08 fl oz/cwt

[v] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Funding: MPIC

Table 6 A-C: Effect of variety and planting time on potato growth and development and yield, East Lansing, MI, 2005. Planting time A, once soil temperatures at a depth of four inches reaches eight degrees C; Planting time B, once soil temperatures at a depth of four inches reaches 14 degrees C; and planting time C, once soil temperatures at a depth of four inches reaches 20 degrees C

Timing	Variety [z]	Rate of Emergence (RAUEPC) [y]		Tuber Number [x]		Stem Number [x]		Stolon Number [x]		Sample weight [w]	
A	Frito Lay 1867	0.045	cd [v]	17.9	b	4.6	a	16.8	b	7.8	a
	Frito Lay 1879	0.057	ab	16.9	b	5.0	a	31.2	a	8.7	a
	I152-A (MSU)	0.031	f	18.6	ab	3.9	ab	16.6	b	5.8	a
	Jacqueline Lee	0.032	ef	18.4	ab	4.2	ab	16.8	b	5.0	a
	Michigan Purple	0.062	a	27.8	a	3.6	ab	34.3	a	10.5	a
	Pike	0.037	def	11.3	b	2.1	b	11.7	b	5.7	a
	Russet Norkotah	0.041	de	16.5	b	3.3	ab	9.5	b	7.3	a
	Snowden	0.051	bc	20.5	ab	4.4	a	17.3	b	7.8	a
B	Frito Lay 1867	0.046	abcd [v]	11.4	bcd	5.3	ab	17.7	bc	5.3	a
	Frito Lay 1879	0.053	ab	16.8	abc	3.9	bc	24.5	b	5.5	a
	I152-A (MSU)	0.028	e	4.5	d	3.3	bc	9.8	cd	2.3	a
	Jacqueline Lee	0.037	de	9.8	bcd	3.0	c	10.5	cd	3.2	a
	Michigan Purple	0.040	cd	23.8	a	4.5	abc	36.8	a	8.8	a
	Pike	0.043	bcd	8.8	cd	3.8	bc	11.3	cd	5.8	a
	Russet Norkotah	0.049	abc	13.9	bc	3.8	bc	5.3	d	7.7	a
	Snowden	0.054	a	18.3	ab	6.2	a	19.8	bc	7.3	a
C	Frito Lay 1867	0.024	d [v]	13.0	a	3.6	b	11.3	a	2.5	b
	Frito Lay 1879	0.038	c	17.0	a	7.4	ab	21.7	a	4.3	ab
	I152-A (MSU)	0.002	e	13.6	a	3.1	b	18.6	a	1.5	b
	Jacqueline Lee	0.014	d	14.9	a	3.9	ab	19.5	a	8.7	a
	Michigan Purple	0.041	bc	17.5	a	4.4	ab	13.1	a	4.2	ab
	Pike	0.024	d	8.5	a	4.0	b	11.8	a	5.3	ab
	Russet Norkotah	0.053	a	18.3	a	5.6	ab	21.8	a	6.0	ab
	Snowden	0.050	ab	19.7	a	8.3	a	25.5	a		

[z] Variety: The variety used in all three planting times

[y] RAUEPC: Relative area under the emergence progress curve (max = 100), calculated from the day of planting to 62 days after planting (dap) for pt 1, 53 dap for pt 2, and 38 dap for pt 3

[x] Numbers of tubers, stems, and stolons are the average of 4 plants (per replicate) taken 97 dap for pt 1; 79 dap for pt 2; and 54 dap for pt 3

[w] Sample weight: The weight (lbs) of all tubers from 4 plants (per replicate) greater than 1cm in any plane, taken 124 dap for pt 1; 115 dap for pt 2, 100 dap for pt 3

[v] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Funding: MPIC

Table 7 A-C: Effect of variety and planting time on disease symptoms caused by *Rhizoctonia solani* growth and development, East Lansing, MI, 2005; Planting time A, once soil temperatures at a depth of four inches reaches eight degrees C; Planting time B, once soil temperatures at a depth of four inches reaches 14 degrees C; and planting time C, once soil temperatures at a depth of four inches reaches 20 degrees C

Timing	Variety	Diseased stems [z]	Diseased stolons[y]	Black scurf incidence	Black scurf severity [x]
A	Frito Lay 1867	49.9 ab [w]	54.0 a	16.7 a	13.0 a
	Frito Lay 1879	23.8 b	49.1 a	18.3 a	12.3 a
	MSI152-A (MSU)	43.8 ab	9.6 c	5.0 a	10.5 a
	Jacqueline Lee	41.2 ab	30.8 abc	13.3 a	11.8 a
	Michigan Purple	61.7 a	22.9 bc	3.3 a	10.3 a
	Pike	63.9 a	14.0 c	1.7 a	10.2 a
	Russet Norkotah	62.9 a	39.6 ab	13.3 a	11.7 a
	Snowden	66.9 a	49.8 a	15.0 a	11.8 a
B	Frito Lay 1867	41.5 ab [v]	43.7 ab	8.3 a	10.8 a
	Frito Lay 1879	41.3 ab	33.7 abc	8.3 a	10.8 a
	MSI152-A (MSU)	38.8 ab	18.9 bc	3.3 a	10.3 a
	Jacqueline Lee	19.0 b	23.2 abc	1.7 a	10.2 a
	Michigan Purple	23.1 ab	9.0 c	5.0 a	10.8 a
	Pike	30.7 ab	32.8 abc	20.0 a	14.0 a
	Russet Norkotah	59.2 a	57.1 a	20.0 a	12.3 a
	Snowden	13.3 b	40.4 abc	31.7 a	15.3 a
C	Frito Lay 1867	23.2 a [v]	15.3 b	3.3 b	10.3 b
	Frito Lay 1879	1.7 a	9.5 b	5.0 ab	11.0 ab
	MSI152-A (MSU)	31.7 a	17.2 ab	7.5 ab	10.8 ab
	Jacqueline Lee	1.8 a	42.5 a	0.0 b	10.0 b
	Michigan Purple	10.8 a	0.9 b	0.0 b	10.0 b
	Pike	13.2 a	12.8 b	20.0 ab	12.3 ab
	Russet Norkotah	9.0 a	21.9 ab	26.7 a	15.8 a
	Snowden	2.8 a	8.9 b		

[z] Percent of stems and stolons with greater than 5% girdling caused by R. solani are from an average of 4 plants (per replicate) taken 98 dap for pt 1; 79 dap for pt 2; and 54 dap for pt 3

[y] Percent incidence of tubers with sclerotia of R. solani from a sample of 20 tubers per replicate taken 124 dap for pt 1, 115 dap for pt 2, 100 dap for pt 3

[x] Severity of black scurf (index calculated by counting the tuber number (n = 20 per replicate) falling into class 0 = 0%; 1 = 1 - 5%; 2 = 6 - 10%; 3 = 11 - 15%; 4 = >16% surface area. Indices of 0 to 25 cover the range 0 - 5%; 25 - 50 cover the range 6 - 10%; 51 - 75 cover the range 11 - 15%; 75 - 100 cover the range >15% surface area of the tuber with sclerotia taken 124 dap for pt 1, 115 dap for pt 2, 100 dap for pt 3

Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

Potato Insect Biology and Management

Report to the Michigan Potato Industry Commission
January 12, 2006

Adam M. Byrne, Walter L. Pett, Edward J. Grafius, Beth A. Bishop

Outline.

I. Resistance of Colorado potato beetle populations to imidacloprid and thiamethoxam was evaluated for field populations from Michigan, as well as other locations in the Midwest and locations in the northeastern U.S.

II. Field insecticide evaluations of registered and experimental insecticides.

III. Use of a trap crop and alternative insecticides were evaluated for managing resistant Colorado potato beetles.

IV. Project GREEEN field trial to test management systems using traditionally bred resistant varieties and low impact insecticides to combat neonicotinoid resistance in Colorado potato beetle.

I. Resistance of Colorado potato beetle populations to imidacloprid and thiamethoxam.

Imidacloprid (Admire®, Provado®) has been the primary insecticide for Colorado potato beetle control since its registration in 1995. In 2002, thiamethoxam (Platinum®, Actara®), also a neonicotinoid, became available for commercial use. Such long term and widespread use of one chemical class greatly increases the chances for resistance development. Growers in the Northeast and Midwest rely heavily on these insecticides for control of Colorado potato beetle – 60-80% of the acreage is treated annually with either imidacloprid or thiamethoxam (Anon. 2004). The similarities between these two compounds and with other neonicotinoid insecticides indicate that resistance to one is likely to lead to resistance to others (Mota-Sanchez et al. 2006).

Our objectives were to continue gathering data on susceptibility to imidacloprid and thiamethoxam in Colorado potato beetle populations collected from commercial potato fields in Michigan and other regions of the United States. A second objective was to monitor the correlation between imidacloprid and thiamethoxam susceptibility. To accomplish these objectives, 29 Colorado potato beetle populations (11 Michigan populations, 15 populations collected in other states, and two laboratory populations) were selected and/or bioassayed with imidacloprid and/or thiamethoxam.

Methods

During 2005, 11 Colorado potato beetle populations were collected from two different Michigan counties (Mecosta and Montcalm). Cooperators also provided one population each from New York, Virginia, and Washington state, three populations each from Minnesota and Massachusetts, and six populations from Wisconsin. Two laboratory strains were also tested (Table I.1).

Colorado potato beetle adults were either kept at room temperature (25 ± 1^{o} C) and fed foliage daily or, for longer term storage, kept in controlled environment chambers (11 ± 1^{o} C) and fed weekly. Beetles were treated with 1 μl of acetone/insecticide solution of known concentration applied to the ventral surface of the abdomen using a 50 μl Hamilton® microsyringe. Following treatment, beetles were placed in 100 mm diameter petri dishes lined with Whatman® No. 1 filter paper and provided with fresh potato foliage. They were kept at 25 ± 1^{o} C and the foliage and filter paper were checked daily and changed as needed.

A preliminary screen was conducted on most populations (for populations tested in previous years, screening was sometimes not necessary) to determine relative susceptibility to imidacloprid and thiamethoxam by testing 10 beetles each with three concentrations of insecticide/acetone solution. Based on the results of these screens, a range of five concentrations was selected for each population to be assayed and each bioassay was replicated up to three times. In each replicate, 10-15 beetles were treated with each concentration (three to five beetles per dish and three dishes per concentration). For some populations, few beetles were available and only preliminary screens were run.

Beetle response was assessed 7 days post treatment. A beetle was classified as dead if its abdomen was shrunken, it did not move when its legs or tarsi were pinched, and its elytra were darkened. A beetle was classified as walking and healthy if it was able to grasp a pencil and walk forward normally. A beetle was classified as poisoned if its legs were extended and shaking, it was unable to right itself or grasp a pencil, and it was unable to walk forward normally at least one body length. Dead and poisoned beetle numbers were pooled for analysis. Data were analyzed using standard log-probit analysis (SAS® System v9.1.3).

Results

The imidacloprid LD_{50} value (dose lethal to 50% of the beetles) for the susceptible laboratory strain (New Jersey) was 0.041 μg/beetle. The LD_{50} values for imidacloprid ranged from 0.052 μg/beetle (Rodney) to 4.063 μg/beetle (Sackett Potatoes, field 28-29) for Michigan populations and from 0.027 μg/beetle (Clay, MN) to 0.108 μg/beetle (Okray, WI) for out-of-state populations (Table I.2, Figure I.1). Preliminary screens of three populations from Massachusetts (Pivot, Soccer, and Whately) indicated high levels of resistance to imidacloprid (mortality was less than 50% at 0.8 µg/beetle), similar to values from the East Coast in recent years.

As in 2004, significant levels of resistance to imidacloprid were present in Michigan. Beetles from Sackett Potatoes, field 28-29 were 100-fold resistant to imidacloprid, compared to the susceptible New Jersey strain. Two other samples from different fields on the same farm (field 3-4 and field 41-42) were also greater than 20-fold resistant to imidacloprid and are believed to be from the same population. Beetles from field 109 (ca. 6 miles northeast of field 28-29) were 10-fold resistant. Two additional populations from this site, plus another from a nearby county (Montcalm Research Farm), had LD_{50} values that were significantly higher than the susceptible New Jersey strain, but less than 10 times higher – a situation also found for five populations from Wisconsin and one each from Minnesota and New York. A preliminary screen from another field at Sackett Potatoes (field 19-20) also indicated high levels of resistance to imidacloprid (53% mortality at 0.8 µg/beetle), while beetles from two other Michigan fields, Sackett Acres field 12 and Sackett Ranch field TO 1-4, appeared to be susceptible, with mortalities of 70% and 93%, respectively, at 0.3 µg/beetle.

The thiamethoxam LD_{50} value for the susceptible New Jersey strain was 0.092 µg/beetle. This value was significantly higher than results from 2004 when the LD_{50} value was 0.033 µg/beetle for the same strain. It is not clear what led to this difference. This year's LD_{50} value for the New Jersey strain was also significantly higher than values for other susceptible field populations tested in 2005 and was, therefore, not used for comparison purposes this year.

The LD_{50} values for thiamethoxam for field populations ranged from 0.042 µg/beetle (Rodney) to 0.554 µg/beetle (Sackett Potatoes, field 28-29) for Michigan populations and from 0.027 µg/beetle (Clay, MN) to 0.209 µg/beetle (Whately, MA) for out-of-state populations (Table I.3, Figure I.2). The results for Sackett Potatoes field 28-29 is a major concern since it is greater than 15 times the typical LD_{50} value for susceptible beetles. No out-of-state populations showed greater than 10-fold resistance to thiamethoxam, mainly because few beetles were sent in from the East Coast. Preliminary screen of a Massachusetts population, Pivot, showed 70% mortality at 0.8 µg/beetle suggesting some resistance.

While all other field populations were still rather susceptible to thiamethoxam, LD_{50} values appear to be slightly higher than normal over much of the Midwest. For example, the 2005 Prairie, WI LD_{50} value (0.072 µg/beetle) was significantly greater than the LD_{50} value from the same site in 2004 (0.042 µg/beetle). Three populations (Sackett Potatoes fields 3-4 and 28-29 and Whately, MA) had significantly higher LD_{50} values than the susceptible New Jersey strain even though the LD_{50} for that strain was unusually high.

Susceptibility to imidacloprid (as measured by LD_{50}) in field-collected Colorado potato beetle populations was highly correlated with susceptibility to thiamethoxam (Figure I.3). This result was also found in 1998, 1999, 2000, 2002, 2003, and 2004 (e.g. Grafius et al.

2004 and 2005). This high correlation and other data on cross resistance (e.g. Mota-Sanchez et al. 2006) indicate that alternation between imidacloprid and thiamethoxam will not be an effective resistance management technique.

The Hadley population was collected from a commercial potato field in Massachusetts in 2003 (Grafius et al. 2004) and survivors from bioassays with thiamethoxam were used to start a laboratory strain. Adults from each generation were selected with thiamethoxam doses causing 60-90% mortality, leading to very high LD_{50} values for both thiamethoxam (1.807 μg/beetle = over 50 fold resistance compared to susceptible beetles) and imidacloprid (24.590 μg/beetle = over 600 fold resistance compared to susceptible beetles). The repeated selections have led to a significantly higher LD_{50} value for thiamethoxam compared to the original field population (0.867 μg/beetle), along with less variability (lower chi-square value and tighter confidence limits). It is interesting to note that repeated selection with thiamethoxam has resulted in much higher resistance to imidacloprid, again indicating that alternations between these two insecticides will not be useful to manage insecticide resistance.

Summary:

- Three locations in Michigan had greater than 10-fold resistance to imidacloprid and three others had significantly higher LD_{50} values than the susceptible strain.
- Six populations from the Midwest (excluding Michigan) had significantly higher LD_{50} values for imidacloprid than the susceptible strain.
- The highest level of thiamethoxam resistance in Michigan was from the same field that showed 100-fold resistance to imidacloprid.
- Laboratory selection shows that thiamethoxam resistance can increase rapidly with selection.
- Under lab selection with thiamethoxam, resistance to imidacloprid remains stable or increases.

Table I.1. Colorado potato beetle populations tested for susceptibility to imidacloprid and thiamethoxam in 2005.

Michigan populations
Montcalm Farm Adults were collected on 21 July 2005 from the Michigan State University Montcalm Potato Research Farm in Entrican, MI.
P. Main R1 Adults were collected on 29 July 2005 by Mark Otto, AgriBusiness Consultants, Inc., from a commercial potato field in Montcalm Co., MI.
Rodney Adults were collected on 11 and 13 June 2005 by Mark Otto, AgriBusiness Consultants, Inc., from a commercial potato field in Mecosta Co., MI.
Sackett Acres *Field 12* Adults were collected on 21 July 2005 by Mark Otto, AgriBusiness Consultants, Inc., from a commercial potato field in Mecosta Co., MI.
Sackett Potatoes Adults were collected by Mark Otto, AgriBusiness Consultants, Inc., and Michigan State University researchers from commercial potato fields in Mecosta Co., MI.
Field 3-4 Same site as “Sackett” in our 2004 summary. Adults were collected on 1, 9, 13, and 25 June 2005.
Field 19-20 Adults were collected on 9, 13, 14, 20, and 21 June 2005.
Field 28-29 Adults were collected on 15 & 29 August 2005.
Field 41-42 Adults were collected on 15 & 29 August 2005.
Field 47-48 Same site as “Mecosta” in our 2004 summary – adults were collected on 13, 14, and 20 June 2005.
Field 103 Adults were collected on 29 July 2005.
Sackett Ranch *Fields TO 1-4* Adults were collected on 29 July 2005 by Mark Otto, AgriBusiness Consultants, Inc., from a commercial potato field in Mecosta Co., MI.
Out-of-state populations
Becker, Minnesota Adults were collected on 19 July 2005 by David Ragsdale, University of Minnesota, from a commercial potato field, treated with Rimon, near Becker, MN.
Clay, Minnesota Adults were collected on 18 May 2005 by Donald R. Carey, North Dakota State University, from untreated guard rows adjacent to a potato insecticide trial in Clay County, MN.
Hancock, Wisconsin Adults were collected on 12 July 2005 by Scott Chapman, University of Wisconsin-Madison, from the Hancock Agricultural Research Station, Waushara Co., WI
Hudson, New York Adults were collected on 6 July 2005 by Sandra Shinn, Syngenta Crop Protection, Inc., from research potatoes, treated with Actara and Warrior, at the Syngenta Eastern Region Technical Center, Hudson, NY.
Miller, Wisconsin Adults were collected on 3 August 2005 by Scott Chapman, University of Wisconsin-Madison, from a commercial potato field in Hancock, WI.
Monticello, Minnesota Adults were collected on 12 July 2005 by Brett Miller, Syngenta Crop Protection, Inc. from a commercial potato field, treated with Admire (16 oz/A at planting) and Diquat (4 days prior to collection), in Monticello, MN.

Table I.1. cont'd. Colorado potato beetle populations tested for susceptibility to imidacloprid and thiamethoxam in 2005.

Out-of-state populations cont'd
Okray, Wisconsin Adults were collected on 1 August 2005 by Scott Chapman, University of Wisconsin-Madison, from a commercial potato field, treated with Admire (16 oz/A at planting) and Asana, in Okray, WI.
Painter, Virginia Adults were collected on 27 June 2005 by Tom Kuhar, Virginia Polytechnic Institute and State University, from untreated potatoes in Painter, VA.
Pasco, Washington Adults were collected on 6 July 2005 by Chris Clemens, Syngenta Crop Protection, Inc. from a commercial potato field, treated with Platinum (8 oz/A) in Pasco, WA.
Pivot, Massachusetts Adults were collected on 12 July 2005 by Sandra Shinn, Syngenta Crop Protection, Inc. from a commercial potato field in West Deerfield, MA.
Plover, Wisconsin Adults were collected on 21 July 2005 by Deana Sexon, University of Wisconsin-Madison, from a commercial potato field treated with Admire at planting.
Prairie, Wisconsin Adults were collected on 1 August 2005 by Scott Chapman, University of Wisconsin-Madison, from a commercial potato field treated with Admire (12 oz/A) at planting.
Soccer, Massachusetts Adults were collected on 12 July 2005 by Sandra Shinn, Syngenta Crop Protection, Inc. from a commercial potato field in South Deerfield, MA.
Spring Green, Wisconsin Adults were collected on 26 July 2005 by Larry Alsum from a commercial potato field treated with foliar applications of Rimon (9 oz/A), Baythroid (1 oz/A), and Leverage (3.75 oz/A).
Whately, Massachusetts Adults were collected on 12 July 2005 by Sandra Shinn, Syngenta Crop Protection, Inc. from a commericial potato field in Whately, MA
Laboratory strains
Hadley Collected from Hadley, MA in July 2003. Adults from each generation have been selected with thiamethoxam doses causing 60-80% mortality.
New Jersey Adults obtained from the Phillip Alampi Beneficial Insects Rearing Laboratory, New Jersey Department of Agriculture.

Table I.2. LD_{50} values (µg/beetle) and 95% fiducial limits for Colorado potato beetle populations treated with imidacloprid at 7 days after treatment.

	LD_{50}	95% fiducial limits
Michigan populations		
Montcalm Farm	0.119[1]	0.084-0.241
Rodney	0.052	0.040-0.063
Sackett Potatoes		
Field 3-4	0.630[2]	0.407-0.793
Field 28-29	4.063[2]	2.003-1688.000
Field 41-42	1.110[2]	*
Field 47-48	0.245[1]	0.152-0.351
Field 103	0.407[1]	0.266-0.517
out-of-state populations		
Becker, MN	0.086[1]	0.070-0.101
Clay, MN	0.027	0.022-0.032
Hancock, WI	0.092[1]	0.074-0.120
Hudson, NY	0.092[1]	0.062-0.167
Miller, WI	0.099[1]	0.054-0.136
Monticello, MN	0.034	0.016-0.045
Okray, WI	0.108[1]	0.088-0.131
Painter, VA	0.052	0.045-0.061
Pasco, WA	0.053	0.045-0.060
Plover, WI	0.055	0.033-0.068
Prairie, WI	0.087[1]	0.071-0.104
Spring Green, WI	0.086[1]	0.069-0.105
laboratory strains		
Hadley	24.590[2]	*
New Jersey	0.041	0.035-0.048

[1] significantly greater than LD_{50} value for susceptible New Jersey strain
[2] greater than 10 times the LD_{50} value for susceptible New Jersey strain

Table II.1. Seasonal mean number of Colorado potato beetle egg masses, small larvae, large larvae, and adults per five plants.

			Seasonal mean of 1st-generation CPB/5 plants			
Treatment/formulation	Rate	Application date	Egg Masses	Small Larvae	Large Larvae	Adults
A13623	49.5 g ai/ha	22 Jun, 6 Jul	0.2	0.6a	0.6a	0.3a
Actara 25 WG	1.5 oz/acre	22 Jun, 6 Jul	0.2	2.9abcd	0.8a	0.3a
Actara 25 WG	3.0 oz/acre	22 Jun, 6 Jul	0.1	4.2 bcd	2.0a	0.2a
Actara 25 WG +	1.5 oz/acre	22 Jun, 6 Jul	0.3	2.2abcd	0.4a	0.1a
Warrior 1 CS	2.9 fl oz/acre					
Admire 2F[a]	16 fl oz/acre	at planting	0.3	0.8a	0.8a	1.0a
AE F106464 550 SC[a]	7 oz/acre	at planting	0.2	0.8a	0.3a	0.5a
Agri-Mek 0.15 EC +	8 fl oz/acre	22 Jun, 6 Jul	0.4	2.1abcd	0.7a	0.5a
Warrior 1 CS	2.3 fl oz/acre					
Assail 30 SG or	5 fl oz/acre	22 Jun	0.3	1.4abcd	0.3a	0.3a
Rimon 0.83 EC	12 fl oz/acre	6 Jul				
BAS 320 +	4.57 fl oz/acre	22 Jun, 6 Jul	0.2	5.6 de	0.4a	0.5a
Penetrator Plus	0.5% v/v					
Baythroid 2E	1.5 oz/acre	22 Jun, 29 Jun, 6 Jul, 13 Jul	0.3	1.9abcd	1.9a	0.9a
Cruiser 5 FS[a]	0.14 fl oz/cwt	at planting	0.1	0.2a	0.1a	0.4a
Leverage 2.7 SE	3.75 oz/acre	22 Jun, 6 Jul	0.2	1.8abcd	1.0a	0.2a
Platinum 2 SC[a]	8 fl oz/acre	at planting	0.3	0.4a	0.3a	0.3a
Rimon 0.83 EC	12 fl oz/acre	22 Jun, 6 Jul	0.3	8.0 e	2.0a	0.8a
Rimon 0.83 EC	9 fl oz/acre	22 Jun, 6 Jul	0.2	5.5 de	1.2a	0.5a
Rimon 0.83 EC +	9 fl oz/acre	22 Jun, 6 Jul	0.3	4.8 cd	1.2a	0.2a
Baythroid 2E	1.5 oz/acre					
SpinTor 2 SC	6 fl oz/acre	22 Jun, 6 Jul	0.1	1.7abcd	0.8a	0.2a
Trigard 75 WP or	5.3 oz/acre	22 Jun	0.1	4.5 bcd	1.1a	0.6a
Actara 25 WG	1.5 oz/acre	29 Jun				
V10112 1% granular[b]	976 g/1000 ft	at planting	0.1	0.7a	0.7a	0.1a
V10112 2% granular[b]	488 g/1000 ft	at planting	0.2	3.1abcd	0.8a	0.2a
Venom 70 SG[a]	13.9 g/1000 ft	at planting	0.3	2.8abcd	1.4a	0.5a
Venom 20 SG	10.5 oz/acre	22 Jun, 29 Jun, 6 Jul, 13 Jul	0.1	2.1abcd	1.5a	0.2a
Venom 70 SG +	13.9 g/1000 ft	at planting	0.2	2.4abcd	1.8a	0.3a
Surfix[a]	2 pints/100 gallons					
Untreated check			0.3	2.5abcd	12.2 b	4.7 b
p value			0.1031	0.0006	0.0002	0.0001

Means within a column followed by different letters are significantly different (P<0.05, Fisher's Protected LSD). Data transformed for analysis with log (x+1 presented in non-transformed units.

[a]treatment applied in furrow at planting

[b]granular treatment sprinkled in furrow at planting

Table II.2. Mean yield (weight/40 row ft) harvested and defoliation ratings taken on two sampling dates.

Treatment/formulation	Rate	Application dates	Yield (lb/40 row ft) Size A[b]	Size B[b]	Total	Defoliation rating[c] 5 Jul	12 Jul
A13623	49.5 g ai/ha	22 Jun, 6 Jul	73.7	4.0	77.7	1.0a	1.0a
Actara 25 WG	1.5 oz/acre	22 Jun, 6 Jul	65.7	2.7	68.3	1.3a	1.0a
Actara 25 WG	3.0 oz/acre	22 Jun, 6 Jul	65.2	2.3	67.5	1.3a	1.0a
Actara 25 WG +	1.5 oz/acre	22 Jun, 6 Jul	58.7	2.5	61.2	1.0a	1.0a
Warrior 1 CS	2.9 fl oz/acre						
Admire 2F[a]	16 fl oz/acre	at planting	46.0	2.8	48.8	1.0a	1.0a
AE F106464 550 SC[a]	7 oz/acre	at planting	70.8	2.3	73.2	1.3a	1.0a
Agri-Mek 0.15 EC +	8 fl oz/acre	22 Jun, 6 Jul	66.0	3.3	69.3	1.0a	1.0a
Warrior 1 CS	2.3 fl oz/acre						
Assail 30 SG or	5 fl oz/acre	22 Jun	66.0	2.3	68.3	1.0a	1.0a
Rimon 0.83 EC	12 fl oz/acre	6 Jul					
BAS 320 +	4.57 fl oz/acre	22 Jun, 6 Jul	60.8	3.5	64.3	1.7a	1.3a
Penetrator Plus	0.5% v/v						
Baythroid 2E	1.5 oz/acre	22 Jun, 29 Jun, 6 Jul, 13 Jul	69.0	2.8	71.8	1.3a	1.0a
Cruiser 5 FS[a]	0.14 fl oz/cwt	at planting	59.7	2.5	62.2	1.0a	1.0a
Leverage 2.7 SE	3.75 oz/acre	22 Jun, 6 Jul	66.5	2.8	69.3	1.3a	1.0a
Platinum 2 SC[a]	8 fl oz/acre	at planting	77.8	2.8	80.7	1.0a	1.0a
Rimon 0.83 EC	12 fl oz/acre	22 Jun, 6 Jul	72.5	2.7	75.2	1.7a	1.7a
Rimon 0.83 EC	9 fl oz/acre	22 Jun, 6 Jul	62.3	2.8	65.2	1.0a	1.0a
Rimon 0.83 EC +	9 fl oz/acre	22 Jun, 6 Jul	68.8	2.5	71.3	1.3a	1.0a
Baythroid 2E	1.5 oz/acre						
SpinTor 2 SC	6 fl oz/acre	22 Jun, 6 Jul	69.3	2.5	71.8	1.0a	1.0a
Trigard 75 WP or	5.3 oz/acre	22 Jun	65.8	2.7	68.5	1.3a	1.0a
Actara 25 WG	1.5 oz/acre	29 Jun					
V10112 1% granular[b]	976 g/1000 ft	at planting	67.3	2.8	70.2	1.0a	1.3a
V10112 2% granular[b]	488 g/1000 ft	at planting	83.7	3.5	87.2	1.0a	1.0a
Venom 70 SG[a]	13.9 g/1000 ft	at planting	61.8	4.0	65.8	1.0a	1.3a
Venom 20 SG	10.5 oz/acre	22 Jun, 29 Jun, 6 Jul, 13 Jul	71.3	3.2	74.5	1.3a	1.3a
Venom 70 SG +	13.9 g/1000 ft	at planting	71.8	3.2	75.0	1.3a	1.3a
Surfix[a]	2 pints/100 gallons						
Untreated check			70.7	2.5	73.2	3.0 b	2.7 b
p value			0.3286	0.2169	0.3059	0.0001	0.0001

Means within a column followed by different letters are significantly different (P<0.05, Fisher's Protected LSD).

[a] treatment applied in-furrow at planting

[b] Size A = tubers greater than 2 inches. Size B = tubers that are 2 inches or less.

[c] Defoliation rating: 1 = no defoliation; 2 = 1-25% defoliation; 3 = 26-50% defoliation; 4 = 51-75% defoliation; 5 = 76-100% def

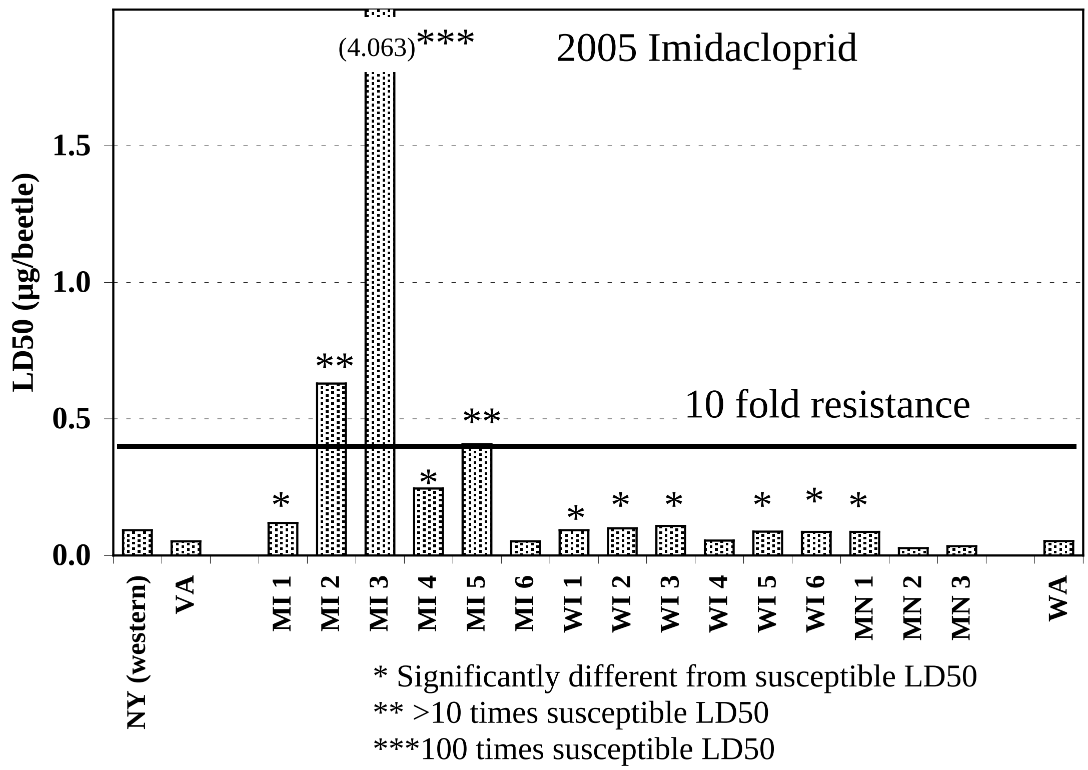

Figure I.1. Susceptibility of field populations of Colorado potato beetle to imidacloprid.

Table I.3. LD_{50} values (µg/beetle) and 95% fiducial limits for Colorado potato beetle populations treated with thiamethoxam at 7 days after treatment.

	LD_{50}	95% fiducial limits
Michigan populations		
Montcalm Farm	0.096[1]	0.079-0.122
Rodney	0.042	0.035-0.052
Sackett Potatoes		
Field 3-4	0.195[1]	0.158-0.232
Field 28-29	0.554[1]	0.446-0.657
Field 41-42	0.171[1]	0.076-0.246
out-of-state populations		
Becker, MN	0.053	1.25×10^{-4}-0.084
Clay, MN	0.027	0.019-0.034
Hancock, WI	0.051	0.028-0.109
Hudson, NY	0.089	0.068-0.174
Miller, WI	0.123	0.094-0.197
Monticello, MN	0.030	0.025-0.036
Okray, WI	0.096	0.077-0.116
Painter, VA	0.113	0.090-0.161
Pasco, WA	0.055	0.047-0.063
Plover, WI	0.056	0.041-0.071
Prairie, WI	0.072	0.057-0.085
Spring Green, WI	0.085	0.024-0.101
Whately, MA	0.209[1]	0.132-0.286
laboratory strains		
Hadley	1.807[2]	1.518-2.111
New Jersey	0.092[3]	0.076-0.125

[1] significantly greater than LD_{50} value for susceptible New Jersey strain
[2] greater than 10 times the LD_{50} value for susceptible New Jersey strain
[3] significantly higher than the LD_{50} value for this strain in 2004 (0.033 µg/beetle)

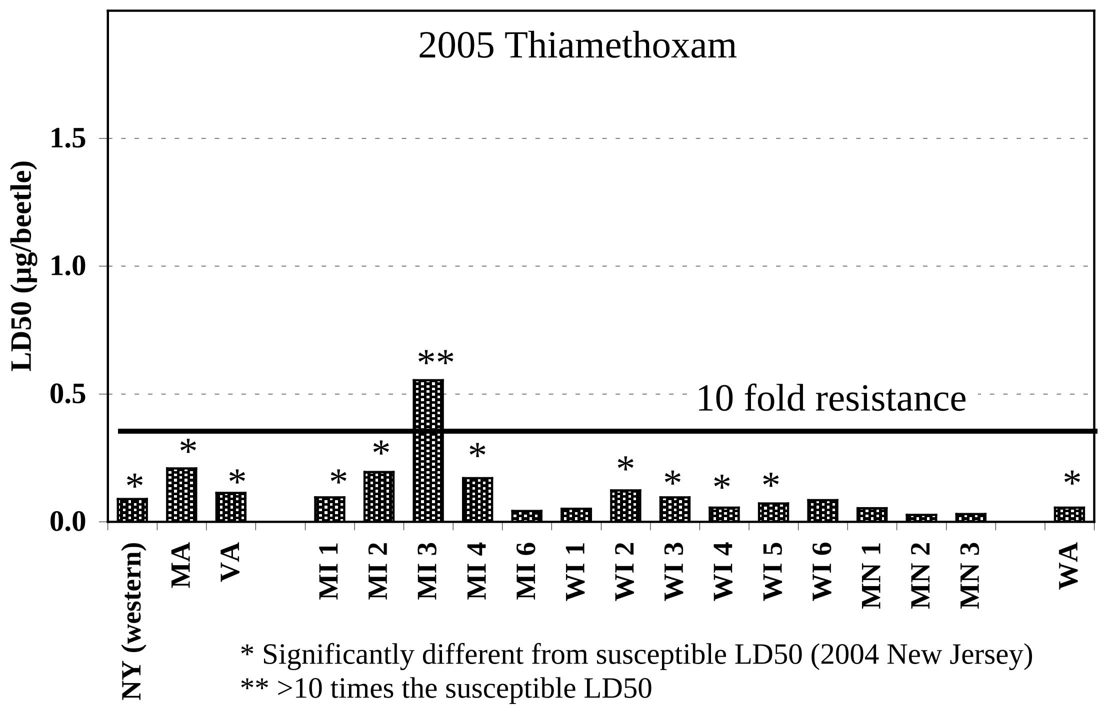

Figure I.2. Susceptibility of field populations of Colorado potato beetle to thiamethoxam.

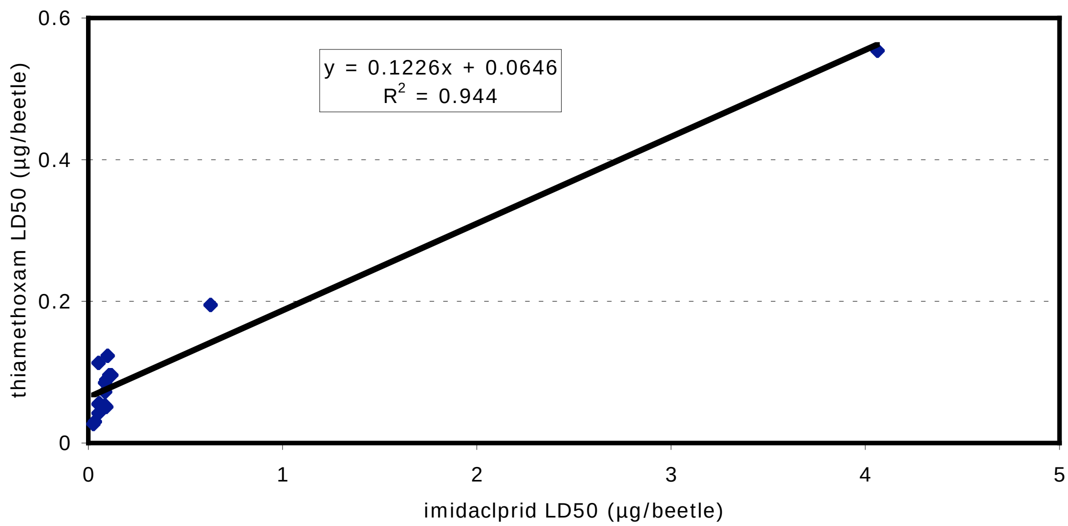

Figure I.3. Correlation between susceptibility to imidacloprid and thiamethoxam for all field populations tested in 2004 (n=15).

II. Field insecticide evaluations of registered and experimental insecticides.

Evaluation of registered and experimental insecticides for control of Colorado potato beetle provides data on comparative effectiveness of products and data to support future product registrations.

Methods.

Twenty-three insecticide treatments (Table 1) were tested at the Michigan State University Montcalm Research Farm, Entrican, MI for control of CPB. 'Atlantic' potatoes were planted 12 in. apart, with 34 in. row spacing on 18 May 2005. Treatments were replicated three times in a RCB design. Plots were 40 ft long and three rows wide.

Admire, AE F106464, Cruiser, Platinum, and Venom treatments were applied in-furrow at planting, using a single-nozzle hand-held boom (30 gpa, 30 psi). V10112 treatments were applied by sprinkling the granular material into the furrow after the seed pieces were dropped. Foliar treatments were first applied at greater than 50% egg hatch on 22 Jun. Subsequent first-generation sprays for most treatments were applied on 29 Jun, 6 Jul, and 13 Jul (depending on treatment, Table 1).

Post-spray counts of CPB adults and larvae (small = 1^{st} and 2^{nd} instars, and large = 3^{rd} and 4^{th} instars) on five randomly selected plants from the middle row of each plot were made 5-6 days after each foliar application. Defoliation ratings were taken on 5 Jul and 12 Jul by making a visual estimation of the middle row of each plot. On 8 Sep, the middle row of each plot was harvested mechanically and the tubers were separated by size and weighed. Data were analyzed using two-way ANOVA (treatment and block) and significant differences were determined with Fisher's Protected LSD test (p=0.05).

Results.

Seasonal means of small larvae, large larvae, and adults were significantly lower in treated plots compared to untreated plots (Table 1). Numbers of small larvae included larvae that were still on the egg masses and had not begun to feed on foliage, resulting in high variability in these numbers. Numbers of small larvae were especially high in treatments that act during the insect's molting process (Rimon and Trigard) because most of these larvae had not yet gone through a molt. All treatments resulted in significantly fewer large larvae and adults than in the untreated plots. All treatments kept large larvae below the economic threshold of 1-2 larvae per plant, compared to an average of over 12 large larvae per plant in untreated plots. There was also significantly less defoliation in treated plots than in untreated plots (Table 2). There were no significant differences in yield due to high variability between plots.

As in previous years, a number of the products tested were neonicotinoid insecticides (Actara, Admire, Assail, Cruiser, Leverage, Platinum, and Venom). This raises concerns because resistance to one neonicotinoid will likely lead to resistance to others in the same category (Mota-Sanchez et al. 2006). However, several products tested this year belong to different insecticide groups; AgriMek, SpinTor and Rimon are already labeled and are effective for control of Colorado potato beetle, although they have limitations in cost, number of applications allowed, and timing of application. BAS 320 (metaflumizone) is a new non-neonicotinoid insecticide that is effective for control of Colorado potato beetle and can be used as a systemic insecticide. Trigard (cyromazine) acts on the insect during the molting process, like Rimon. Overall, results show a number of products effective against Colorado potato beetle at this site, but there are concerns if resistance to neonicotinoids should appear at this site.

III. Use of a trap crop and alternative insecticides were evaluated for managing resistant Colorado potato beetles.

Once resistance to a neonicotinoid insecticide appears in the field, there are two management objectives. First, to manage the resistant beetles economically and without increasing neonicotinoid resistance. To accomplish this, the grower will need to use non-neonicotinoid insecticides and mechanical and cultural controls, including crop rotation. Second, it is critical that the dispersal of the resistant beetles be limited as much as possible to keep the problem from spreading to other fields or other growers. Crop rotation is an essential part of managing Colorado potato beetles, but encourages beetle dispersal, which is not desirable if the problem involves a localized pocket of insecticide resistant beetles. Trap crops in the year following potatoes may reduce beetle dispersal and concentrate beetles in a small area where non-neonicotinoid insecticides can be used economically.

Methods.

A preliminary trial of a trap crop to manage resistant Colorado potato beetles was conducted in cooperation with Sackett Potatoes and Agri-Business Consultants, Inc. Six rows of potatoes were planted on the north, east, and south edges of a field that had been in potatoes in 2004 (field 3-4, described in section I), where beetles were resistant to imidacloprid. This constituted about 2 acres surrounding the 75 acre field. The remainder of the field was planted to seed corn, following normal agronomic practices. The trap crop was sprayed with AgriMek and Rimon to control overwintered adults and larvae and disced under before larvae had reached maturity. Beetles from the trap crop were tested for imidacloprid and thiamethoxam resistance (field 3-4, in section I). 1000 beetles from the trap crop were marked with paint pens and released back in the south side trap crop, adjacent to a field planted to potatoes in 2005.

Results.

Exact counts were not made, but we estimate that more than 100,000 beetles were attracted to the trap crop. The insecticides used on the trap crop cost approximately $120, compared to $4,500 if treatment had been applied to the entire 75 acre field. None of the marked beetles were found in the adjacent potatoes.

Overwintered beetles from this site were approximately 20-fold resistant to imidacloprid compared to the susceptible New Jersey strain and 6 fold resistant to thiamethoxam, compared to the 2004 LD_{50} for the New Jersey strain (see section I). These results are comparable to results from the same field in August of 2004 (Grafius et al. 2005).

Trap crops appear to be an economical way to control resistant Colorado potato beetles. There appeared to be little dispersal from field 3-4 to the field immediately to the south, planted to potatoes in 2005. However, we don't know if beetles from field 3-4 dispersed to other nearby fields. Also unknown is whether beetles from the center of field 3-4 moved to the trap crop or flew over the trap crop to other locations. High numbers of resistant beetles were present in field 28-29, immediately to the north of field 3-4, in late August of 2005. These may have come from field 3-4 or from other locations. Future research will need to determine how far beetles will move to a trap crop and what is the likelihood that they will fly over the trap crop to other potato fields.

IV. Project GREEEN field trial to test management systems using traditionally bred resistant varieties and low impact insecticides to combat neonicotinoid resistance in Colorado potato beetle.

Development of a sustainable system for management of Colorado potato beetle is critical to the long term economic survival of the Michigan potato industry. We used low levels of imidacloprid to simulate the early stages of neonicotinoid resistance in our field trial to examine the potential for controlling neonicotinoid resistant Colorado potato beetles with host plant resistance and low impact biopesticides.

Methods:
A field trial was planted on 18 May 2005 at the Montcalm Research Farm to test a management system using host plant resistance and biopesticides to combat neonicotinoid resistance in Colorado potato beetle. ‘Atlantic’ and ND58822C-7 (North Dakota, a potato line expressing glycoalkaloid/leptine-like host plant resistance) potatoes were planted 12 in. apart, with 34 in. row spacing on 18 May 2005. Both potato lines were treated with Admire (8 oz/A, 1.6 oz/A, or 0 oz/A), with or without foliar applications of abamectin, spinosad, and novaluran. Treatments were replicated four times in a RCD design.

Counts of adults and larvae (small = 1st and 2nd instars, and large = 3rd and 4th instars) on five randomly selected plants from the middle row of each plot were on 17, 21, 27 June, 6, 12, 25 July, and 2 August. On 29 September, the middle row of each plot was harvested mechanically and the tubers were separated by size and weighed. Data were analyzed using two-way ANOVA (treatment and block) and significant differences were determined with Fisher’s Protected LSD test (p=0.05).

Results:

There were significant differences between all treatments and the Atlantic untreated for the number of 1st generation of large larvae/plant (Table IV.1). Significantly fewer numbers of 1st generation small larvae/plant were found on the North Dakota and Atlantic plants that were treated with Admire (8 fl oz/Acre), all spray treatments, and the North Dakota untreated compared to Atlantic untreated. All treatments resulted in significantly fewer large larvae and adults than in the untreated plots. The seasonal mean of large larvae was significantly higher on the untreated Atlantic plants compared to all other treatments (Table IV.2). There were significant differences in yield between treatments with the Atlantic untreated having the lowest yield and a trend for the North Dakota treatments having higher yields.

Table IV.1. Mean number of 1st generation Colorado potato beetle egg masses, small larvae, large larvae, and ac per plant.

Treatment/ formulation	Rate	Egg Masses	Small Larvae	Large Larvae	Adults
		1st generation mean of CPB/plant			
ATLANTIC					
Foliar[a]		6.1 cd	20.2abc	0.0a	1.7
Admire 2F	1.6 fl oz/Acre	5.6 c	34.0 cd	1.2a	4.3
Admire 2F + Foliar[a]	1.6 fl oz/Acre	2.9ab	11.6ab	0.0a	2.9
Admire 2F	8 fl oz/Acre	1.7a	3.4a	0.0a	3.7
Admire 2F + Foliar[a]	8 fl oz/Acre	0.5a	4.1a	0.0a	1.3
Untreated		7.4 cde	39.5 d	14.7 b	1.9
NORTH DAKOTA					
Foliar[a]		6.3 cde	14.0ab	0.0a	1.9
Admire 2F	1.6 fl oz/Acre	9.3 e	24.2 bcd	0.2a	1.4
Admire 2F + Foliar[a]	1.6 fl oz/Acre	2.9ab	18.4abc	0.1a	1.7
Admire 2F	8 fl oz/Acre	1.4a	2.8a	0.2a	3.8
Admire 2F + Foliar[a]	8 fl oz/Acre	1.2a	5.5a	0.0a	2.6
Untreated		8.7 de	18.0abc	1.3a	1.5
p value		.0001	.0025	.0058	.1719

Means within a column followed by different letters are significantly different (P<0.05, Fisher's Protected LSD). Data transformed for analysis with log (x+1), means presented in non-transformed units.

[a]foliar treatments used were SpinTor (applied on 22 Jun), Rimon (applied on 6 Jul), and Agri-Mek (applied on 28 Jul)

Table IV.2. Seasonal mean number of Colorado potato beetle egg masses, small larvae, large larvae, and adults plant and potato yield (weight/25 row ft).

		Seasonal mean of CPB/plant				
Treatment/ formulation	Rate	Egg Masses	Small Larvae	Large Larvae	Adults	Yield (lbs/25 row ft)
ATLANTIC						
Foliar[a]		11.6 cd	42.3 de	5.1ab	6.8ab	40.5 bcd
Admire 2F	1.6 fl oz/Acre	9.0 bc	42.5 de	7.8ab	22.0 c	33.5ab
Admire 2F + Foliar[a]	1.6 fl oz/Acre	7.8ab	24.5abcd	3.4ab	7.8ab	37.1abc
Admire 2F	8 fl oz/Acre	6.8ab	17.3abc	1.2a	8.6ab	42.0 cde
Admire 2F + Foliar[a]	8 fl oz/Acre	7.8ab	9.8ab	6.6ab	4.8a	40.0 bcd
Untreated		11.8 cd	59.3 e	27.0 c	12.6abc	30.5a
NORTH DAKOTA						
Foliar[a]		9.1 bc	35.0 cd	8.0ab	13.8abc	45.4 de
Admire 2F	1.6 fl oz/Acre	13.8 d	31.4 bcd	11.4ab	16.6 bc	39.9 bcd
Admire 2F + Foliar[a]	1.6 fl oz/Acre	8.6 bc	20.0abcd	3.8ab	7.0ab	48.2 e
Admire 2F	8 fl oz/Acre	6.7ab	14.8abc	3.8ab	10.0ab	46.5 de
Admire 2F + Foliar[a]	8 fl oz/Acre	5.0a	7.7a	3.0ab	7.0ab	49.0 e
Untreated		13.0 d	22.4abcd	14.2 b	22.2 c	40.5 bcd
p value						

Means within a column followed by different letters are significantly different (P<0.05, Fisher's Protected LSD). Data transformed for analysis with log (x+1), means presented in non-transformed units.

[a]foliar treatments used were SpinTor (6 oz/Acre, applied on 22 Jun), Rimon (12 oz/Acre, applied on 6 Jul), and Agri-Mek (16 oz/Acre, applied on 28 Jul)

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Funding: MPIC

Table 8: Effect of planting time on potato growth, development and yield, and disease symptoms caused by *Rhizoctonia solani* growth and development East Lansing, MI, 2005

Planting Time [z]	Rate of Emergence (RAUEPC) [y]	Tuber Number [x]	Stem Number [x]	Stolon Number [x]	Sample weight [w]
A	0.045 a [v]	18.5 a	3.9 b	19.3 a	7.3 a
B	0.044 a	13.4 b	4.2 b	17.0 a	5.8 ab
C	0.031 b	15.3 b	5.2 a	18.0 a	4.8 b

Planting Time [z]	Percentage of diseased stems [u]	Percentage of diseased stolons [u]	Black scurf incidence on mature tubers [t]	Black scurf severity on mature tubers [s]
A	51.8 a [v]	33.7 a	10.8 a	11.5 a
B	33.4 b	32.4 a	12.3 a	11.8 a
C	11.3 c	15.7 b	9.0 a	11.5 a

[z] Planting time (pt): planting done once soil temperatures at 4 inch depth reached 8 degrees C (1: 4/21/05); 14 degrees C (2: 5/9/05); and 20 degrees C (3: 6/3/05)

[y] RAUEPC: Relative area under the emergence progress curve (max = 100), calculated from the day of planting to 62 days after planting (dap) for pt 1, 53 dap for pt 2, and 38 dap for pt 3

[x] Numbers of tubers, stems, and stolons are the average of 4 plants (per replicate) taken 97 dap for pt 1; 79 dap for pt 2; and 54 dap for pt 3

[w] Sample weight: The weight (lbs) of all tubers from 4 plants (per replicate) greater than 1cm in any plane, taken 124 dap for pt 1; 115 dap for pt 2, 100 dap for pt 3

[v] Values followed by the same letter are not significantly different at a = 0.05 (Tukey's HSD Comparison)

[u] Percent of stems and stolons with greater than 5% girdling caused by R. solani are from an average of 4 plants (per replicate) taken 98 dap for pt 1; 79 dap for pt 2; and 54 dap for pt 3

[t] Percent incidence of tubers with sclerotia of R. solani from a sample of 20 tubers per replicate taken 124 dap for pt 1, 115 dap for pt 2, 100 dap for pt 3

[s] Severity of black scurf (index calculated by counting the tuber number (n = 20 per replicate) falling into class 0 = 0%; 1 = 1 - 5%; 2 = 6 - 10%; 3 = 11 - 15%; 4 = >16% surface area. Indices of 0 to 25 cover the range 0 - 5%; 25 - 50 cover the range 6 - 10%; 51 - 75 cover the range 11 - 15%; 75 - 100 cover the range >15% surface area of the tuber with sclerotia taken 124 dap for pt 1, 115 dap for pt 2, 100 dap for pt 3

Michigan Potato Industry Commission
2005 G. W. Bird Nematology Laboratory Annual Report

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The 2005 Michigan State University Potato Nematode Research Program consisted of the following four projects:

1. Impact of alternative tillage practices on tuber yield and root-lesion nematodes associated with potato production (MPIC funded).

2. Evaluation of potato lines and varieties for tolerance or resistance to the Potato Early-Die Disease Complex (Federal Project funded).

3. Identification of the impacts of a two-year potato/vegetable cropping system trial on soil quality as measured by nematode community structure analysis (MPIC funded).

4. Identification of the impacts of a soil restoration trial on soil quality as measured by nematode community structure analysis (MPIC funded).

Impact of Tillage on Potato Tuber Yield and Root-Lesion Nematodes

The research consists of two tillage systems (chisel plow and mold board plow) used in a three-year rotation with potato, wheat and corn. Clover is frost-seeded into the wheat. It is a six-year trial with two cycles of the three-year rotation. At the end of the first five years of the research project designed to determine the impact of tillage (chisel plow vs mold board plow) on potato tuber yield and population dynamics of the root-lesion nematode (*Pratylenchus penetrans*), total tuber yields associated with the chisel plow system averaged 18% or 52 cwt/acre more ($P = 0.01$) than those associated with the mold board plow system (Table 1). A-size tuber yields associated with the chisel plow system were 21% or 57 cwt/acre greater ($P = 0.01$) than those associated with the mold board plow system (Table 2). The early-season soil population densities of root-lesion nematodes associated with wheat were significantly lower ($P = 0.05$) for both the soil tillage systems, compared to the corn and potato (Table 3). Mid-season root system population densities of the root-lesion nematode were significantly higher ($P = 0.05$) in the corn and wheat, compared to potato (Table 4). While the chisel plot system has a positive impact on potato tuber yields, it does not impact the Potato Early-Die Disease Complex (PED) and the resulting yields are inadequate for commercial potato production.

Evaluation of Potato Varieties and Breeding Lines for Tolerance to Early-Die

Since 1998, selected potato varieties and lines have been evaluated annually at the Montcalm Potato Research Farm for tolerance to the Early-Die Disease Complex. This work has been supported by the USDA Potato Grant and done in cooperation with the MSU Potato Breeding Program under the direction of Dr. Dave Douches. Twenty-four lines and varieties were evaluated in 2005. Seven varieties-lines exhibited possible tolerance to PED based on a lack of yield response to soil fumigation (Table 5). The 2005 root-lesion nematode population pressure was very high and Bolder, which had previously been classified as tolerant, responded to soil fumigation. From a tuber yield and nematode response, both MSJ461-1 and MSJ036-A appear to be excellent candidates for development as PED resistant varieties. Thirteen of the varieties-lines tested were classified as PED susceptible in 2005. All four of the PED standards exhibited high levels of susceptibility.

During the past eight years, one variety (Boulder) and one line (MSE228-1) have been classified as tolerant to PED (Table 6). An additional 17 lines-varieties have exhibited PED tolerance, but require one to three additional years of data before being classified as tolerant. The research involves six varieties that are known to be highly susceptible. An additional seven varieties-lines have been classified as PED susceptible. Thirty-three other lines-varieties are probably susceptible, but one to three more years of observations are required before making a formal classification. Results from seven varieties-lines, including Marcy) have been inconclusive, and MSF349-1RY responded as a PED resistant line.

Two-year Potato-Snap Bean Rotation Trial: Soil Quality Component

The short-term potato/vegetable rotation trial was established with Dr. Snapp in 2001. The nematology responsibility was to monitor soil quality using nematode community structure analysis. The trial consists of eight cropping systems, in a two-year rotation, with potato, snap bean and corn. Rye, clover/wheat and hairy vetch are used as cover crops and compared to base winter fallow. The trial also includes comparison of the use of manure with no manure application. The G. W. Bird Nematology Laboratory has developed a set of Nematode Community Structure Standards for some highly diverse ecosystems (Table 7). These exhibit major differences in nematode community structure as determined by both relative and absolute densities of six different feeding groups: bacterivores, fungivores, herbivores, omnivores, carnivores and algavores. The 2001 baseline nematode community structure data for the research site show a soil that has a relatively low absolute population density of nematodes that is dominated by bacterivores (Table 7). The soil biology is not well balanced and the site should be classified as highly degraded, of poor quality and in need of restoration.

In general, at the end of the second two-year cycle, the total nematode population density had declined and there were more fungivores present (Table 9). The wheat clover system had a unique signature with a generally reduced relative density of bacterivores. This system and the hairy vetch also resulted in relatively high population densities of herbivores. The highest absolute nematode densities were associated with the rye-wheat and the rye-vetch systems.

Potato tuber yields associated with the manure treatments were higher than those grown without the manure (Table 10). When manure was applied to the bare soil system, it resulted in a decrease in the relative population density of the herbivores, but had no overall impact on absolute density. The highest absolute population densities were associated with the manure when it was used in the rye and wheat/clover systems.

From a soil quality point-of-view, after the first two rotation cycles, it is clear that a two-year rotation system with potato and snap beans does not enhance soil quality. Potato is a fairly heavy ecosystem disruption crop and snap beans add very little back to the soil. Even with the cover crops and manure, there was no evidence of improvement of the soil quality associated with this site. None of the system reduced risk to PED and at this location, profitable potato production is not possible without management of this disease complex.

Soil Quality Restoration (BOKS Trial)

In 2003, a soil quality restoration research site was established at the Montcalm Potato Research Farm. This is a cooperative projective with George Bird, Sieglinde Snapp, Willie Kirk and Mark Otto serving as co-principal investigators. The trial consists of four soil management systems: 1) Fumigated control (wheat/rye/potato), 2) Biofumigant (mustard and rye/sudax/mustard & rye/potato 3) Wheat and mustard (wheat/mustard and rye/potato), and 4) Legume (hairy vetch and rye/soybean green manure/vetch and rye/potato. At the end of the first growing season, the overall soil quality and nematode community structure was poor (Table 11). There were, however, significant differences among the four management systems. The fumigated system had the highest relative density of fungivores. The biofumigation system had the highest population density of bacterivores and the highest overall absolute density. The legume system had highest relative and absolute population densities of herbivores, leading to a significant negative impact on tuber yield.

Tuber yields in 2005 were highly correlated with cover-crop root early-season (April) population density of the root-lesion nematode (Figure 1.). The highest nematode population densities (200/g root tissue) and lowest tuber yields (<350 cwt/acre) were associated with the legume system. The lowest nematode population densities (very close to 0) and the highest potato tuber yields (438 cwt/acre) were associated with the fumigant system. Yields from the fumigated and bio-fumigated plots, however, were not significantly different from each other.

The bio-fumigation system looks very promising and will be improved on during the second two-year cycle of the project. The post-fumigation recovery of beneficial nematodes (from a potato production point-of-view) appears to be more rapid with the bio-fumigation than following chemical fumigation with metham. The highest yielding plot (>460 cwt/are) was a bio-fumigation plot (Figure 2). Yields associated with all of the fumigation plots were nearly identical. The low yields in three of the four legume plots, one wheat/mustard plot and one failed bio-fumigation plot were all associated with early-season cover-crop root-lesion nematode population densities greater than 50/1.0 gram of root tissue. Although the bio-fumigation associated with this trial looks very promising, the two-year nature of the trial may be inadequate. It is estimated that at least three cycles of the soil enhancement systems will be required to see a significant improvement in overall soil quality.

Table 1. 2001-2005 influence of alternative tillage systems on potato tuber yield (cwt/acre).

Tillage	2001	2002	2003	2004	2005	Mean
Chisel Plow	247	487	180	280	268	293
Mold Board Plow	196	382	134	232	259	241
T Test P Value	0.33	0.64	0.00	0.09	0.33	0.01

Table 2. 2001-2004 influence of alternative tillage systems on A-size potato tuber yield (cwt/acre).

Tillage	2001	2002	2003	2004	2005	Mean
Chisel Plow	220	452	159	256	262	270
Mold Board Plow	165	340	103	202	251	213
T Test P Value	0.31	0.23	0.00	0.09	0.30	0.01

Table 3. Early-season soil population densities of root-lesion nematodes (*Pratylenchus penetrans*)associated with alternative potato production till systems.

System	2001	2002	2003	2004	2005	Mean
Chisel plow						
Corn	102 c	160 c	76 b	110 bc	67	103 b
Potato	131 bc	62 b	107 bc	97 bc	22	84 ab
Wheat	95 bc	6 a	6 a	33 ab	17	31 a
Mold board plow						
Corn	42 a	78 b	124 b	111 c	26	76 ab
Potato	43 a	124 bc	76 b	86 abc	53	76 ab
Wheat	67 ab	8 a	7 a	24 a	25	26 a

Table 4. Mid-season (1.0 g root tissue) population densities of root-lesion nematodes (*Pratylenchus penetrans*)associated with alternative potato production till systems.

System	2001	2002	2003	2004	2005	Mean
Chisel plow						
Corn	520 b	304 bc	145 a	323 ab	240	306 ab
Potato	169 a	46 a	125 a	134 a	129	120 a
Wheat	278 ab	132 ab	524 b	424 b	340	332 ab
Mold board plow						
Corn	316 b	382 c	525 b	453 b	578	451 b
Potato	130 a	54 a	216 a	154 a	179	147 a
Wheat	270 ab	87 a	450 b	423 b	680	382 ab

Table 5. 2005 Potato PED assessment variety trial selected data.

Variety	Fumigated		Non-fumigated		Yield Advantage (%)
	TotalYield (cwt/A)	*P. penetrans* (1.0 g root)	Total Yield (cwt/A	*P. penetrans* (1.0 g root)	U.S. # 1
PED Tolerant in 2005					
1. MSJ461-1	**494cde**	**0**	**467d**	**168**	**6.7a**
2. MSE192-8Rus	***269a***	***0***	***259ab***	***181***	***8.0a***
3. Beacon Chipper	***381abcde***	***0***	***356abcd***	***72***	***8.7a***
4. GemStar	***365abcd***	***0***	***339abc***	***66***	***11.1a***
5. MSJ147-1	**392abcde**	**0**	**343abc**	**183**	**15.4a**
6. MSJ036-A	**424abcde**	**0**	**357abcd**	**156**	**19.3a**
7. Boulder	452bcde	0	358abcd	149	28.4ab
PED Susceptible in 2005					
8. FL1833	423abcde	0	352abcd	193	23.7a
9. FL 1879	431abcde	0	347abcd	138	27.8a
10. MI Purple	456bcde	0	368abcd	233	29.3ab
11. MSJ126-9Y	308ab	0	247a	111	30.4
12. MSK061-4	359abcd	0	274ab	94	33.1ab
13. MSE018-1	486cde	0	365abcd	134	35.9ab
14. FL1922	331abc	0	249a	165	36.2ab
15. FL 1867	379abcde	0	280abc	160	38.7ab
16. MSI005-20Y	505de	0	365abcd	150	38.8ab
17. NY126 539e		0	380cd	146	40.8ab
18. MSM051-3	517de	0	375bcd	133	41.8ab
19. MSG227-2	409abcde	0	288abc	135	48.2ab
20. NY132	472bcde	0	324bcde	146	49.4ab
2005 PED Standards					
21. Atlantic	409abcde	1	305abc	393	43.8ab
22. Snowden	437bcde	0	292abc	210	44.8ab
23. Russet Norkotah	426abcde	0	261ab	333	64.5ab
24. Russet Burbank	411abcde	0	262ab	243	100.1b
T-test P value					0.005

Table 6. Summary of 1998-2005 Michigan State University Potato Early-Die Nematode Tolerance-Resistance Research conducted at the Montcalm Potato Research Farm.

Potato Early-Die Tolerant Variety-Line

High yield in presence of potato early-die conditions with normal root-lesion nematode reproduction during four or more growing seasons.

Boulder, MSF 373-3 (98, 00, 03, 04)
PED susceptible in 05 under higher nematode pressure

MSE 228-1, Russet Nuggett x Spartan Pearl (98, 99, 00, 01)

Possible Tolerance Varieties-Lines

Seventeen varieties-lines with one to three years of additional PED evaluation are required to be designated as PED tolerant.

MSJ 461-1 (03, 05)
Beacon Chipper (05)
MSJ147-1 (05)
Gem Star (05)
WI 1201 (02, 04)
MSE 018-1 (99, 00, 03)
MSH 095-4 (03)
MSJ 316-A (03)
Bannock Russet (02)
NY 120 (01, 02)
MSH 094-8 (01, 02)
MSH 333-3 (01
WI 1431 (01)
MSE 028-1 (00)
MSE 273-8 (00)
MSF 060-6 (00)
MSJ 036A (05)

Susceptible Varieties and Lines (Table 6. continued)

Low yields in presence of potato early-die conditions, normal or high root-lesion nematode reproduction, and good response to soil fumigation.

Standards
Atlantic (97, 99, 00, 01, 02, 03, 04,05)
Snowden (97, 99, 00, 01, 02, 03, 04,05)
Russet Norkotah (02, 03, 04, 05)
Onaway (01, 02, 03)
Russet Burbank (03, 05)
Superior (01, 02, 03)

Others
Jacqueline Lee MSG 274-3 (99, 00, 01, 02)
MI Purple (00, 02 tolerant, 01, 03, 04, 05 susceptible)
Liberator [MSA 091 (01, 02)]
MSE 202-3 Rus (00, 01, 02, 03)
MSF 099-3 (99, 00, 01, 02)
MSE 149-5Y (98, 99, 00,01)
MSG 227-2 (00, 03, 04 05 susceptible, 01 tolerant, 02 tolerant)

Probable Susceptibility (Table 6 continued)

One to three years of additional PED evaluation are required.

FL 1833 (04, 05)
FL 1867 (04, 05)
FL 1879 (05)
FL 1922 (04, 05)
MSK 061-4 (03, 05)
MSI005-20Y (04, 05)
MSJ126-9Y (05)
MSE018-1 (04, 05)
NY126 (05)
NY132 (05)
MSM051-3
MSH 067-3 (03, 04)
MSH094-8 (03, 04)
MSE 192-8Rus (03, 04)
MSF349-1RY (04)
Spunta (04)
Pike (02)
Goldrush (02, 03)
MSE 221-1 (00, 01, 03)
BO 766-3 (03)
WI 1836-3Rus (03)
NDTX 4271-SR (03)
MS I005-20Y (03)
MSJ 317-1 (03)
MSJ 167-1 (03)
MSB 076G-3 (01)
MSB 106-7 (00)
MSG 015-C (01)
MSG 124-85 (00)
MSH 026-3 Rus (01)
MSP 81-11-5 (00)
WI 1368 (01)
WI 1386 (01)

Inconclusive Results (Table 6 continued)

Variable response to soil fumigation, additional information required.

NY112, Marcy (01 tolerant, 02 tolerant, 04, 05 susceptible)

MSG 004-3 (00 susceptible, 01 tolerant)
MSH 031-5 (00 tolerant, 01 susceptible)
MSB 107-1 (98 inconclusive, 99 susceptible, 00 tolerant)
MSF 313-3 (98 susceptible, 00 tolerant)
MSG 050-2 (99 possible resistance, 00 susceptible)
MSE 048-2Y (98 possible tolerant., 99 susceptible, 00 susceptible)

Highly Unique Response

MSF349-1RY (98, 00, 01, 02 resistant; 03 tolerant; 04 susceptible)
Rose Gold x WI 877, highly susceptible to scab. The resistant reaction most likely was antibiotic mediated through extensive Actinomycetes pressure in 98, 00, 01 and 02, but not in 04.

Table 7. Michigan Nematode Community Structure Composition associated with four types of ecosystems (2006 Michigan Relative Density Standard).

Feeding Behavior	Woodlot	Old Field Succession	Certified Organic	Conventional Agriculture
Bacterivore	51	83	73	28
Fungivore	18	7	26	14
Herbivore	28	7	0.6	57
Omnivore	3	2	0.2	0.2
Carnivore	1	1	0.003	0.05
Algavore	NA	0.3	NA	NA
Absolute Density	500	1700	3,500	200

Table 8 2001 baseline nematode community structure [relative (%) and absolute (100 cm^3 soil populations) associated with the Montcalm two-year potato-snap bean rotation trial.

Nematode feeding behavior	Relative density
Bacterivores	96
Fungivores	1
Herbivores	0,07
Omnivores	2.2
Carnivores	0.3
Absolute Density	935

Table 9. Influence of manure on tuber yield and mid-season nematode community structure during the second-year of the second cycle of a two-year potato-snap bean rotation system.

System		Yield	Bacterivores	Fungivores	Herbivores	Omnivores	Carnivores	Density
Bare 9.								
Potato								
	-	268	0.85	0.05	0.07	0.04	0.00	353
	+	355	0.83	0.07	0.01	0.09	0.00	309
Rye 10.								
Potato								
	-	196	0.85	0.08	0.01	0.06	0.00	413
	+	251	0.89	0.04	0.00	0.06	0.00	636
Wheat/Clover 14.								
Potato								
	-	---	0.85	0.04	0.03	0.14	0.00	364
	+	---	0.87	0.06	0.01	0.08	0.00	632

Table 10.. Mid-season nematode community structure associated with 16 different potato-snap bean cover-crop rotations in the second-year of the second cycle of the project at the Montcalm potato Research Farm.

System	Bactivore	Fungivore	Herbivore	Omnivore	Carnivore	Density
Bare						
Beans 1.	0.75	0.14	0.02	0.10	0.01	376
Potato 9.	0.85	0.05	0.07	0.04	0.00	353
Rye						
Beans 2.	0.76	0.10	0.03	0.11	0.00	388
Potato 10.	0.85	0.08	0.05	0.06	0.00	413
Bare						
Corn 3.	0.76	0.12	0.05	0.14	0.02	213
Potato 11.	0.89	0.02	0.05	0.09	0.00	376
Rye						
Wheat 4.	0.77	0.03	0.10	0.09	0.01	788
Potato 12.	0.73	0.03	0.16	0.08	0.00	612
Wheat/clover						
Wheat/clover 5.	0.57	0.06	0.13	0.18	0.07	379
Potato 13.	0.60	0.16	0.15	0.08	0.01	244
Rye/vetch						
Beans 6.	0.81	0.04	0.02	0.12	0.01	612
Potato 14.	0.85	0.04	0.03	0.14	0.00	364
Rye/vetch						
Corn 7.	0.62	0.12	0.02	0.24	0.00	123
Potato 15.	0.76	0.11	0.02	0.12	0.00	428
Rye/vetch						
Potato 8.	0.85	0.03	0.07	0.04	0.00	646
Corn 16.	0.67	0.07	0.09	0.16	0.00	267

Table 11. Nematode community structure [relative (%) and absolute population densities (100 cm^3)] at end of the first year of the soil quality restoration trial (BOKS Trial)calm Potato Research Farm soil restoration trial.

Nematode Guild (P)	Fumigation	Biofumigation	Wheat/Mustard	Legume
Bacterivores (0.001)	0.75	0.91	0.79	0.68
Fungivores (0.252)	0.15	0.04	0.04	0.08
Herbivores (0.088)	0.03	0.02	0.10	0.21
Omnivores (0.300)	0.07	0.02	0.06	0.04
Carnivores (1.000)	0.00	0.00	0.00	0.00
Absolute Density (100 cm3 soil)	59	633	290	391

Figure 1. 2005 potato tuber yields (cwt/A) and root-lesion nematode (*Pratylenchus penetrans*) population densities per 1.0 g cover-crop root tissue at the beginning of the growing season in the soil restoration (BOKS) trial at the Montcalm Potato Research Farm.

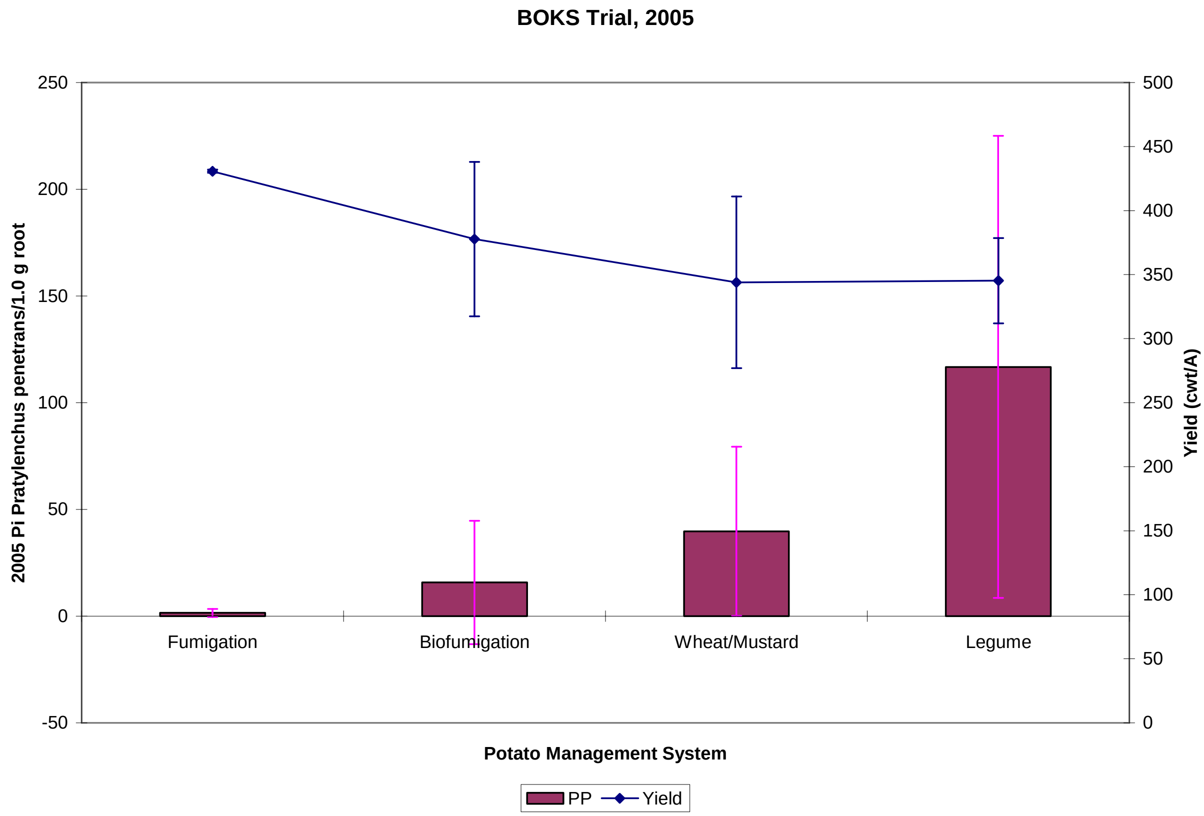
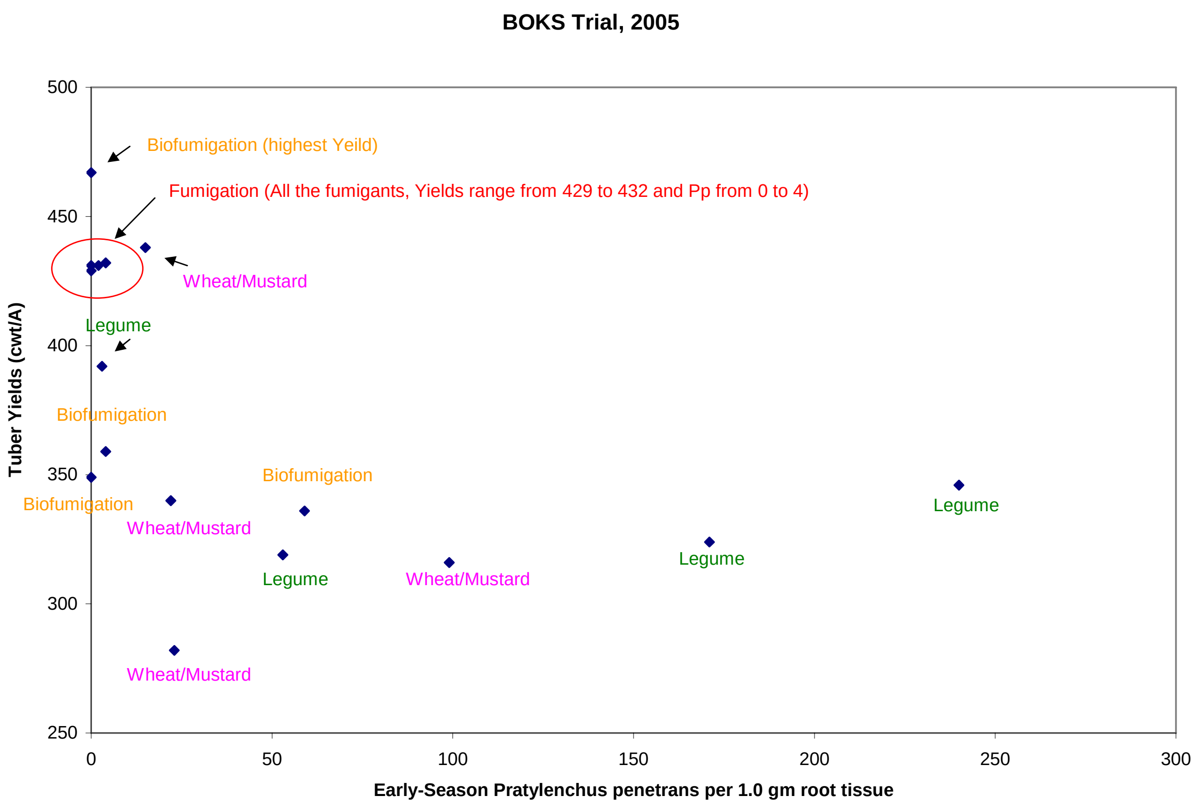


Figure 2. Relationships among 2005 potato tuber yields, early-season root-lesion nematode (*Pratylenchus penetrans*) population densities and management systems.



Funded by: MPIC/MDA/Celery Research Inc.

Biological Approaches to Nematode Management in Michigan Agriculture: Use of Biofumigants in Potato Soils

By

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Introduction

This preliminary report is part of a project jointly funded by MPIC, MDA and Celery Research Inc. to look at the effects of mustard type biofumigants on the northern root-knot nematode populations. After almost 16 years at MSU and writing my first report to MPIC, however, I thought it might be appropriate to first introduce my program to the readers at-large. My research program goal is to develop sustainable nematode management practices through strategic understanding of plant-nematode interactions at the organismal and ecosystem levels, evaluating agroecological and economic implications, and exploring genetic basis of the interactions. *Pratylenchus* (root-lesion), *Heterodera* (cyst) and *Meloidogyne* (root-knot) are among the nematodes we have been studying. In addition to being economically significant, the nematodes represent the three known feeding behaviors: **destructive** (host cells killed), **adaptive** (cells modified), and **neoplastic** (cells modified and undergo new growth), respectively. For more details, visit our website <http://www.ent.msu.edu/People/faculty/melakeberhan.htm>.

The northern root-knot nematode (RKN, *Meloidogyne hapla*), root-lesion (RLN, *Pratylenchus* spp.), and cyst (*Heterodera* spp.) are the most problem nematodes in the diversified Michigan agriculture (Bird et al., 2004). Without nematode resistant cultivars and the gradual phase out and/or restrictions of broad-spectrum nematicides, many commodities, including potato, face short- and long-term challenges in managing nematodes. For example, RKN, a pest in 22 of the 31 vegetable crops, and RLN, either alone or interacting with *Verticillium* (wilt fungus) in potato, present the most management challenges.

The potato, carrot, celery, and vegetable advisory council stakeholders research priorities include mapping of nematode populations, breeding for nematode resistance, developing alternatives to broad-spectrum pesticides and nematicides, identifying effective cultural practices, biosuppression, nematicidal plants, and effective and sustainable soil amendments (http://www.greeen.msu.edu/priorities.htm). Meeting the stakeholders' multi-dimensional and short- and mid-term (most) and long-term (breeding for resistance) priorities hinge on understanding the complexities of the nematodes and the production systems in question. For example, RKN has a high degree of genetic (Chen et al. 2003; Liu and Williamson, 2004) and parasitic variability even in populations that come from about 20 miles apart (Melakeberhan et al. 2005). Although most ideal, developing management practices based on each nematodes' interaction with its hosts will be expensive. A worthwhile strategy, within the umbrella of industry priorities, is to design practices that affect multiple crops and/or nematodes. Using an RKN model, this project was developed to look at the effects of mustard type biofumigants on nematode populations. The objective is to test the efficacy of oilseed radish (OSR) on RKN populations in muck, loamy sand and sandy soils under greenhouse conditions.

MATERIALS AND METHODS

The study was conducted under greenhouse conditions set at 28 ± 2 ^{o}C with diurnal cycles of 8 hours dark and 16 hours day with photosynthetically active radiation of 450 to 550 $\mu mol.s^{-1}.m^{-2}$ at canopy level. One-week-old OSR cultivar cv 'Common' (OSRC) and an organically certified stoke (OSRS, Lot # RO4S-PSOSR, R. Stuckey, North Alger Rd. Alma, MI, 48801) seedlings were transplanted from potting soil into 300 cm^3 of steam-sterilized sandy, sandy loam, or muck soils contained in styrofoam cups. Pots were watered to saturation with tap water one hour prior to transplanting and as needed thereafter. Three days after transplanting, seedlings were inoculated with either 0 or 3,000 eggs of three Michigan RKN populations (ED, PN and SW) per pot (Mennan et al., 2006). Inocula were collected from greenhouse cultures following Hussey and Barker's (1973) bleach (5% NaOCl) method. The nematodes were originally obtained from a sandy (PN), loamy sand (SW) and muck (ED) soils with pHs of 6.56, 7.15 and 6.30, respectively, and cultured in tomato (*Lycopersicon esculentum* L.) cv 'Rutgers' (Melakeberhan et al., 2005). The muck and loamy sand soils used in the study were brought from the fields where the nematodes were isolated. The sandy soil was brought from a different location (WL). A total of 48 experimental units (4 nems x 3 soils x 4 reps) were used. The test was terminated 28 days after nematode inoculation and nematode developmental stages determined as described in Melakeberhan and Dey (2003). At the experimental temperature, 504 ± 56 degree-days (DD, base 10 C) were accumulated, enough heat units to complete a life cycle (Insera et al., 1982). Nematode population densities were standardized on a per g fresh root weight basis. Statistical analysis of gall indices and standardized data were performed with SAS System Release 8 (SAS Institute, Cary, NC, 2000).

Results and Discussion

Mustard types of crops can be used as trap or cover crops, or as biofumigants when incorporated into the soil to suppress weeds, nematodes and other soil borne yield-limiting biological factors (Hafez and Sundararaj, 2001; McSorley et al., 1997; Ngouajio and Mutch, 2004; Tseo et al., 2002). In order to exploit the multipurpose use of biofumigants, we need to understand the intricate relationships among nematode biology, their living environments, and the performance of the biofumigants. Although galling was more in OSRC than in OSRS, this preliminary test shows that both hosts carried similar numbers of nematodes (Fig. 1). Which OSR to use may depend on availability and cost.

The nematodes used in this study came from approximately 20 miles apart and have been used in other parasitic variability studies, with some characteristic differences (Melakeberhan et al. 2005). In this test, the SW nematode population appears to be most pathogenic, which may good or bad depending on the purpose the OSR use. For example, if the OSR is to be used as a trap crop for RKN it is good that more nematodes invade the roots. However, the nematode should not be allowed to complete a generation. One way to stop the nematode from completing a generation is to incorporate the OSR crop into the soil, which, in turn, may serve as a biofumigant against RKN. Because RKN has only one infective stage (second-stage juvenile), suppressing its population density with trap cropping may easier than RLN, whose four vermiform stages are infective.

The effect of soil type was most striking. Across nematodes, sandy soil was the most and muck soil the least favorable for nematode invasion of OSR (Fig. 1). Thus, suggesting the best use of OSR will be dependent on soil type. On going are repeat experiments that will be able to determine how OSR may be used most efficiently. In the meantime, from this and other related studies, it is fair to say that the one-option-fits-all management approach may have to be reconsidered. Further laying the groundwork for adopting site-specific management approaches (Melakeberhan, 2002).

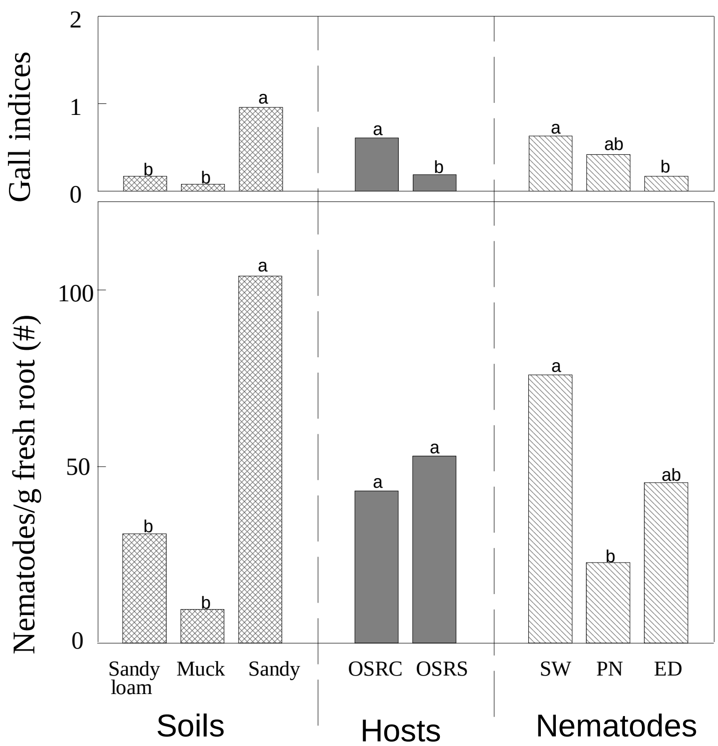

Fig. 1. The effects of soil types, oil seed radish cultivars (OSRC and OSRS), and three Michigan RKN populations (ED, PN and SW) on the numbers of nematodes per g fresh root and galling indices.

Gall indices are based on a 0 (none) to 5 (100%) scale.

Bars with the same letters within a category are not statistically different from one another.

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Summary Report for the 2004-2005 Dr. B. F. (Burt) Cargill Potato Demonstration Storage

Brian Sackett, Chris Long, Dick Crawford, Todd Forbush (Techmark, Inc.), Steve Crooks, Dennis Iott, Keith Tinsey, Tim Young, Jason Walther, Troy Sackett, Randy Styma and Ben Kudwa

Introduction

This is a summary report of the 2004-2005 Dr. B.F. (Burt) Cargill Potato Demonstration Storage Annual Report Volume 4. This report is designed to provide a short summary of the 2004-2005 storage committee activities. To obtain a copy of the full 2004-2005 Demonstration Storage Report please contact the Michigan Potato Industry Commission office (517-669-8377) or Chris Long at Michigan State University (517-355-0271 ext.#193). The full report will be provided to you free of charge.

Goals and Objectives

The 2004 growing season resulted in above average specific gravity with some black spot and pressure bruise issues as a result. The early and middle part of the season was cool and wet. The harvest season was generally dry, but the heat at harvest caused some breakdown in early storage varieties. Recorded yields across the state in 2004 were above average.

The goal of the MPIC Storage and Handling Committee for the 2004-2005 storage season was to develop storage profiles on four promising advanced seedlings. Liberator (MSA091-1), MSG227-2 and MSJ461-1 are from the potato breeding program at Michigan State University. Beacon Chipper (UEC)* is a clone that has an unknown origin and pedigree but is of great interest in Michigan, and is likely to be jointly released by the states of Michigan and Maine. The committee's objective was to determine what the optimal storage temperature was for each variety, while maintaining acceptable storage quality. Also of interest was the level of pressure bruise damage that may be incurred by each variety at a given storage temperature. Beacon Chipper was evaluated for its ability to withstand cold harvest conditions and was harvested under two different sets of harvest conditions. While lines are evaluated for many other characteristics in the storage, long-term storability is an objective of growing interest.

The goal for the variety Liberator was to evaluate longevity at a given storage temperature while maintaining chip quality. Based on blackspot bruise numbers and glucose levels, this variety was left warm and slated for a December to January shipping window. MSG227-2 was evaluated for duration of storability. As the chip quality improved on this variety the pile would be cooled to extend storage life in hopes of reaching a February to March shipping window. Bin 4, MSJ461-1 was tested to evaluate storability. Initial blackspot and sugar defects in this line caused the committee to keep the variety warm (58 ºF) and maintain 20 to 24 hour fresh air in the bin to clean up the defects. If it was possible to remove the sugar caused by the defects then this variety would be cooled to extend storage life and then a shipping schedule would be established. Based on past success with the Beacon Chipper the storage committee wanted to see if this variety would recondition after experiencing cold harvest temperatures much like the Snowden variety is capable of doing. Tubers in Bin 6 (Beacon Chipper-Early) were harvested during warm conditions with a pulp temperature of 62 ºF. The second bin of Beacon Chipper (Late), Bin 5, was harvested 14 days later when the tuber pulp temperature was 50 ºF. These tubers were held two days on field trucks before loading into the storage and the tubers pulped 44 ºF upon loading into Bin 5. The committee was interested in determining the impact of these harvest conditions on the chip quality of this variety.

<u>Results for the Bulk Bins:</u>

<u>Liberator (MSA091-1) in bulk bin 2.</u> Sugar readings were taken on March 9th and 22nd, 2005 from the bulk bin and the corresponding sucrose and glucose readings were as follows: March 9th, sucrose 0.679, glucose 0.006 and on March 22nd the sucrose was 0.968 and glucose was 0.011. After seeing the sugars move in this upward direction and having made no progress in improving chip quality with warm storage temperatures and 24 hour fresh-air, it was decided to dump Bin 2. Based on two unsuccessful seasons

storing Liberator the storage committee felt there was little value in this variety for commercial processing.

MSG227-2 in bulk bin 3. In early February 2005, the storage committee thought the bulk bin of MSG227-2 was looking as good as it was going to and made the decision to ship the bin for processing. The committee was aware of the possibility of some internal sprouting and this was brought to greater light after the bulk bin was processed at UTZ. The committee feels that the internal sprouts are a result of poor sprout control with 1,4-DMN and should not reflect negatively on the variety itself. If the internal sprouts were taken out of the picture the variety performed quite nicely. Some concern was expressed about the shape of this variety by UTZ when it was commercially peeled. This variety expressed good scab resistance on–farm and appeared this season to have acceptable chip quality into January and February. The variety could possibly be used as a scab resistant early storage season chipper to replace Pike.

MSJ461-1 in bulk bin 4. The high storage temperature (58 ºF) and the 24 hour fresh-air appeared to have no affect on burning off any of the accumulated sugars in this variety. It is hard to begin to suggest what might have caused this variety to be in the state it appeared to be in chemically in the storage. There were some greenheads on tubers when they were loaded into storage and late blight was prevalent in the area that these tubers were grown, but it is hard to pinpoint what created this kind of sugar accumulation other than it is simply a characteristic of this variety. The late blight resistance of this variety is excellent, but this experiment draws into question the value of this variety to the commercial chip processing industry. This variety was dumped in late March 2005.

Beacon Chipper*-Late (UEC) bulk bin 5. This bulk bin of Beacon Chipper was shipped to UTZ Quality Foods for processing on March 10, 2005. Overall this variety has been a successful yielding and storage performer in the MPIC storage into early March for three consecutive seasons. It has proven the ability to withstand exposure to cold harvest conditions and be reconditioned for chip processing. The duration of storage for this variety is not extensive, but it is predictable. A grower would gain a yield and size profile advantage over a variety such as Pike while maintaining good early storage chip quality. The scab resistance of Beacon Chipper is not as good as Pike.

Beacon Chipper-Early bulk bin 6. This bulk bin of Beacon Chipper served as the control bin for bulk bin 5. These tubers were harvested earlier than those in Bin 5. The tubers in bulk Bin 6 did not experience any cold harvesting conditions and pulped 62 ºF when they were loaded into storage on October 1, 2004. This variety has proven over the course of three years that it can be a chip processing variety. The biggest question is what larger commercial needs can be met with this variety which are not currently being met in some other variety.

Promising Varieties In the Box Bin Trial:

Varieties that look promising in the Box Bin trial in 2004 were Monticello, MSJ036-A, MSJ147-1and W2128-8. These varieties will be considered for larger scale evaluations in the 2005-2006 storage season.

BEACON CHIPPER

Unknown Eastern Chipper, (UEC)

*Unknown Eastern Chipper (UEC), now "Beacon Chipper", was previously tested and labeled as the clone B0766-3. B0766-3, a USDA Beltsville potato clone from Dr. Kathleen Haynes' Breeding Program, Beltsville, Maryland is being considered for release. The official seed source for B0766-3 is the Uihlein Seed Farm, NY. The two clones UEC and B0766-3 have undergone fingerprint analysis at Michigan State University and the pattern of B0766-3 does not match that of UEC. Thus, the UEC clone tested was incorrectly referred to as B0766-3. No known variety or breeding clone matches the UEC fingerprint pattern to date. The origin and pedigree of UEC is unknown. **UEC seed that was tested and reported in the 2001-2002, 2002-2003, 2003-2004 and 2004-2005 Cargill Potato Demonstration Storage Annual Report Volumes 1, 2, 3 and 4 was obtained from Devoe Seed Farm, Limestone, ME.** The initial seed stock was obtained from the Maine State Seed Farm which is the Porter Seed Farm. The Michigan State University fingerprint data of UEC shows an identical match between the Devoe Farm seed and the tissue culture plantlets at the Porter Seed Farm from which all the seed labeled as UEC has been derived.