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MICHIGAN POTATO RESEARCH REPORT

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THE 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 Cooperative Extension Service are pleased to provide you with a copy of the results from the 2003 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. The Commission is pleased to provide you with a copy of this report.

Best wishes for a prosperous 2004 season.

The Michigan Potato Industry Commission

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INTRODUCTION AND ACKNOWLEDGMENTS

The 2003 Potato Research Report contains reports of the many potato research projects conducted by MSU potato researchers at several locations. The 2003 report is the 35th report, 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 goes to Dick Crawford for the management of the MSU Montcalm Research Farm and the many details, which are a part of its operation. Thanks also to the Montcalm County Extension office for maintaining the weather records from the MRF computerized weather station. We also want to recognize Barb Smith and Sarah Henry at MPIC for helping with the details of this final draft.

WEATHER

The overall 6-month average temperatures during the 2003 growing season were slightly cooler than the 2002 season, but were right at the 15-year average (Table 1). There were 4 days that the temperature reached 90°F or above in 2003. There were 10 days in April and 1 day in early May that the temperature was below 32°F. The first daytime low, during harvest, below 32°F occurred on October 2nd. The average maximum temperatures for July, August, and September of 2003 were right at the 15-year average.

Rainfall for April through September was 13.25 inches which is 7.82 inches less than the 15-year average for these same months (Table 2). Rainfall recorded during the month of April was the lowest recorded for the month in 15 years. Irrigation at MRF was applied 12 times from June 17th to August 30th averaging 0.72 inches for each application. The total amount of irrigation water applied during this time period was 8.6 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.
1989	56	32	72	34	81	53	83	59	79	55	71	44	74	46
1990	NA	NA	64	43	77	55	79	58	78	57	72	47	NA	NA
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**
15-Year Average	56	34	68	44	78	55	81	59	78	58	71	48	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
1989	2.43	2.68	4.85	0.82	5.52	1.33	17.63
1990	1.87	4.65	3.53	3.76	4.06	3.64	21.51
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**
15-Year Average	3.03	3.63	3.75	3.35	4.56	2.75	21.07

GROWING DEGREE DAYS

Table 3 summarizes the cumulative, base 50°F growing degree days (GDD) for May through September, 2003. The total GDD for 2003 were 2,256 which is 357 GDD fewer than 2002, and slightly lower then the 10-year average.

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

Cumulative Monthly Totals					
Year	May	June	July	August	September
1994	231	730	1318	1780	2148
1995	202	779	1421	2136	2348
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**
10-Year Average	277	788	1394	1965	2309

*1994-2003 data from the weather station at MSU Montcalm Research Farm (Montcalm County Extension Office).

PREVIOUS CROPS, SOIL TESTS AND FERTILIZERS

The general potato research area utilized in 2003 was rented from Steve Comden, directly to the West of the Montcalm Research Farm. This acreage was planted to winter wheat in the fall of 2000 and was harvested late in the summer of 2001. Red clover was drilled into the winter wheat in the spring of 2001 and then later harvested in the fall of 2002. In the spring of 2003 the clover stubble was disked several times then moldboard plowed for direct potato planting. The area was not fumigated prior to potato planting. Potato early die was not a problem in 2003.

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

	lbs/A			
pH	P_2O_5	K_2O	Ca	Mg
6.2	336	210	1000	200

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-$P_2 0_5$-$K_2 0$)
Broadcast at plow down	0-0-60	350 lbs/A	0-0-210
At planting	19-17-0	19 gpa	40-36-0
At emergence	46-0-0	135 lbs/A	62-0-0
1st Early side dress	46-0-0	197 lbs/A	91-0-0
2nd Late side dress (late varieties)	46-0-0	167 lbs/A	77-0-0

HERBICIDES AND PEST CONTROL

Hilling was done in late May, followed by a pre-emergence application of Sencor DF at 0.66 lb/A and Dual at 1.33 pints/A. A post-emergence application of Matrix was applied on July 2nd at a 1oz/A rate.

Admire was applied at planting at a rate of 13.6 oz/A. Dimetholate was applied once in mid July at 1 pint/A. Fungicides used were Bravo and Polyram 80DF over 13 applications.
Potato vines were desiccated with Reglone once in mid September at a rate of 1 pint/A.

2003 POTATO BREEDING AND GENETICS RESEARCH REPORT

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INTRODUCTION

At MSU, we conduct a multi-disciplinary program for potato breeding and variety development that integrates traditional and biotechnological approaches. 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 17 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 and disease resistance. 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.

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.

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 11 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 (*Bt-cry3A* and avidin), potato tuber moth, late blight resistance via the *RB* gene, lowering glycoalkaloids (*STG*), and drought resistance (*CBF1*). We also have the *glgC16* gene (ADP-glucose pyrophosphorylase (AGPase or starch gene) from Monsanto to modify starch and sugar levels in potato tubers. 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 2003 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 2003 harvest, about 1800 selections were made from the 45,000 seedlings grown. Following harvest, specific gravity was measured and potential chip-processing selections were chipped out of the field. All potential chip-processing selections will be tested in January or March 2003 directly out of 42°F and 50°F storage. 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, 400 and 150 selections were made, respectively. **Table 1** lists some of the potential lines for grower trials in year 2004.

Chip-Processing

Excellent chip-processing selections have been identified in the breeding program, despite switching to a more stringent screening temperature (42 vs. 45°F storage) a few years ago. Over 70% of the single hill selections have a chip-processing parent in their pedigree. Of those selections, about 75% have a SFA chip score of 1.5 or less. Based upon the pedigrees of the parents we have identified for breeding cold-chipping potato varieties, we have a diverse genetic base. We believe that 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 MSF099-3 (42°F chipper), MSG227-2 (scab resistant 45°F chipper), MSH095-4, MSH094-8, MSH067-3, MSH228-6, MSJ147-1, MSJ126-9Y, MSJ167-1, 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 involved in chipping. His analysis will 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 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 2003, while others were tested under replicated conditions at the Montcalm Research Farm. Promising tablestock lines include MSE221-1 as a scab resistant tablestock, while MSE018-1 is a high yielding tablestock with a large oval shape. Boulder (MSF373-8) is a high yielding line with large tubers that also chip out of the field. Michigan Purple also performs well. In addition, all these clones performed well in the dry land trial at Montcalm Research Farm. MSE192-8RUS and MSE202-3RUS are two russet table selections that have excellent type and scab resistance. MSI005-20Y and MSJ033-10Y are yellow-fleshed lines with smooth round appearance and high yield potential.

Disease and Insect Resistance Breeding

Disease screening for scab has been an on-going process since 1988. Results from the 2003 MSU scab nursery indicate that 42 of 190 lines evaluated demonstrated little to no infection to common scab. In addition, 23 other MSU breeding lines showed moderate scab resistance. 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. Secondly, the scab nursery space has been full. In response, we have spent 3 years developing a second scab nursery. In 2004, we will begin early generation evaluation of scab reaction in the breeding program. This additional effort should lead to more clones with scab resistance.

Since the mid-1990's we have directed efforts to identify sources of late blight resistance and use this resistance to breed late blight resistant varieties. At MSU, we have also participated in the national late blight trial and we have conducted our own efforts to use field and greenhouse screening to identify additional sources of resistance that can be used by the breeding community. In the past 7 years the MSU breeding program has intensely evaluated over 1200 crosses between late blight resistant x late blight susceptible parents and have identified parents that transmit strong late blight resistance to the highest percentage of the offspring. This year we added an early generation screen which will improve our ability to select late blight resistant lines.

As of 2003, based upon 7 years of inoculated field experiments, we have at least 8 sources of foliar resistance to the US8 genotype of *Phytophthora infestans* (Mont.) that have different pedigrees from which their resistance is derived. The resistance in Jacqueline Lee has now held resistance for 7 years of testing. MSJ461-1, the chip-processing selection, has the same late blight resistance source Jacqueline Lee and was resistant to a US-17 genotype of *Phytophthora infestans* in New York this year. Our other promising late blight resistant lines that have been tested in replicated agronomic trials are MSJ317-1, MSI152-A, MSJ453-4, MSK136-2, MSL159-AY, MSL179-AY and MSL211-3 (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. This year we added a transgenic strategy using the late blight resistant *RB* gene cloned from *S. bulbocastanum*. We should have initial field tests using transplants in 2004.

With support from GREEEN, we also introduced an early generation Colorado potato beetle screen at the Montcalm Research Farm. From this screen we identified 32 individuals with either transgenic or non-transgenic foliar resistance to Colorado potato beetle. Eighteen lines were categorized as moderately resistant and 36 were susceptible.

Single-hill selections in 2003 also had an exciting number of individuals with pedigrees for potential late blight, Colorado potato beetle or scab resistance or some combination of the three. Of the single hill selections, 75% of progeny have at least one late blight parent, 15% have a Colorado potato beetle resistant parent, and 25% have a scab resistant parent in its pedigree.

II. Evaluation of Advanced Selections for Extended Storage: MSU Potato Breeding Chip-processing Results From the MPIC Demonstration Commercial Storage (October 2001 - June 2002)

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 4 years we have been conducting a 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.

In October 2002, tuber samples from 6 lines in the Montcalm Research Farm trials were placed in the bin to be cooled to 48°F. Tubers from another 9 lines were placed in the bin that was to be cooled then held at 51°F. The first samples were chip-processed at MSU in October and then, each month until June 2003. Samples were evaluated for chip-processing color and quality.

Table 2 summarizes the chip-processing color of select lines over the 8-month storage season. In the 48°F bin, Snowden was the check variety. In April the Snowden and MSH095-4 chips began to go off-color. In contrast only MSG227-2, MSH094-8 and MSF099-3 and W1201 maintained acceptable chip color throughout the storage sampling. Of these lines, MSG227-2, MSF099-3 and MSH094-8 maintained the lightest chip color throughout the storage season. MSG227-2 also has scab resistance.

In the 51°F bin Atlantic and Pike were used as check varieties and both varieties chip-processed acceptably until May. Of the 7 advanced breeding lines evaluated Liberator chip-processed acceptably throughout the storage season until June. Liberator offers chip-processing from storage and scab resistance. MSJ461-1 had the most consistent chip color throughout the storage season until May. MSJ461-1 also offers strong foliar late blight resistance along with the chip-processing quality; however the solids content can be lower than other chip-processing lines. UEC also had good chip color until the May sampling.

In addition, Liberator and MSF099-3 was grown by Sandyland Farms and placed in one of the 500 cwt bins. Despite field frost occurring in MSF099-3's harvested tubers, the potatoes chip-processed successfully out of the bin in April 2003 at Utz. The Liberator bin was sent to Shearers in March and produced a good chip product.

III. Germplasm Enhancement

In 2003, about 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 2,000 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. About 100 selections were made among the diploid material in 2003. 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 2004.

Late Blight Breeding and Genetics: Mapping Late Blight Resistance in three Populations

A high priority objective of the breeding program is to identify sources of late blight resistance and use these sources for breeding varieties with late blight resistance. In 1999 we initiated a set of studies (via GREEEN) to identify the genes in potato associated with late blight resistance. If we can identify the genes that contribute to late blight resistance we feel that we could more effectively breed varieties with durable late blight resistance. A diploid potato population was developed with the objectives to map quantitative trait loci (QTL) conferring resistance to *Phytophthora infestans* (Mont.) de Bary and other agronomic traits using simple sequence repeats (SSR) and isozymes and to examine associations between late blight resistance and other agronomic traits. The mapping population was a cross between a late blight resistant selection of *Solanum microdontum* Bitter and a susceptible diploid advanced breeding clone. A second diploid population derives its late blight resistance from *S. berthaultii*. The third population is tetraploid and the resistance comes from Jacqueline Lee. Based upon field trials at the Muck Soils Research Farm, Bath, MI between 1999 and 2002, we have identified major late blight resistance genes in the three populations. Currently, one chromosome region containing the resistance is linked to a genetic marker has been identified in *S. microdontum.* This past year we identified a major QTL associated with late blight resistance was found in the tetraploid population and multiple QTLs for late blight resistance in the *S. berthaultii* mapping population. These QTLs should be suitable for marker-assisted selection to introgress a new source of resistance to *P. infestans* to the cultivated tetraploid germplasm of potato.

The tetraploid cross for mapping (Jacqueline Lee x MSG227-2) offers more than just mapping late blight resistance genes. This cross has traits such as late blight resistance, scab resistance, chip-processing, specific gravity, maturity all segregating at one time. This summer we screened a sub sample of the population for scab reaction. A number of the progeny showed little scab. In 2004 we hope to screen a greater number of the population.

IV. Integration of Genetic Engineering with Potato Breeding

Assessment of Natural (Glandular Trichomes and Glycoalkaloid-Based) and Engineered (*Bt-cry3A*) Potato Host Plant Resistance Mechanisms for Control of Colorado potato beetle: Caged no-choice studies.

The Colorado potato beetle, *Leptinotarsa decemlineata* Say (Coleoptera: Chrysomelidae), is the leading insect pest of potato (*Solanum tuberosum* L.) in northern latitudes. Host plant resistance is an important tool in an integrated pest management program for controlling insect pests. A field study was conducted in 2003 to compare natural (glandular trichomes (NYL235-4) and glycoalkaloid-based (ND5822C-7)), engineered (*Bt-cry3A*: NO8.8, Atlantic NewLeaf, *Bt-cry1Ia1*: Spunta G2) host plant resistance mechanisms of potato for control of Colorado potato beetle. Six different potato lines representing 5 different host plant resistance lines were evaluated in caged studies (no-choice) at the MSU campus farms. Each cage with 10 plants represented one plot. The cages were arranged in a randomized complete block design consisting of three replications. Twenty egg masses were placed on the plants in each cage. Observations were recorded weekly for a visual estimation of percent defoliation by Colorado potato beetles, and the number of egg masses, larvae, and adults. The *Bt-cry3A* transgenic line and the combined resistance line were effective in controlling feeding by Colorado potato beetle adults and larvae. The high glycoalkaloid line had less feeding, but the beetles clipped the petioles, which led to greater defoliation in the first few weeks. Foliage re-growth occurred by the end of the season. The glandular trichome line suffered less feeding than the susceptible control. Spunta G2 was effective in limiting defoliation, but larval mortality was not as high as in the *Bt-cry3a* lines. Based on these results, the *Bt-cry3A* gene in combination with glandular trichome mechanism is an effective strategy that could be used to develop potato varieties for use in a resistance management program for control of Colorado potato beetle. **Figure 1** shows the results of caged trial in 2003.

Bt-cry3A-transgenic line Agronomic Trial

In 2001 and 2002, we had extensive field testing for agronomic performance in replicated trials of our most advanced *Bt-cry3A* transgenic lines. Based upon 2001 agronomic performance and 2002 Bt-cry3A protein concentrations in foliage, 12 of 26 transgenic lines were eliminated. In general, the *Bt-cry3A* transgenic lines had similar agronomic and tuber characteristics compared to the non-transgenic parental line. These selections represent a diverse portfolio of *Bt-cry3A* lines that could be commercialized if the intellectual property rights and regulatory requirements could be met. We will maintain these lines in our program. These lines are MSE018-1, NYL235-4, NY123, Jacqueline Lee, Onaway, Norwis and Spunta. If the acceptance of transgenic food crops becomes deregulated, we will consider these lines for commercialization. In 2003 we developed a new Bt-cry3A construct that uses a different gene promoter. We are currently transforming MSJ461-1 and Michigan Purple.

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. In the field, the moths lay their eggs on the potato foliage and the hatched larvae mine the foliage and the stems. This feeding damage leads to irregular transparent tunnels in the leaves and weakening of the stem. The larvae attack the tubers through infected stems or directly from eggs, which are oviposited on exposed tubers or where soil cracks allow moths to reach the tubers. Larvae mine the tuber in the field and in storage reducing potato quality and increasing the potential for pathogen infection. Field and storage studies were conducted to evaluate *Bt-cry5* potato lines for resistance to potato tuber moth in Egypt under natural infestations and their agronomic performance in both Egypt and Michigan. From 1997-2001, field experiments were conducted at the International Potato Center (CIP) Research Station, Kafr El-Zyat, Egypt and/or Agricultural Genetic Engineering Institute (AGERI), Giza, Egypt to evaluate resistance to tuber moth.

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'. We are currently working with USAID, Syngenta and South Africa to commercialize the Spunta-G2 and

Spunta-G3 lines. We have also transformed Atlantic, Lady Rosetta and Jacqueline Lee with the *Bt-cry5* gene. We hope to have approval to field test these in Mexico some time in the future.

V. Variety Release

The MSU breeding program has now named and released its first varieties and is in the process of licensing the new varieties to the Michigan Potato Industry Commission. Three potato varieties were released in 2001: Jacqueline Lee (MSG274-3), Liberator (MSA091-1), and Michigan Purple. MSU is currently licensing the first 3 varieties to MPIC and working out procedures to market these varieties. Boulder (MSF373-8) was released in 2003. Virus-free tissue culture plantlets are maintained at MSU.

Development of a DNA-based Fingerprint System for Potato Varieties

The ability to quickly and accurately identify potato clones is important to potato breeding programs and to the potato seed industry and commercial growers. Since 1990, the Michigan State University Potato Breeding and Genetics Program has used an isozyme-based fingerprint system to identify potato cultivars. Isozyme analysis has been an economical and effective means of discriminating potato clones; however, they require fresh, healthy tuber or leaf tissue. DNA-based fingerprinting using simple sequence repeats (SSRs or microsatellites) has been shown to discriminate between potato clones. The objective of this study was to identify those SSR primer combinations that accurately and efficiently distinguish clones on polyacrylamide and agarose gels. SSR primer combinations used were based on polymorphism levels in previous tetraploid studies from PCR amplification products. DNA isolated from 17 potato clones representing chip processing, tablestock, russet and red market classes were visualized on both polyacrylamide and low melting point (Metaphor ®) agarose gel systems. Eighteen SSR primer combinations were screened on both gel systems. Polymorphism was observed in all eighteen of the primer combinations on polyacrylamide (PAGE) and fourteen on agarose gel systems. The PAGE system was determined to be the preferred system for variety identification, but agarose can be used to differentiate lines when specific varietal comparisons need to be made. The primer combination STM0031 with STACCAS3 was able to differentiate all 17 clones on agarose. In addition, five different DNA source tissue types were evaluated (fresh foliar, freeze-dried foliar, fresh tuber skin, freeze-dried tuber skin, and freeze-dried tuber tissue). Amplification products were similar for all five tissue sources used for DNA isolation. This ability to isolate DNA from freeze-dried tissue will allow us to fingerprint varieties when fresh tissue is not available. The SSR fingerprinting system presented here can be used as a practical fingerprint system for cultivated potato. This research will be published in the American Journal of Potato Research.

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Table 1. Potential Lines for 2004 On-Farm Grower Trials

Line	Pedigree Female	Pedigree Male	Comments
Processing			
BOULDER (MSF373-8)	MS702-80	NY88	Chips out of the field, large tubers
MSF099-3	Snowden	Chaleur	42 °F chipper
MSG227-2	Prestile	MSC127-3	Scab resistant
MSH067-3	MSC127-3	W877	Flat, round
MSH094-8	MSE251-1	W877	45 °F chipper
MSH095-4	MSE266-2	OP	45 °F chipper
MSH112-6	Michigold	Zarevo	42 °F chipper, high solids
MSH228-6	MSC127-3	OP	Scab tolerant
MSJ036-A	A7961-1	Zarevo	Scab tolerant chipper
MSJ080-1	MSC148-A	S440	High yield
MSJ147-1	Norvalley	S440	cold chipper
MSJ461-1	Tollocan	NY88	Late blight resistant
MSK061-4	MSC148-A	ND2676-10	Scab tolerant chipper
Tablestock			
BOULDER (MSF373-8)	MS702-80	NY88	Chips out of the field, large tubers
MICHIGAN PURPLE	W870	Maris Piper	Bright purple skin, white flesh
MSE192-8RUS	A8163-8	Russet Norkotah	Scab resistant russet (Norkotah replacement)
MSE202-3RUS	Frontier Russet	A8469-5	Scab resistant russet
MSH031-5	MSB110-3	MSC108-2	Bright skin
MSI005-20Y	MSA097-1Y	Penta	Yukon appearance
MSI152-A	Mainestay	B0718-3	Late blight resistant, round white
MSJ033-10Y	MSA097-1	Penta	Yellow, Scab resistant
MSJ317-1	B0718-3	Prestile	Late blight resistant, round white

Table 2. 2002-2003 DEMONSTRATION STORAGE CHIP RESULTS
Chip Scores represented using SFA Scale†

	2002 DOH* CWT/A		2002 DOH*	2002 SCAB††	Sample Dates:							
					11/12/02	12/18/02	01/07/03	02/11/03	03/10/03	04/10/03	05/05/03	06/03/03
					Bin Temperature (^oF)							
POTATO LINE	US#1	TOTAL	SP GR	RATING	57 °F	50 °F	48 °F	48 °F	48 °F	48 °F	- °F	- °F
MSF099-3	323	348	1.076	3.7	1.0	1.5	1.0	1.0	1.5	1.5	-	-
MSG227-2[SCABRES]	256	326	1.072	0.5	1.5	1.0	1.5	1.5	1.0	1.5	-	-
MSH094-8	299	324	1.075	2.3	1.0	1.5	1.0	1.5	1.0	1.5	-	-
MSH095-4	326	351	1.076	2.0	1.5	1.5	1.5	1.5	1.0	2.0	-	-
SNOWDEN	**262**	**304**	**1.073**	**2.0**	**1.5**	**1.5**	**1.0**	**1.5**	**1.5**	**2.0**	-	-
W1201	364	391	1.081	1.3	1.5	1.5	1.5	1.5	1.5	1.5	-	-
					57 °F	55 °F	51 °F	55 °F	55 °F	54 °F	54 °F	56 °F
ATLANTIC	**328**	**352**	**1.078**	**2.7**	**1.0**	**1.5**	**1.5**	**1.5**	**1.5**	**2.0**	**1.0**	**2.5**
UEC	390	407	1.072	1.5	1.0	1.0	1.5	1.5	1.5	1.5	1.0	2.5
LIBERATOR[SCABRES]	276	309	1.074	0.0	1.5	1.5	1.5	1.5	1.0	1.5	1.5	1.5
MSE018-1	438	470	1.079	3.6	2.0	2.0	1.5	1.5	1.5	2.0	1.0	2.0
MSF373-8	392	401	1.072	2.5	2.0	1.5	1.0	1.5	2.0	1.5	1.5	2.0
MSI002-3	376	420	1.077	4.0	1.5	2.0	1.5	1.5	1.5	2.5	1.5	2.5
MSI083-5	255	288	1.072	3.3	1.5	1.5	1.5	1.5	2.0	1.5	1.5	2.5
MSJ461-1[LBR]	279	330	1.069	2.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5
PIKE	**262**	**302**	**1.077**	**1.1**	**1.5**	**1.5**	**1.5**	**1.0**	**1.0**	**1.5**	**2.0**	**2.0**
$LSD_{0.05}$	53	50	0.002									

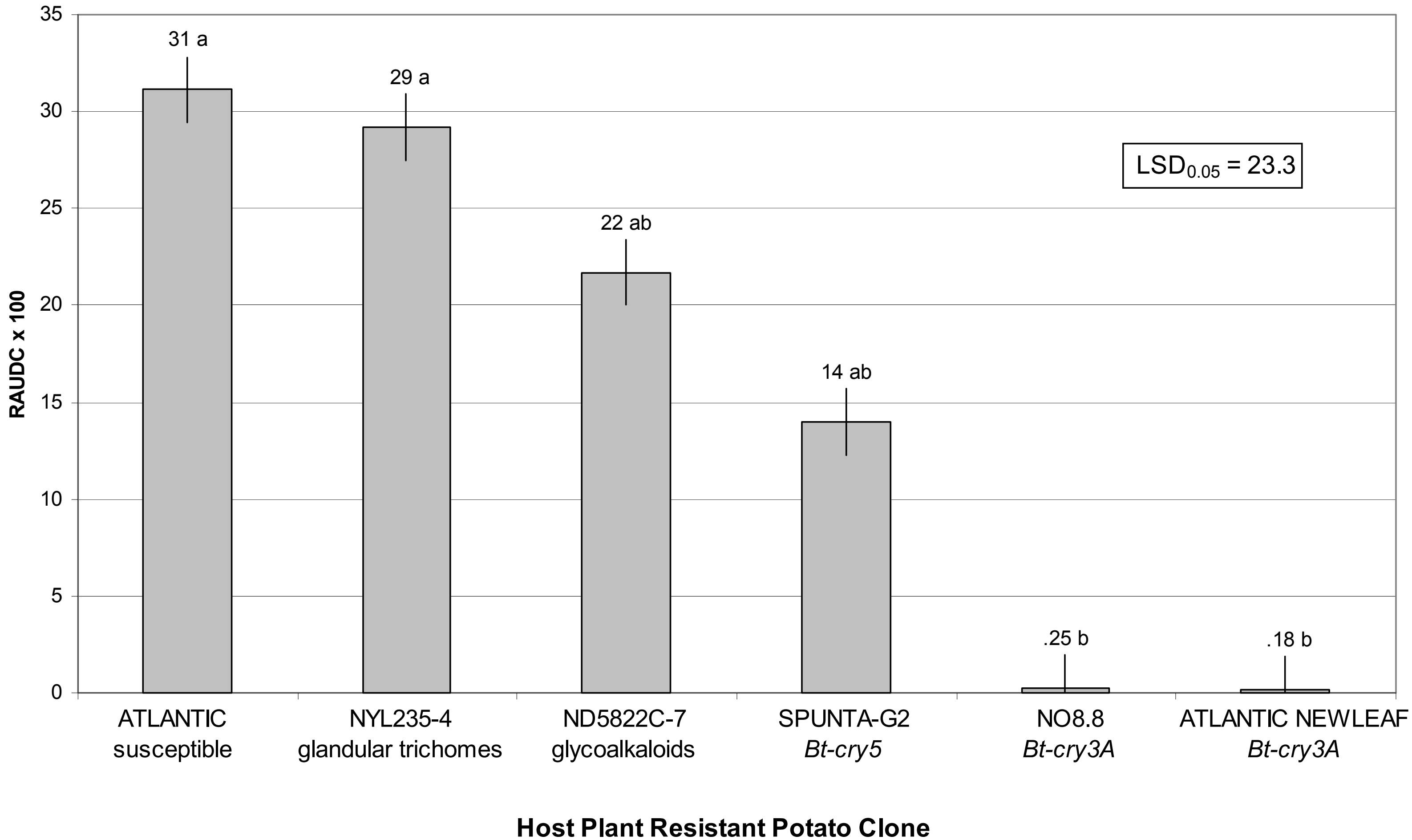
†CHIP SCORE: Snack Food Association Scale (Out of the field); Ratings: 1-5; 1: Excellent, 5: Poor.
††SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
*Agronomic data from Date of Harvest, Round-White Late Harvest (DOH) Trial; Montcalm Research Farm, September 21, 2001.
Chip scores were from two-slice samples from five tubers of each line collected at each sample date.
SCABRES Resistant to Common Scab *Streptomyces scabies*
LBR Resistant to foliar Late Blight, *Phytopthora infestans*

Table 3. Potato Seed Inventory 2003
MSU Potato Breeding Program Introductions
Availability of Michigan Certified Seed
A Cumulative Inventory

LINE	MINI-TUBERS (UNITS)	FY1 (CWT)	FY2 (CWT)	FY3 (CWT)	FY4 (CWT)
JACQUELINE LEE (MSG274-3)	-	-	12	-	-
LIBERATOR (MSA091-1)	750	60	484	-	-
MICHIGAN PURPLE	15,500	123	103	244	-
MSE192-8RUS	1,500	-	25	300	-
MSE202-3RUS	-	-	-	-	-
MSF099-3	-	-	12	-	144
MSG227-2	-	-	750	-	-
MSH031-5	-	95	-	-	-
MSH067-3	-	50	-	-	-
MSH095-4	-	20	-	-	-
MSI152-A	875	-	-	-	-
MSJ461-1	400	53	32	-	-

Information listed above is a cumulative count from Golden Seed Farms, Hanson Farms, Iott Seed Farms Inc., Krueger Seed Farm, Marker Farms, Makarewicz Seed Farm, and Sklarczyk Seed Farm.
Table courtesy of Chris Long.

Fig. 1. Colorado Potato Beetle Field Cage No-Choice Trial, Relative Area Under the Defoliation Curve (RAUDC) Results of Host Plant Resistance Potato Lines (2003)



Funding: Fed. Grant/MPIC

2003 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. 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, 42°F and 50°F storage), as well as susceptibilities to late blight (foliar and tuber), common scab, and blackspot bruising are determined.

PROCEDURE

Eight field experiments were conducted at the Montcalm Research Farm in Entrican, MI. They were planted as randomized complete block designs with 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. This year the new land which was leased to MSU was used for the field trials.

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 Regional, Adaptation (tablestock and chip-processors), and Preliminary (tablestock and chip-processors) 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 42°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 (Tables 1 and 2)

There were 17 entries that were compared at two harvest dates. Atlantic, Snowden and four Frito Lay clones were used as checks. The plot yields were below average in the early harvest (99 days), and most lines increased between 60-150 cwt/a in yield for the second harvest date (145 days). The results are summarized in **Tables 1 and 2**. Tuber specific gravity readings were significantly average to above average for 2003. Incidence of internal defects was generally low, but Atlantic and Snowden had a higher frequency of hollow heart in both early and late harvests. In the early harvest trial, MSJ147-1 had the highest yield, while FL1833, MSH112-6 and AC87340-2W were similar in yield behind MSJ147-1. At the later harvest, different lines were found at the top tier for yield. MSG227-2 and MSJ461-1 were new additions, along with AC87340-2W and MSH112-6. MSF373-8 (Boulder), MSF099-3 and MSH112-6 were also high in specific gravity along with Atlantic, MSH067-3, and MSH095-4. MSF099-3 and UEC were also the top yielding lines in the on-farm processing trials. MSJ461-1 is a promising chip-processing line with strong foliar resistance to late blight. It also has tablestock cooking quality. Liberator, Pike and MSG227-2 continue to be the lines with the highest scab resistance along with chip-processing ability. UEC, Dakota Pearl and FL1922 demonstrated scab tolerance in 2003. Chip-processing quality was high among all the entries in the out-of-the-field samples. UEC, Liberator and W1201 are in the 500 cwt bins of the Commercial Demonstration Storage this year.

Variety Characteristics

<u>LIBERATOR</u> - a MSU selection for chip-processing with strong scab resistance. Yield and specific gravity over the past 6 years were comparable to Snowden. It has performed well in other states (Nebraska, Pennsylvania and California). It was in the national SFA and the North Central regional trials. Liberator was released in 2001 and is in the 2003 Commercial Demonstration Storage.

<u>MSG227-2</u> – a MSU chip-processing selection with strong scab resistance. It has a specific gravity acceptable for chip-processing, excellent chip quality and cold-chipping potential. The tubers are smooth-shaped with a flattened round appearance that is attractive. It has chip-processed well from the 42°F MPIC demonstration storage studies. It has yielded well in some on-farm trials. This line will be considered for release in 2004.

<u>MSF099-3</u> – a MSU chip-processing selection. It has high specific gravity, smooth attractive tubers, and excellent chip quality and will chip-process from 45°F cold storage. In 2000 it was one of the best chip-processors in the 42°F MPIC demonstration storage. It yielded well on the on-farm trials, but the large tubers tended to elongate. It is also scab susceptible. MSF099-3 is in the 2001 and 2002 Commercial Demonstration Storage.

<u>MSJ461-1</u> – an exciting, new 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 average yield, but an intermediate specific gravity. Has good tablestock quality too.

UEC – 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 and 2003 Commercial Demonstration Storage bins.

Boulder (MSF373-8) - a high yielding selection with acceptable specific gravity for chip-processing. It will chip out-of-the-field and from 50°F storage. Produces large tubers with a low incidence of internal defects. Performance is good under dry land conditions. Scab tolerance is intermediate.

MSH095-4 - a mid-season maturing line with excellent chip quality and bruise susceptibility equal to Snowden. It was comparable to Atlantic for yield and solids at the Montcalm Research Farm. It is intermediate in scab tolerance between Atlantic and MSG227-2.

B. Round White Varieties: Tablestock (Tables 3 and 4)

There were 9 entries that were compared at two harvest dates. Onaway was used as a check. The plot yields were average in the early harvest (99 days), and a yield increase was observed for the second harvest date (141 days). Tuber specific gravity readings were average. The results are summarized in **Tables 3 and 4**. In the early harvest trial, Onaway, Michigan Purple, MSE018-1, MSE221-1 and MSH031-5 were the top yielding lines. There was very little incidence of internal defects in the early harvest. In the later harvest, MSE018-1, Onaway, and Michigan Purple were the top yielding lines. Overall, incidence of internal defects was low in comparison to previous years. MSE221-1 and Onaway were the only lines to classify as scab tolerant. Jacqueline Lee, MSI152-A and MSJ317-1 are late blight resistant. Michigan Purple is also a strong performing line under dryland conditions.

Variety Characteristics

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. We regard this as a variety that can compete in the red market.

MSH031-5 – a MSU tablestock/chip selection with high yield potential, attractive round shape and bright skin. It has also performed well in North Carolina. It is not scab resistant.

MSE221-1 - a MSU tablestock selection. It has high yield potential as seen in the MSU and on-farm trials in other years. General appearance is good, but it has a netted appearance similar to Superior. It has strong resistance to scab.

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. The strength of this selection is 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.

C. Russet Varieties (Table 5)

The russet trial had 19 lines evaluated in 2003. GoldRush and Russet were the standard varieties in the trial and the results are summarized in **Table 5**. Scab resistance was prevalent among the lines tested. Internal quality was high except for hollow heart in CO93016-3RUS and ATX84378-6RUS. Specific gravity measurements were below average with Russet Burbank and GoldRush having 1.074 and 1.068 readings. The yield of the overall trial was below average for 2003. Off type and cull tubers were found in all lines tested with Russet Burbank, ATX84378-6RU and A9305-10 being the greatest. The earliest maturing lines were MSE192-8RUS, Silverton Russet and CO93001-11RU.

Variety Characteristics

MSE192-8RUS - a MSU tablestock selection. The tubers have an attractive russeting and shape. The vine is small which may make this line uncompetitive in small plot trials. The tuber type suggests that it be considered a replacement for Russet Norkotah. The tubers have a clean white flesh that does not darken after cooking. Scab resistance is better than Russet Norkotah. It has performed well in taste tests.

MSE202-3RUS – a MSU dual-purpose russet selection. It has a late maturity and high yield potential. Its specific gravity is equivalent to Russet Burbank and the tubers are long with a lighter, but attractive russet skin. Scab resistance is also high. It performed well in Minnesota in 2003.

D. North Central Regional Trial (Table 6)

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. Twenty-two breeding lines and 7 check varieties were tested in Michigan. The results are presented in **Table 6**. The range of yield was very wide (553 cwt – 170 cwt) and specific gravities of the lines were high in 2003. The MSU lines MSG227-2, MSE221-1, MSE202-3RUS and MSH031-5 were all included in the North Central Trial. Similar to 2002, ND5822C-7 was very high yielding, but was susceptible to hollow heart. This line also has some Colorado potato beetle resistance. ND2470-27 was also a high performing line and chip-processed out of the field. MSG227-2 and W1773-7 offer good chip-processing and scab resistance. A9014-2RUS is an excellent russet selection for yield and type. The top-rated red-skinned line was W2275-3R because of its combination of good skin color, round shape and uniform small red tubers. MSE221-1, a scab resistant MSU tablestock selection, was also a promising selection in the trial.

E. Adaptation Trial (Tables 7A and 7B)

The Adaptation trial was divided into chip-processing and tablestock trials. Three cultivars (Snowden, Pike and Atlantic) and 15 advanced breeding lines are reported in the chip-processing trial. The trial was harvested after 124 days and the results are summarized in **Table 7A**. The high yielding lines identified in 2003 were MSJ036-A, MSJ453-4, MSK498-1Y and MSL757-1. The specific gravity readings were high with the check varieties at or above 1.086. Many MSU selections had specific gravity readings similar or higher than Atlantic. Other lines of interest were observed. MSJ316-A, MSK061-4, MSG301-9, MSK409-1 and MSK476-1 has some scab resistance and chip-processing ability. MSJ453-4, MSL757-1 and MSJ456-4 have strong foliar late blight resistance.

In the tablestock trial Onaway and Yukon Gold were the check varieties and 17 advanced breeding lines and new varieties are summarized in the table. The trial was harvested after 141 days and the results are summarized in **Table 7B**. Seven red-skinned entries were compared. NDTX4271-5R and ND5281-2RED had the best combination of shape and red skin color. MSI049-A was the highest yielding line and was also a strong performing line in the dry land trial. MSK136-2 is a round white selection with chip-processing and strong foliar resistance to late blight. MSI005-20Y is a scab tolerant yellow-fleshed selection that shows promise. MSK125-3 has some late blight tolerance (not resistance) and high yield potential. MSJ204-3 and MSL175-1 are round white selections with bright attractive tuber skins and may have some scab tolerance.

F. Preliminary Trial (Tables 8A, 8B and 8C)

The Preliminary trial is the first replicated trial for evaluating new advanced selections from the MSU potato breeding program. Fifty-nine advanced selections and three check varieties were tested and reported in three separate Preliminary trials. The division of the trials was based upon chip-processing, late blight resistance pedigree and tablestock utilization. The chip-processing trial is summarized in **Table 8A** was harvested after 119 days. Most lines chip-processed well from the field. Specific gravities were high, but yield was below average. The top yielding line was MSK117-AY. MSM051-3, MSM190-8, MS046-4, MSL007-B and MSM188-1 are promising lines that demonstrated some scab tolerance along with chip-processing ability. MSM190-8 and MSM185-1 have some tolerance to Colorado potato beetle damage in the field. **Table 8B** summarizes the chip-processing lines with late blight resistant pedigrees. This trial was harvested and evaluated after 119 days. Eight of the 13 lines were late blight resistant. Despite the late blight resistance, the vine maturities were not late in all cases. Seven different late blight resistance sources were also represented. The most promising lines combining chip-processing and late blight resistance are MSM417-A, MSL737-A, MSK128-A and MSL179-AY. MSL179-AY also has an attractive bright skin that would serve the tablestock market well. **Table 8C** summarizes the results from the Preliminary tablestock trial. Harvest was completed after 120 days. Of the 22 entries evaluated, 10 had foliar late blight resistance. The most promising lines with late blight resistance were MSM224-1, MSM171-A, MSL159-AY and MSL211-3. MSL025-ARUS is a russet selection with good type and MSL228-2 is selection with purple splashes. MSL159-AY also chip-processes out of the field.

G. Potato Scab Evaluation (Table 9)

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 9** categorizes many of the varieties and advanced selections tested in 2003 at the MSU Soils Farm Scab Nursery. This disease trial is a severe test. 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. In 2003 the scab disease incidence at the nursery was typical compared to other years, and the data were separated into three categories (Resistant = 0.0-1.0; Moderately Resistant = 1.3 – 1.8; and Susceptible = 2 or higher).The check varieties Russet Burbank, GoldRush, Superior, Onaway, Pike, Red Pontiac, Yukon Gold, Atlantic and Snowden can be used as references (bolded in **Table 9**). This year's results 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, MSG301-9, MSH228-6, MSK409-1, MSK476-1, 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, 4-8C**).

H. Late Blight Trial (Table 10)

In 2003, 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 4 June and inoculated 25 July with isolate 95-7, 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 10**. 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 2003 as in previous years (not shown in table). Twenty-one MSU lines were highly resistant to late blight. In addition 5 MSU lines (Jacqueline Lee, MSJ461-1, MSI152-A, MSJ317-1 and MSJ453-4) were highly resistant in a separate National Breeder Trial. Resistance of the MSU lines is derived from Tollocan (a Mexican variety), B0718-3 (USDA clone), AWN96518-2 (USDA clone), Stirling (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. Some of the most promising late blight resistant clones are MSJ461-1, MSL159-AY, MSL179-AY, MSM171-A, MSI152-A and MSK136-2. We find these late blight resistant lines valuable because many of them also have marketable maturity. Many of these lines also have other desirable traits such as scab tolerance resistance and/or chip-processing quality. Tuber late blight resistance is being evaluated on many of the selections with foliar late blight resistance.

I. Blackspot Susceptibility (Table 11)

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 11**. The bruise data are represented in two ways: percentage of bruise free potatoes and average number of bruises per tuber. A high percentage of bruise-free potatoes is the desired goal; however, the numbers of blackspot bruises per potato is also important. Cultivars which show blackspot incidence greater than Atlantic are approaching the bruise-susceptible rating. In addition, the data is grouped by trial, since the bruise levels can vary between trials. 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. However, these results become more meaningful when evaluated over 3 years that reflects different growing seasons and harvest conditions. In 2003 the bruise levels were lower than other years. The most bruise resistant lines this year were FL1922, Keystone Russet, GoldRush, Onaway, Silverton Russet, MSE202-3RUS, and MSE221-1. The most susceptible lines were MSH095-4, UEC, Norvalley, FL1833, Snowden, Atlantic, Jacqueline Lee and MSI005-20Y.

Table 1

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ROUND WHITE CHIP POTATOES: EARLY HARVEST
MONTCALM RESEARCH FARM
AUGUST 14, 2003 (99 DAYS)

	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	CWT/A
MSJ147-1	302	320	94	5	92	2	0	1.081	1.0	5	0	0	0	40	-
FL1833	287	297	97	3	79	17	0	1.080	1.0	17	0	0	0	40	-
MSH112-6	278	304	92	7	87	5	1	1.087	1.0	2	0	0	0	40	-
AC87340-2W	271	313	87	13	86	0	0	1.072	1.0	0	0	0	0	40	-
FL1879	254	266	96	4	72	23	0	1.073	1.0	8	0	0	0	40	-
ATLANTIC	**252**	**268**	**94**	**5**	**86**	**8**	**1**	**1.085**	**1.5**	**12**	**1**	**0**	**0**	**40**	**288**
MSJ080-1	249	271	92	8	76	16	0	1.072	1.0	12	0	0	0	40	-
FL1867	239	251	95	5	92	4	0	1.087	1.0	8	0	0	0	40	-
MSF099-3	230	251	92	8	91	1	0	1.083	1.0	1	0	0	0	40	215
DAKOTA PEARL	224	241	93	7	90	3	0	1.075	1.0	0	1	0	2	40	272*
MSG227-2	222	240	92	7	86	7	1	1.079	1.0	6	0	0	0	40	222
MSF373-8	221	233	95	4	62	33	1	1.070	2.0	5	0	0	0	40	262
MSH095-4	209	223	94	5	79	15	2	1.080	1.0	0	0	0	0	40	269
SNOWDEN	**209**	**234**	**89**	**11**	**87**	**3**	**0**	**1.083**	**1.0**	**8**	**1**	**0**	**0**	**40**	**217**
LIBERATOR	203	229	89	6	80	9	5	1.083	1.0	1	1	0	0	40	227
UEC	201	211	96	4	76	19	0	1.076	1.0	8	1	0	0	40	226*
MSH067-3	195	206	95	4	92	3	1	1.084	1.0	16	0	0	0	40	251*
FL1922	192	222	86	12	86	0	2	1.079	1.0	0	0	0	0	40	-
MSJ461-1[LBR]	180	200	90	10	81	9	0	1.068	1.0	3	0	0	0	40	193
MSH360-1	170	194	88	12	85	3	0	1.082	1.0	0	0	0	0	40	-
MSH228-6	168	178	95	5	88	6	0	1.077	1.0	2	0	0	0	40	-
MSH094-8	143	161	89	11	80	9	0	1.078	1.0	11	0	0	0	40	204
MSJ167-1	86	128	68	32	68	0	0	1.079	1.0	0	0	0	0	40	-
MEAN	217	237						1.079							
$LSD_{0.05}$	43	45						0.005							

* Two-Year Average

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

Planted May 7, 2003

Table 2

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ROUND WHITE CHIP POTATOES: LATE HARVEST
MONTCALM RESEARCH FARM
SEPTEMBER 29, 2003 (145 DAYS)

	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	SCAB[4]	MAT[5]	CWT/A
FL1879	364	372	98	2	67	31	1	1.076	1.0	4	0	0	1	40	-	2.3	-
AC87340-2W	360	400	90	9	87	3	1	1.076	1.0	0	0	0	0	40	2.7	3.8	-
MSJ080-1	360	389	92	6	73	20	1	1.073	1.0	11	0	1	0	40	2.0	2.8	-
MSF373-8	349	357	98	1	42	55	1	1.082	1.0	6	0	0	0	40	2.0	4.0	401
ATLANTIC	**341**	**366**	**93**	**3**	**84**	**9**	**3**	**1.089**	**1.0**	**11**	**0**	**0**	**1**	**40**	**2.3**	**3.0**	**372**
MSH112-6	330	361	91	5	81	11	4	1.087	1.0	0	0	0	0	40	2.3	2.0	-
MSF099-3	327	349	94	5	88	5	1	1.088	1.0	0	0	0	0	40	2.7	3.0	310
MSG227-2	323	346	93	5	82	11	2	1.081	1.0	8	0	0	0	40	0.8	3.5	327
MSJ461-1[LBR]	321	349	92	8	78	14	0	1.076	1.0	1	0	0	0	40	2.0	3.5	300
UEC	309	317	97	3	72	25	0	1.082	1.0	7	0	1	0	40	1.3	3.0	349
FL1833	302	320	95	4	70	25	1	1.084	1.0	11	0	0	0	40	1.7	2.8	-
MSH095-4	297	312	95	3	75	20	2	1.086	1.0	0	0	1	0	40	1.7	3.0	356
MSH067-3	291	299	97	2	74	23	1	1.087	1.0	28	0	0	0	40	2.0	2.8	330*
MSH228-6	286	301	95	4	76	20	1	1.082	1.0	1	0	0	1	40	0.7	4.0	-
LIBERATOR	284	334	85	4	72	13	11	1.080	1.0	1	0	0	0	40	0.0	2.8	318
MSJ147-1	284	302	94	5	81	13	1	1.081	1.0	6	0	0	0	40	1.7	3.8	-
SNOWDEN	**273**	**294**	**93**	**6**	**88**	**5**	**1**	**1.085**	**1.0**	**14**	**0**	**0**	**0**	**40**	**2.4**	**3.5**	**310**
DAKOTA PEARL	243	266	91	7	86	5	2	1.079	1.0	1	2	0	2	40	1.3	1.5	254*
MSH094-8	238	259	92	6	73	18	2	1.084	1.0	7	0	0	0	40	2.3	3.8	302
FL1922	231	264	87	9	83	5	4	1.076	1.0	1	0	0	0	40	1.3	1.3	-
FL1867	231	241	96	3	90	5	1	1.085	1.0	9	0	0	0	40	1.5	1.8	-
MSH360-1	212	235	90	7	86	4	3	1.084	1.0	1	1	0	1	40	2.3	2.3	-
MSJ167-1	150	172	87	11	84	3	2	1.087	1.0	0	0	0	0	40	2.0	4.0	-
MEAN	292	313						1.082									
$LSD_{0.05}$	60	59						0.004									

* Two-Year Average

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

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

[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 7, 2003

Table 3

MICHIGAN STATE UNIVERSITY

POTATO BREEDING and GENETICS

ROUND WHITE TABLESTOCK POTATOES: EARLY HARVEST
MONTCALM RESEARCH FARM
AUGUST 14, 2003 (99 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL	3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	CWT/A
ONAWAY	**291**	**307**	**95**	**3**	**76**	**19**	**2**	**1.071**	**0**	**0**	**0**	**0**	**40**	**332**
MICHIGAN PURPLE	269	288	93	5	73	20	2	1.070	1	0	0	0	40	317
MSE018-1	262	286	92	8	84	8	0	1.085	7	0	0	1	40	248
MSH031-5	236	259	91	8	86	5	1	1.084	0	0	0	0	40	290
MSE221-1	230	253	91	4	72	19	5	1.071	6	0	0	0	40	316
JACQUELINE LEE[LBR]	207	280	74	25	73	1	1	1.083	0	0	0	0	40	173
MSG050-2	202	220	92	8	88	3	1	1.078	0	0	0	0	40	-
MSI152-A[LBR]	193	250	77	22	75	2	0	1.072	1	0	0	0	40	264*
MSJ197-1	168	188	90	10	81	8	0	1.077	4	0	0	0	40	-
MSJ317-1[LBR]	167	197	85	15	83	2	0	1.072	1	0	0	0	40	-
MEAN	223	253						1.076						
$LSD_{0.05}$	51	55						0.003						* Two-Year Average

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

Planted May 7, 2003

Table 4

ROUND WHITE TABLESTOCK POTATOES: LATE HARVEST
MONTCALM RESEARCH FARM
SEPTEMBER 25, 2003 (141 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL			3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	SCAB[3]	MAT[4]	CWT/A
MSE018-1	430	456	94	4	73	21	2	1.088	5	10	0	0	40	2.0	4.0	409
ONAWAY	**326**	**364**	**90**	**2**	**58**	**32**	**8**	**1.066**	**0**	**4**	**0**	**0**	**40**	**1.4**	**1.0**	**334**
MICHIGAN PURPLE	323	346	93	3	62	32	4	1.066	2	1	0	0	40	2.3	1.8	328
MSG050-2	313	345	91	7	73	18	2	1.075	0	0	1	0	40	1.7	2.0	-
JACQUELINE LEE LBR	299	368	81	18	80	1	1	1.084	0	0	0	0	40	2.5	2.8	236
MSJ197-1	295	314	94	5	76	18	1	1.077	12	4	0	0	40	1.7	3.5	-
MSI152-A LBR	282	314	90	10	84	6	1	1.070	6	0	0	0	40	3.0	3.8	296*
MSH031-5	276	309	90	9	80	10	1	1.079	0	2	0	0	40	1.7	1.8	307
MSJ317-1 LBR	270	302	89	9	85	5	1	1.079	6	4	1	0	40	3.7	3.8	-
MSE221-1	263	307	86	3	61	25	11	1.067	4	2	0	0	40	1.0	1.3	324
MEAN	308	343						1.075								
$LSD_{0.05}$	44	51						0.003								

* Two-Year Average

LBR Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm

1SIZE: B: <2"; A: 2-3.25"; OV: >3.25"; PO: Pickouts.

2QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

4MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 7, 2003

RUSSET TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 18, 2003 (128 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL			3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	CWT/A
CO93016-3RU	325	371	88	10	66	21	3	1.080	15	0	0	0	40	1.0	3.5	-
A8254-2BRUS	310	394	79	13	69	10	8	1.075	2	0	0	0	40	0.0	4.0	-
KEYSTONE RUSSET	299	324	92	4	62	31	4	1.068	0	11	0	0	40	0.5	3.5	-
ALTURAS RUSSET	297	356	84	14	78	6	3	1.077	2	5	0	0	40	1.7	4.3	-
RUSSET BURBANK	**257**	**343**	**75**	**9**	**62**	**12**	**17**	**1.074**	**0**	**1**	**0**	**0**	**40**	**0.5**	**3.3**	**205**
A9305-10	252	335	75	12	67	8	13	1.076	0	4	0	0	40	1.7	3.8	-
AC89536-5RU	235	302	78	19	71	7	3	1.081	6	0	0	0	40	0.0	3.5	255
AC93026-9RU	234	279	84	9	59	25	7	1.077	3	4	0	0	40	0.0	4.0	-
A95109-1	224	253	89	7	76	13	4	1.078	0	10	0	0	40	0.0	3.0	-
CO93001-11RU	218	268	82	11	68	13	8	1.072	1	0	0	0	40	1.8	2.5	-
GOLDRUSH	**217**	**261**	**83**	**11**	**75**	**9**	**6**	**1.068**	**0**	**0**	**0**	**0**	**40**	**1.0**	**3.0**	**224**
MSE192-8RUS	212	251	85	14	64	21	2	1.070	0	3	0	0	40	0.3	2.3	231
SILVERTON RUSSET	204	235	87	6	68	19	7	1.067	1	0	1	0	40	0.3	2.5	184
AC92009-4RU	198	219	91	6	65	26	3	1.081	3	2	0	0	40	0.3	3.0	243*
ATX84706-2RU	193	216	89	7	79	10	3	1.071	1	1	0	0	40	2.0	3.5	-
A9304-3	192	240	80	10	57	23	10	1.078	7	2	0	0	40	0.5	2.8	-
MSE202-3RUS	184	243	76	14	66	9	10	1.075	1	0	0	0	40	0.3	2.8	266
CO85026-4RU	178	204	87	8	67	21	5	1.085	4	2	0	0	40	2.3	3.3	209
ATX84378-6RU	170	218	78	3	42	36	19	1.072	15	3	1	0	40	0.5	3.0	-
MEAN	232	279						1.075								
$LSD_{0.05}$	65	69						0.004								

* Two-Year Average

[1]SIZE: B: < 4oz.; A: 4-10oz.; OV: > 10oz.; PO: Pickouts.
[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.
[4]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[6]BRUISE: These lines demonstrated blackspot bruise susceptibility in simulated bruise testing in 2003.
Planted May 13, 2003

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

NORTH CENTRAL REGIONAL TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 23, 2003 (133 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL			
ENTRY	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	MERIT[6]
ND5822C-7	553	579	96	3	71	25	2	1.086	1.0	12	1	0	2	40	1.7	3.3	1W
RED PONTIAC	**450**	**487**	**92**	**4**	**60**	**32**	**3**	**1.063**	**3.5**	**9**	**2**	**0**	**0**	**40**	**3.2**	**2.8**	
SNOWDEN	**433**	**456**	**95**	**3**	**77**	**19**	**1**	**1.089**	**1.0**	**20**	**7**	**0**	**1**	**40**	**2.7**	**4.0**	
ND2470-27	421	448	94	3	67	27	3	1.077	1.0	0	6	0	0	40	3.0	3.0	
A9014-2RUS	391	447	87	6	51	37	6	1.079	2.0	3	1	0	0	40	1.0	3.3	1RUS
W1773-7	378	402	94	6	77	17	0	1.089	1.0	2	3	1	0	40	0.7	2.8	2W
MSG227-2	373	398	94	5	83	10	1	1.081	1.0	2	1	0	0	40	1.3	3.0	3W
V0056-1	360	377	95	3	75	21	1	1.082	1.0	9	0	0	0	40	2.3	1.8	
W1201	350	373	94	4	78	15	3	1.091	1.0	0	8	0	2	40	1.7	3.5	
CV89023-2R	348	397	88	10	75	12	3	1.068	3.5	0	3	0	0	40	3.0	2.5	
W1836-3RUS	341	382	89	8	72	17	3	1.080	2.5	6	0	0	0	40	0.7	3.3	2RUS
MN18710RUS	329	359	91	7	73	18	2	1.078	2.5	2	1	0	0	40	0.3	3.8	
UEC	312	330	95	3	64	31	2	1.082	1.0	4	0	0	0	40	1.3	3.5	
ATLANTIC	**294**	**318**	**92**	**4**	**72**	**20**	**3**	**1.089**	**1.0**	**14**	**2**	**0**	**0**	**40**	**2.3**	**2.8**	
MSE221-1	293	323	90	2	66	25	7	1.069	2.5	3	2	0	1	40	1.0	1.8	
V0379-2	279	309	90	7	83	8	3	1.075	1.5	0	3	0	0	40	3.0	1.0	
MSH031-5	266	294	91	9	82	8	1	1.080	1.5	0	0	0	0	40	1.7	2.3	
PACIFIC RUSSET (V0168-3)	239	255	94	6	85	8	0	1.069	2.0	0	1	0	0	40	1.7	1.0	
MN15620LR	229	302	76	20	71	5	5	1.073	2.0	0	4	0	0	40	2.3	2.8	
MN19525R	219	280	78	13	71	7	9	1.064	3.5	2	2	0	0	40	1.0	2.3	3RD
MN18747RUS	210	225	93	5	70	23	2	1.068	1.0	0	5	2	0	40	-	1.0	
NORVALLEY	**206**	**235**	**88**	**3**	**57**	**30**	**9**	**1.076**	**1.0**	**1**	**1**	**1**	**0**	**40**	**-**	**2.8**	
MSE202-3RUS	204	270	76	16	68	8	8	1.079	2.5	0	1	0	0	40	0.3	2.5	
RED NORLAND	**201**	**237**	**85**	**15**	**83**	**2**	**0**	**1.064**	**1.5**	**4**	**2**	**1**	**0**	**40**	**1.0**	**1.0**	

continued on following page:

Table 6 continued

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

NORTH CENTRAL REGIONAL TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 23, 2003 (133 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL			
ENTRY	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	MERIT[6]
continued:																	
ND3196-1R	200	230	87	9	73	14	4	1.069	3.5	3	1	1	1	40	1.0	1.3	2RD
RUSSET BURBANK	**199**	**325**	**61**	**10**	**51**	**10**	**29**	**1.075**	**2.0**	**5**	**0**	**0**	**0**	**40**	**0.5**	**3.3**	
W2275-3R	182	252	72	27	72	0	1	1.057	2.0	0	3	0	0	40	1.0	2.5	1RD
STAMPEDE RUSSET (AC)	182	213	85	13	68	17	1	1.060	1.5	0	4	1	0	40	0.3	1.5	3RUS
RUSSET NORKOTAH	**170**	**229**	**74**	**23**	**68**	**6**	**3**	**1.070**	**2.0**	**1**	**3**	**0**	**0**	**40**	**2.0**	**1.5**	
MEAN	297	336						1.075									
$LSD_{0.05}$	66	71						0.003									

[1]SIZE: B: <2"; A: 2-3.25"; OV: >3.25"; PO: Pickouts.
[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.
[3]CHIP SCORE: Snack Food Association Scale (Out of the field); Ratings: 1-5; 1: Excellent, 5: Poor.
[4]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
[6]MERIT: A Merit rating was given for the best 3 entries within each market class (rank order, 1 = best).
Planted May 13, 2003

Table 7A

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADAPTATION TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
SEPTEMBER 15, 2003 (124 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL		
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]
MSJ036-A	389	424	92	8	81	10	0	1.083	1.0	6	2	1	1	40	1.3	3.0
MSJ453-4[LBR]	331	380	87	12	77	10	1	1.087	1.5	15	3	1	0	40	1.7	3.3
ATLANTIC	**330**	**402**	**82**	**18**	**82**	**0**	**0**	**1.086**	**1.5**	**0**	**4**	**1**	**1**	**40**	**2.3**	**3.5**
MSK498-1Y	326	352	93	7	88	5	1	1.079	1.5	0	0	0	0	40	2.7	4.0
MSL757-1[LBR]	325	362	90	10	76	14	1	1.084	2.0	6	0	0	0	40	2.5	3.0
MSJ316-A	296	313	95	5	83	12	0	1.083	1.5	0	0	0	0	40	1.7	4.0
SNOWDEN	**277**	**295**	**94**	**6**	**86**	**8**	**0**	**1.087**	**1.0**	**15**	**5**	**0**	**0**	**40**	**2.4**	**3.3**
MSK061-4	264	293	90	10	88	2	0	1.086	1.0	0	10	0	0	40	2.0	3.5
MSK476-1	260	290	90	9	87	3	1	1.097	1.5	0	1	0	0	40	1.0	3.3
MSK437-A	245	256	96	3	60	36	1	1.076	1.0	8	0	0	1	40	2.0	3.8
MSK409-1	229	250	91	8	80	11	1	1.085	1.0	1	2	0	0	40	0.7	2.5
MSJ080-8	226	248	91	8	84	7	1	1.086	1.0	0	0	0	0	40	2.0	2.5
MSH356-A	210	234	90	9	84	5	1	1.081	1.5	11	2	0	0	40	1.7	3.3
MSG301-9	207	231	90	10	85	4	0	1.078	1.0	0	0	0	0	40	0.0	1.5
PIKE	**203**	**224**	**91**	**9**	**91**	**0**	**0**	**1.086**	**1.0**	**0**	**0**	**0**	**0**	**40**	**1.5**	**3.3**
MSJ456-4[LBR]	181	223	81	19	72	10	0	1.079	1.0	7	2	0	0	40	2.3	2.0
MSH015-2	126	142	89	7	83	6	4	1.091	1.0	2	0	0	0	40	1.0	3.0
MSJ126-9Y	119	146	81	18	81	1	1	1.073	1.0	0	0	0	0	40	1.3	2.5
MEAN	252	281						1.084								
$LSD_{0.05}$	61	63						0.003								

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

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

[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 14, 2003

Table 7B

ADAPTATION TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
SEPTEMBER 25, 2003 (141 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL		
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[3]	MAT[4]
MSI049-A	365	394	93	4	70	22	4	1.069	1.0	8	1	0	0	40	2.3	2.8
MSK125-3	350	391	90	9	82	7	1	1.075	2.0	5	2	0	0	40	2.0	4.0
STIRLING[LBR]	346	371	93	4	70	23	3	1.075	2.0	18	0	0	0	40	2.7	4.0
NDTX4271-5R	329	367	90	5	75	15	5	1.065	-	0	0	0	0	40	2.0	1.0
MSE149-5Y	328	350	94	4	77	17	2	1.070	1.0	5	0	0	0	40	2.0	2.0
ONAWAY	**327**	**352**	**93**	**2**	**70**	**23**	**5**	**1.068**	**-**	**0**	**6**	**0**	**0**	**40**	**1.5**	**1.0**
MSI005-20Y	303	341	89	6	79	10	5	1.077	-	0	0	0	0	40	1.0	1.5
CO89097-2RED	302	342	88	7	68	20	5	1.074	-	0	6	0	0	40	3.0	2.3
NDTX4304-1R	295	311	95	5	86	9	1	1.056	-	1	6	0	0	40	1.7	1.0
MSK136-2[LBR]	287	321	89	11	89	1	0	1.090	1.0	0	2	0	0	40	2.0	4.0
MSJ204-3	273	287	95	4	81	14	1	1.078	-	0	2	0	0	40	1.0	3.8
CO93037-6RED	269	350	77	15	70	7	8	1.065	-	0	0	0	0	40	2.0	2.5
DAKOTA ROSE	**258**	**276**	**93**	**4**	**76**	**18**	**3**	**1.058**	**-**	**1**	**3**	**0**	**0**	**40**	**1.5**	**1.0**
NDC5281-2RED	256	290	88	11	83	5	1	1.074	-	0	1	0	0	40	2.3	1.0
MSK068-2	231	267	86	13	83	3	0	1.081	-	1	1	0	0	40	3.3	4.0
MSL175-1	227	234	97	2	61	36	1	1.069	-	0	0	0	0	40	1.7	2.5
A83350-9R	222	246	90	10	87	3	0	1.068	-	0	0	0	0	40	2.5	1.0
YUKON GOLD	**220**	**238**	**92**	**6**	**78**	**14**	**2**	**1.080**	**-**	**4**	**1**	**0**	**0**	**40**	**2.3**	**1.0**
MSG004-3	193	206	94	6	81	13	0	1.070	-	1	2	0	0	40	2.0	2.5
MSJ033-6Y	171	231	74	13	64	10	13	1.070	-	0	0	0	0	40	2.7	1.5
MEAN	278	308						1.072								
$LSD_{0.05}$	49	49						0.003								

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.
[1]SIZE: B: <2"; A: 2-3.25"; OV: >3.25"; PO: Pickouts.
[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.
[3]SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
[4]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)
Planted May 7, 2003

Table 8A

PRELIMINARY TRIAL, CHIP-PROCESSING LINES
MONTCALM RESEARCH FARM
SEPTEMBER 10, 2003 (119 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL		
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]
MSK117-AY	365	395	93	7	77	16	0	1.086	1.0	0	1	0	1	20	-	3.5
MSM072-1	337	360	93	7	76	17	0	1.092	1.0	1	0	0	0	20	3.0	3.5
ATLANTIC	**327**	**339**	**97**	**3**	**89**	**8**	**0**	**1.095**	**1.0**	**2**	**0**	**1**	**0**	**20**	**2.3**	**1.0**
MSK085-A	299	334	90	10	88	1	0	1.083	1.5	0	0	0	0	20	2.3	4.0
SNOWDEN	**298**	**320**	**93**	**7**	**85**	**8**	**0**	**1.089**	**1.0**	**3**	**4**	**0**	**0**	**20**	**2.4**	**2.5**
MSM051-3	284	287	99	1	85	13	0	1.086	1.0	1	0	0	0	20	1.0	2.0
MSK009-B	267	285	94	6	82	12	0	1.079	1.0	0	0	0	0	20	3.0	3.0
MSR3-26	264	284	93	6	92	2	1	1.093	2.0	1	0	0	0	20	1.3	2.5
MSI037-5	260	280	93	7	87	6	0	1.087	1.5	0	0	0	0	20	3.3	4.0
MSM190-8	241	270	89	11	89	0	0	1.087	1.0	0	0	0	0	20	1.0	2.0
MSM083-A	240	279	86	14	86	0	0	1.091	1.0	0	0	0	0	20	2.5	2.5
MSL164-A	239	250	95	5	75	21	0	1.090	1.0	4	0	0	0	20	1.5	3.5
MSM414-1Y	236	255	93	5	88	5	2	1.088	1.0	0	0	1	1	20	1.7	3.5
MSM046-4	226	265	85	15	85	0	0	1.095	1.0	0	2	0	0	20	0.7	3.5
MSL007-B	225	261	86	14	86	0	0	1.086	1.5	0	0	0	0	20	0.7	2.5
MSM058-3	221	248	89	11	89	0	0	1.077	1.0	0	4	0	0	20	2.0	1.0
MSM144-CY	220	253	87	12	85	2	1	1.074	1.0	0	2	0	0	20	2.0	1.0
MSK072-B	220	228	96	4	92	4	0	1.091	1.0	0	1	0	0	20	2.5	2.5
MSK116-B	201	211	95	5	88	7	0	1.079	1.0	1	0	0	0	20	2.7	1.0
MSM188-1	188	228	82	18	82	0	0	1.092	1.5	0	0	0	0	20	1.3	2.5
MSM185-1	176	197	89	11	84	5	0	1.087	1.0	1	0	0	0	20	3.3	1.0
MSM107-7	166	187	89	11	89	0	0	1.069	1.0	0	0	0	0	20	2.0	2.0
PIKE	**155**	**171**	**90**	**10**	**90**	**0**	**0**	**1.088**	**1.0**	**0**	**0**	**0**	**0**	**20**	**1.5**	**2.0**
MSM414-3Y[LBR]	151	230	66	34	64	2	0	1.079	1.0	0	0	0	0	20	3.0	1.0
MSM060-3	148	216	68	31	68	0	1	1.092	1.0	0	0	1	1	20	0.7	1.0
MSM109-3Y	146	191	77	23	77	0	0	1.085	1.0	0	0	0	0	20	2.0	2.0
MEAN	229	257						1.086								
$LSD_{0.05}$	80	83						0.004								

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

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

[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 14, 2003

Table 8B

PRELIMINARY TRIAL, CHIP-PROCESSING LINES WITH LATE BLIGHT RESISTANT PEDIGREES
MONTCALM RESEARCH FARM
SEPTEMBER 10, 2003 (119 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL		
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]
ATLANTIC	**327**	**339**	**97**	**3**	**89**	**8**	**0**	**1.095**	**1.0**	**2**	**0**	**1**	**0**	**20**	**2.3**	**1.0**
MSM417-A[LBR]	305	327	93	7	77	16	0	1.084	1.0	0	1	0	0	20	4.0	2.0
SNOWDEN	**298**	**320**	**93**	**7**	**85**	**8**	**0**	**1.089**	**1.0**	**3**	**4**	**0**	**0**	**20**	**2.4**	**2.5**
MSM164-2Y	296	322	92	5	64	28	4	1.080	1.0	2	0	3	0	20	1.3	3.5
MSM170-D	282	306	92	8	83	10	0	1.078	1.5	0	0	0	0	20	3.3	1.5
MSL737-A[LBR]	273	301	91	9	88	3	0	1.085	1.0	0	0	0	0	20	4.0	4.0
MSK027-C[LBR]	267	302	88	12	86	3	0	1.093	1.5	0	0	0	0	20	2.7	1.5
MSK128-A[LBR]	255	276	92	7	86	6	1	1.080	1.0	0	0	0	0	20	-	1.5
MSK124-A[LBR]	254	281	90	10	83	7	0	1.077	1.5	0	0	0	0	20	4.0	3.5
MSL045-AY[LBR]	253	272	93	6	89	4	1	1.073	1.0	0	0	0	0	20	3.0	3.0
MSL179-AY[LBR]	245	279	88	12	82	5	0	1.072	1.5	0	0	0	0	20	3.0	1.5
MSL023-B	241	268	90	6	79	11	4	1.082	1.0	1	0	0	0	20	3.3	2.0
MSL258-CY	225	252	89	10	83	6	1	1.081	1.0	0	0	0	0	20	2.0	2.5
MSM409-2Y[LBR]	212	286	74	26	74	0	0	1.084	1.0	0	0	0	0	20	2.7	2.0
MSL276-A	192	241	80	19	77	3	1	1.097	1.0	0	0	0	0	20	2.0	4.0
PIKE	**155**	**171**	**90**	**10**	**90**	**0**	**0**	**1.088**	**1.0**	**0**	**0**	**0**	**0**	**20**	**1.5**	**2.0**
MEAN	255	284						1.084								
$LSD_{0.05}$	NS	NS						0.008								

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

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

[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 14, 2003

Table 8C

PRELIMINARY TRIAL, TABLESTOCK LINES
MONTCALM RESEARCH FARM
SEPTEMBER 11, 2003 (120 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL		
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]
MSM224-1[LBR]	444	483	92	8	77	15	0	1.078	1.5	0	0	0	0	20	-	4.5
MSM418-5[LBR]	378	393	96	2	83	13	2	1.077	1.0	0	3	0	0	20	2.0	3.0
MSM171-A[LBR]	349	357	98	2	78	20	0	1.068	1.5	0	0	0	1	20	2.0	1.5
MSM183-1[LBR]	327	391	84	16	80	4	0	1.092	1.0	0	0	0	0	20	1.3	4.0
MSM200-6	287	336	85	14	79	6	0	1.088	1.0	1	0	0	0	20	1.3	2.5
MSK193-B	283	302	94	4	78	15	3	1.082	1.0	1	0	0	0	20	3.0	3.5
ONAWAY	**274**	**335**	**82**	**3**	**61**	**20**	**16**	**1.067**	**3.0**	**0**	**1**	**0**	**0**	**20**	**1.5**	**1.0**
MSM066-4	272	285	95	4	91	4	1	1.076	1.0	4	0	0	0	20	1.0	3.5
MSL175-B	260	283	92	8	82	10	0	1.083	3.0	0	0	0	0	20	2.0	2.0
MSL228-1	259	283	92	7	82	9	2	1.084	1.5	0	0	0	0	20	1.3	2.0
MSM205-A	252	323	78	14	78	0	8	1.085	1.5	0	0	0	0	20	3.0	3.5
MSL210-A	249	295	84	14	83	1	2	1.081	1.0	1	1	0	0	20	3.0	1.0
MSL159-AY[LBR]	244	299	82	18	82	0	0	1.096	1.0	0	1	0	0	20	2.7	2.5
MSM143-CY	230	256	90	10	85	5	0	1.078	1.0	0	0	0	2	20	2.0	1.5
MSM182-1[LBR]	229	276	83	16	83	0	1	1.080	2.5	0	0	0	0	20	-	1.5
MSM140-B	229	295	78	22	77	1	0	1.078	1.0	0	0	0	0	20	3.0	3.0
MSL211-3[LBR]	228	269	85	15	83	1	1	1.076	2.5	0	0	0	0	20	1.0	1.5
A95053-61	217	301	72	26	72	0	2	1.085	1.5	0	0	0	0	20	3.0	3.5
MSL025-ARUS	212	290	73	26	66	7	1	1.071	2.0	0	1	0	0	20	0.7	3.0
MSM288-2Y	181	231	78	22	78	0	0	1.072	1.0	0	0	0	0	20	2.7	1.5
A96895-58LB[LBR]	167	195	86	5	52	33	9	1.065	3.0	11	1	0	0	20	2.3	3.0
A97039-51LB[LBR]	164	206	79	19	76	4	1	1.082	1.0	0	0	0	0	20	3.7	1.5
MSM286-EY	147	177	83	17	83	0	0	1.072	1.0	0	0	0	0	20	2.0	1.0
MEAN	256	298						1.079								
$LSD_{0.05}$	94	102						0.004								

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

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

[2]QUALITY: HH: Hollow Heart; BC: Brown Center; VD: Vascular Discoloration; IBS: Internal Brown Spot.

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

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

[5]MATURITY RATING: Taken August 28, 2003; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 14, 2003

2003 SCAB DISEASE TRIAL
SCAB NURSERY, EAST LANSING, MI

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Potato Line	Mean Rating (0-5)	Worst Rating (0-5)
RESISTANT CATEGORY:			*MODERATELY-RESISTANT CATEGORY:*		
A8254-2BRUS	0.0	0	**DAKOTA PEARL**	**1.3**	**2**
A95109-1	0.0	0	FL1922	1.3	2
AC89536-5RU	0.0	0	MSJ036-A	1.3	2
AC93026-9RU	0.0	0	MSJ047-5	1.3	2
LIBERATOR	0.0	0	MSJ126-9Y	1.3	2
MSG301-9	0.0	0	MSJ453-4[LBR]	1.3	2
AC92009-4RUS	0.3	1	MSL228-1	1.3	2
MN18710RUS	0.3	1	MSM164-2Y	1.3	2
MSE192-8RUS	0.3	1	MSM188-1	1.3	2
MSE202-3RUS	0.3	1	MSM200-6	1.3	2
SILVERTON RUSSET	0.3	1	MSR3-26	1.3	2
STAMPEDE RUSSET	0.3	1	UEC	1.3	2
A9304-3	0.5	1	**ONAWAY**	**1.4**	**3**
ATX84378-6RU	0.5	1	**DAKOTA ROSE**	**1.5**	**2**
KEYSTONE RUSSET	0.5	1	FL1867	1.5	3
RUSSET BURBANK	**0.5**	**2**	MN18747LW	1.5	3
MSH228-6	0.7	1	MSL164-A	1.5	2
MSK409-1	0.7	1	MSM151-1Y	1.5	2
MSL007-B	0.7	1	**PIKE**	**1.5**	**2**
MSL019-AY	0.7	1	A83350-9R	1.7	3
MSL025-ARUS	0.7	1	A9305-10	1.7	2
MSM046-4	0.7	1	ALTURAS RUSSET	1.7	2
MSM060-3	0.7	1	FL1833	1.7	2
RED NORLAND	**0.7**	**1**	MSG050-2	1.7	2
W1773-7	0.7	1	MSH031-5	1.7	2
W1836-3RUS	0.7	1	MSH095-4	1.7	2
MSG227-2	0.8	2	MSH356-A	1.7	3
A9014-2RUS	1.0	1	MSJ042-3	1.7	2
CO93016-3RU	1.0	2	MSJ147-1	1.7	3
GOLDRUSH	**1.0**	**1**	MSJ197-1	1.7	2
MN19525R	1.0	1	MSJ316-A	1.7	3
MSE221-1	1.0	2	MSM057-A	1.7	2
MSH015-2	1.0	2	MSM058-3	1.7	3
MSI005-20Y	1.0	1	MSM414-1Y	1.7	2
MSJ204-3	1.0	2	MSM418-5[LBR]	1.7	3
MSK476-1	1.0	1	ND5822C-7	1.7	2
MSL211-3[LBR]	1.0	1	NDTX4304-1R	1.7	2
MSM051-3	1.0	1	V0168-3	1.7	3
MSM066-4	1.0	1	W1201	1.7	2
MSM190-8	1.0	1	CO93001-11RUS	1.8	4
ND3196-1R	1.0	1			
W2275-3R	1.0	1			

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

$LSD_{0.05}$ = 1.3

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

2003 SCAB DISEASE TRIAL
SCAB NURSERY, EAST LANSING, MI

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Potato Line	Mean Rating (0-5)	Worst Rating (0-5)
SUSCEPTIBLE CATEGORY:			*SUSCEPTIBLE CATEGORY:*			*SUSCEPTIBLE CATEGORY:*		
ATX84706-2Rus	2.0	3	MSK125-3	2.2	3	A95053-61	3.0	4
CO93037-6R	2.0	3	MSL766-1	2.2	3	CO89097-2R	3.0	3
LADY ROSETTA	2.0	5	**ATLANTIC**	**2.3**	**4**	CV89023-2	3.0	4
MSE018-1	2.0	3	A96895-58LB LBR	2.3	3	MSI152-A LBR	3.0	3
MSE149-5Y	2.0	3	CO85026-4Rus	2.3	3	MSK009-B	3.0	3
MSF373-8	2.0	3	**MICHIGAN PURPLE**	2.3	4	MSL045-AY LBR	3.0	3
MSG004-3	2.0	3	MN15620R	2.3	3	MSL181-A	3.0	4
MSH067-3	2.0	3	MSH094-8	2.3	3	MSL210-A	3.0	3
MSI032-6	2.0	3	MSH112-6	2.3	3	MSL727-CY	3.0	3
MSJ080-1	2.0	2	MSH360-1	2.3	3	MSM072-1	3.0	3
MSJ080-8	2.0	2	MSI049-A	2.3	3	MSM140-8	3.0	3
MSJ167-1	2.0	4	MSJ456-4 LBR	2.3	3	MSM205-A	3.0	4
MSJ461-1 LBR	2.0	2	MSK085-A	2.3	3	MSM288-AY	3.0	3
MSK061-4	2.0	3	MSM151-2	2.3	3	MSM414-3Y LBR	3.0	4
MSK136-2 LBR	2.0	2	NDC5281-2R	2.3	3	ND2470-27	3.0	3
MSK437-A	2.0	2	V0056-1	2.3	3	SPUNTA	3.0	5
MSK469-1	2.0	3	**YUKON GOLD**	**2.3**	**3**	**RED PONTIAC**	**3.2**	**4**
MSL143-1	2.0	2	**SNOWDEN**	**2.4**	**3**	MSI037-5	3.3	4
MSL175-1	2.0	2	**JACQUELINE LEE** LBR	2.5	3	MSK068-2	3.3	4
MSL175-B	2.0	3	MSI002-3	2.5	3	MSK482-A	3.3	4
MSL258-CY	2.0	3	MSK072-B	2.5	3	MSL023-B	3.3	4
MSL265-BY	2.0	2	MSL757-1 LBR	2.5	4	MSM170-D	3.3	4
MSL276-A	2.0	2	MSM083-A	2.5	3	MSM185-1	3.3	5
MSM107-7	2.0	2	MSM288-2Y	2.5	3	A97039-51LB LBR	3.7	4
MSM109-3Y	2.0	2	SPUNTA G2	2.5	4	MSJ317-1 LBR	3.7	4
MSM144-CY	2.0	3	SPUNTA G3	2.5	4	B0718-1 LBR	4.0	4
MSM147-A	2.0	2	AC87340-2W	2.7	4	MSK124-A LBR	4.0	4
MSM171-A LBR	2.0	2	MSF099-3	2.7	4	MSL737-A LBR	4.0	4
MSM286-EY	2.0	3	MSI061-B	2.7	4	MSM417-A LBR	4.0	5
NDTX4271-5R	2.0	2	MSJ033-6Y	2.7	3			
RUSSET NORKOTAH	**2.0**	**2**	MSJ143-4	2.7	3			
			MSJ456-2Y LBR	2.7	3			
			MSK027-C LBR	2.7	4			
			MSK116-B	2.7	4			
			MSK188-AY	2.7	3			
			MSK193-B	2.7	4			
			MSK410-2Y	2.7	3			
			MSK498-1Y	2.7	4			
			MSL159-AY LBR	2.7	3			
			MSL179-AY LBR	2.7	4			
			MSL753-AR	2.7	3			
			MSM183-1 LBR	2.7	3			
			MSM409-2Y LBR	2.7	3			
			STIRLING	2.7	4			

*SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
$LSD_{0.05}$ = 1.3

2003 LATE BLIGHT VARIETY TRIAL
MUCK SOILS RESEARCH FARM

LINE	RAUDPC[1] MEAN	Table[2]	LINE	RAUDPC[1] MEAN
Foliar Resistance Category:			***Foliar Susceptibility Category (select lines)[3]:***	
A97039-51LB	0.0	Table 8C	**SNOWDEN**	**18.2**
MSL159-AY	**0.0**	**Table 8C**	KEYSTONE RUSSET	18.6
MSL179-AY	**0.0**	**Table 8B**	ALTURAS RUSSET	21.2
MSM183-1	**0.0**	**Table 8C**	FL1879	22.8
MSL766-1	**0.0**		SILVERTON RUSSET	23.1
MSK128-A	**0.1**	**Table 8B**	GOLDRUSH	24.3
MSL265-BY	**0.1**		**NORVALLEY**	**24.3**
MSM140-B	**0.2**		FL1833	25.0
MSM182-1	**0.2**	**Table 8C**	**PIKE**	**25.1**
STIRLING	0.2	Table 7B	W1201	27.0
MSL045-AY	**0.3**	**Table 8B**	UEC	31.4
MSL211-3	**0.4**	**Table 8C**	**RUSSET BURBANK**	**32.3**
MSM224-1	**0.4**	**Table 8C**	FL1867	32.7
A96895-58LB	0.4	Table 8C	STAMPEDE RUSSET	34.4
MSL737-A	**0.5**	**Table 8B**	**YUKON GOLD**	**34.5**
MSM171-A	**0.6**	**Table 8C**	**RED NORLAND**	**36.3**
MSI152-A	**0.7**	**Tables 3,4**	**RUSSET NORKOTAH**	**37.3**
MSK136-2	**1.5**	**Table 7B**	**ATLANTIC**	**39.3**
MSM151-1Y	**1.6**		**ONAWAY**	**46.3**
MSL757-1	**1.6**	**Table 7A**	FL1922	47.8
MSJ453-4	**2.0**	**Table 7A**		
MSK124-A	**4.5**	**Table 8B**		
MSK027-C	**4.6**	**Table 8B**		
MSM418-5	**6.0**	**Table 8C**		
$LSD_{0.05}$	8.4			8.4

[1] Ratings indicate the average plot RAUDPC (Relative Area Under the Disease Progress Curve).
[2] Agronomic performance data of this line may be found on the referenced table.
[3] 100 potato varieties and advanced breeding lines were tested in all. For brevity purposes, only selected varieties and breeding lines are listed. Varieties and breeding lines with a mean RAUDPC value of 8.4 and less are considered resistant in 2003.
Phytopthora infestans isolate 95-7 was inoculated 25 July 2003.
Planted as a randomized complete block design consisting of 3 replications of 4 hill plots on 4 June 20

2003 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
ROUND WHITES: CHIP-PROCESSING LINES								
FL1922	24	1					96	0.0
DAKOTA PEARL	18	6	1				72	0.3
AC87340-2W	17	7	1				68	0.4
B0766-3	15	9	1				60	0.4
MSJ080-1	18	4	1	2			72	0.5
LIBERATOR	16	6	2	1			64	0.5
MSH228-6	13	11	1				52	0.5
MSJ147-1	12	13					48	0.5
MSJ461-1[LBR]	13	11	1				52	0.5
MSF099-3	13	10	2				52	0.6
MSH112-6	14	9	1	1			56	0.6
FL1879	13	8	2	1			52	0.6
MSG227-2	14	6	4	1			56	0.7
MSH094-8	14	6	3	2			56	0.7
MSF373-8	12	8	4		1		48	0.8
MSJ167-1	11	9	2	2	1		44	0.9
MSH067-3	12	6	3	4			48	1.0
MSH360-1	13	6	2	2	1	1	52	1.0
FL1833	11	6	2	5		1	44	1.2
SNOWDEN	**5**	**12**	**5**	**2**	**1**		**20**	**1.3**
ATLANTIC	**10**	**5**	**3**	**3**	**1**	**3**	**40**	**1.6**
MSH095-4	6	3	7	4	4	1	24	2.0

* 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 on October 24, 2002. The table is presented in ascending order of average number of spots per tuber.

[LBR] Line(s) demonstrated foliar resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials in 2003 at the MSU Muck Soils Research Farm.

2003 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
ROUND WHITES: TABLESTOCK LINES								
MSE221-1	19	6					76	0.2
MICHIGAN PURPLE	17	8					68	0.3
MSH031-5	19	4	1	1			76	0.4
MSJ317-1 LBR	15	9	1				60	0.4
ONAWAY	**17**	**6**	**1**	**1**			**68**	**0.4**
MSI152-A LBR	13	10	2				52	0.6
MSJ197-1	10	11	3	1			40	0.8
MSG050-2	12	8	2	3			48	0.8
MSE018-1	4	6	8	5	1	1	16	1.8
JACQUELINE LEE LBR	3	9	4	6	3		12	1.9
RUSSET TRIAL								
ATX84706-2RU	24	1					96	0.0
ALTURAS RUSSET	23	2					92	0.1
KEYSTONE RUSSET	23	2					92	0.1
A9305-10	22	3					88	0.1
GOLDRUSH	**22**	**3**					**88**	**0.1**
MSE202-3RUS	22	3					88	0.1
SILVERTON RUSSET	21	4					84	0.2
A8254-2BRUS	20	5					80	0.2
AC93026-9RU	22	1	2				88	0.2
RUSSET BURBANK	**20**	**4**	**1**				**80**	**0.2**
AC89536-5RU	19	5	1				76	0.3
MSE192-8RUS	18	5	2				72	0.4
CO93016-3RU	16	7	2				64	0.4
A9304-3	14	7	4				56	0.6
ATX84378-6RU	14	7	4				56	0.6
AC92009-4RU	16	5	2	1	1		64	0.6
A95109-1	11	11	3				44	0.7
CO85026-4RU	12	7	4	2			48	0.8
CO93001-11RU	9	11	4	1			36	0.9

2003 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
NORTH CENTRAL REGIONAL TRIAL								
MSE202-3RUS	24	1					96	0.0
RED NORLAND	**24**	**1**					**96**	**0.0**
STAMPEDE RUSSET (AC)	24	1					96	0.0
MN18710RUS	23	2					92	0.1
W2275-3R	23	2					92	0.1
MN19525R	20	5					80	0.2
MN15620LR	19	6					76	0.2
RUSSET NORKOTAH	**21**	**3**		**1**			**84**	**0.2**
MN18747RUS	21	2	1	1			84	0.3
RED PONTIAC	**19**	**5**	**1**				**76**	**0.3**
CV89023-2R	18	6	1				72	0.3
ND3196-1R	18	6	1				72	0.3
MSG227-2	18	5	2				72	0.4
MSH031-5	18	6		1			72	0.4
PACIFIC RUSSET (V0168-3)	18	5	1	1			72	0.4
RUSSET BURBANK	**18**	**4**	**3**				**72**	**0.4**
W1836-3RUS	19	3	2	1			76	0.4
A9014-2RUS	18	4	2	1			72	0.4
ND2470-27	17	3	4		1		68	0.6
V0379-2	17	3	3	2			68	0.6
V0056-1	12	10	2	1			48	0.7
ATLANTIC	**13**	**8**	**3**			**1**	**52**	**0.8**
W1773-7	13	6	3	3			52	0.8
ND5822C-7	7	14	4				28	0.9
W1201	8	13	2	2			32	0.9
MSE221-1	13	4	4	3	1		52	1.0
NORVALLEY	13	2	7	2		1	52	1.1
B0766-3	9	6	8	2			36	1.1
SNOWDEN	**3**	**5**	**4**	**6**	**2**	**5**	**12**	**2.6**

Table 11

2003 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
ADAPTATION TRIAL, CHIP-PROCESSING LINES								
MSG301-9	25						100	0.0
MSK437-A	24	1					96	0.0
MSJ126-9Y	23	1	1				92	0.1
MSJ316-A	18	7					72	0.3
MSL757-1[LBR]	19	5	1				76	0.3
PIKE	**21**	**1**	**3**				**84**	**0.3**
MSK476-1	18	6	1				72	0.3
MSJ080-8	17	6	2				68	0.4
MSK061-4	16	7	1	1			64	0.5
MSK498-1Y	15	7	3				60	0.5
MSJ456-4[LBR]	15	6	3	1			60	0.6
MSH015-2	13	6	4	1	1		52	0.8
MSK409-1	11	7	5	2			44	0.9
MSJ036-A	11	7	3	3	1		44	1.0
SNOWDEN	**10**	**6**	**4**	**4**	**1**		**40**	**1.2**
ATLANTIC	**9**	**5**	**5**	**6**			**36**	**1.3**
MSH356-A	9	7	2	5	2		36	1.4
MSJ453-4Y[LBR]	8	7	4	5	1		32	1.4
ADAPTATION TRIAL, TABLESTOCK LINES								
DAKOTA ROSE	23	2					92	0.1
MSL175-1	22	3					88	0.1
NDTX4304-1R	22	3					88	0.1
ONAWAY	**22**	**3**					**88**	**0.1**
MSJ033-6Y	21	4					84	0.2
NDC5281-2RED	22	2	1				88	0.2
A83350-9R	22	1	2				88	0.2
CO89097-2RED	18	7					72	0.3
MSK068-2	18	7					72	0.3
YUKON GOLD	20	3	2				80	0.3
CO93037-6RED	19	4	2				76	0.3
MSG004-3	16	6	3				64	0.5
NDTX4271-5R	14	8	3				56	0.6
MSE149-5Y	13	7	5				52	0.7
MSI049-A	12	5	6	2			48	0.9
MSK136-2[LBR]	7	12	6				28	1.0
MSJ204-3	8	9	4	4			32	1.2
MSI005-20Y	4	7	9	4	1		16	1.6
MSK125-3	5	6	8	5	1		20	1.6
STIRLING[LBR]	4	1	5	9	3	3	16	2.6

2003 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
PRELIMINARY TRIAL, CHIP-PROCESSING LINES								
MSM072-1	22	3					88	0.1
MSM060-3	20	5					80	0.2
MSM107-7	21	3	1				84	0.2
MSK072-B	20	4		1			80	0.3
PIKE	**19**	**5**	**1**				**76**	**0.3**
MSI037-5	19	4	2				76	0.3
MSK085-A	18	5	2				72	0.4
MSM058-3	18	5	2				72	0.4
MSM144-CY	17	7	1				68	0.4
MSK009-B	17	6	2				68	0.4
MSM185-1	17	5	3				68	0.4
MSM190-8	18	4	2	1			72	0.4
MSM109-3Y	15	8	2				60	0.5
MSM188-1	15	8	2				60	0.5
MSM051-3	15	6	3	1			60	0.6
MSM414-3Y[LBR]	18	3	2		2		72	0.6
MSR3-26	13	9	2	1			52	0.6
MSM046-4	13	7	5				52	0.7
MSK116-B	15	5	2	3			60	0.7
MSM083-A	10	11	3	1			40	0.8
ATLANTIC	**11**	**7**	**4**	**2**	**1**		**44**	**1.0**
MSK117-AY	9	9	5	2			36	1.0
MSL007-B	6	12	7				24	1.0
SNOWDEN	**10**	**6**	**7**	**2**			**40**	**1.0**
MSL164-A	10	6	6	3			40	1.1
MSM414-1Y	11	5	6	1	2		44	1.1

2003 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
PRELIMINARY TRIAL, CHIP-PROCESSING LINES with LATE BLIGHT RESISTANT PEDIGREES								
MSL179-AY^{LBR}	23	2					92	0.1
MSK128-A^{LBR}	23	1		1			92	0.2
MSL737-A^{LBR}	19	5	1				76	0.3
MSM409-2Y^{LBR}	19	5	1				76	0.3
PIKE	**19**	**5**	**1**				**76**	**0.3**
MSM170-D	15	8	2				60	0.5
MSL258-CY	18	3	2	2			72	0.5
MSL023-B	15	6	3	1			60	0.6
MSL045-AY^{LBR}	15	7	1	2			60	0.6
MSK027-C^{LBR}	14	6	5				56	0.6
MSK124-A^{LBR}	11	10	3	1			44	0.8
MSM417-A^{LBR}	14	6	3	1	1		56	0.8
ATLANTIC	**11**	**7**	**4**	**2**	**1**		**44**	**1.0**
SNOWDEN	**10**	**6**	**7**	**2**			**40**	**1.0**
MSL276-A	10	6	6	2	1		40	1.1
MSM164-2Y	11	6	4	2	2		44	1.1
PRELIMINARY TRIAL, TABLESTOCK LINES								
MSM286-EY	25						100	0.0
MSL025-ARUS	23	2					92	0.1
MSM288-2Y	23	2					92	0.1
MSL210-A	22	3					88	0.1
MSL175-B	20	5					80	0.2
MSM066-4	20	5					80	0.2
MSM140-B	20	5					80	0.2
A97039-51LB^{LBR}	18	4	3				72	0.4
MSL211-3^{LBR}	17	6	2				68	0.4
MSL228-1	18	4	3				72	0.4
MSM171-A^{LBR}	19	3	2	1			76	0.4
ONAWAY	**17**	**5**	**2**	**1**			**68**	**0.5**
A96895-58LB^{LBR}	16	5	4				64	0.5
MSM143-CY	17	5	1	2			68	0.5
MSM182-1^{LBR}	13	7	5				52	0.7
MSK193-B	14	6	4		1		56	0.7
MSM224-1^{LBR}	15	3	5	1	1		60	0.8
MSM205-A	12	7	2	4			48	0.9
MSM200-6	6	13	2	4			24	1.2
MSL159-AY^{LBR}	9	7	5	2	2		36	1.2
A95053-61$^{LBR?}$	10	4	6	4		1	40	1.3
MSM418-5^{LBR}	7	5	4	8	1		28	1.6
MSM183-1^{LBR}	5	6	5	5	1	3	20	2.0

2003 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
SNACK FOOD ASSOCIATION: BRUISE SAMPLES								
AF1424-7	24	1					96	0.0
SNOWDEN	**23**	**2**					**92**	**0.1**
MSF099-3	23	1	1				92	0.1
NDTX4930-5W	22	3					88	0.1
A91790-13	21	3	1				84	0.2
ATLANTIC	**20**	**5**					**80**	**0.2**
MSH095-4	19	3	2	1			76	0.4
MSG227-2	14	9	2				56	0.5
ND5822C-7	16	7	1		1		64	0.5
ND2470-27	14	8	3				56	0.6
W1355-1	14	8	3				56	0.6
W1201	12	10	3				48	0.6
SNACK FOOD ASSOCIATION: CHECK SAMPLES								
A91790-13	25						100	0.0
AF1424-7	25						100	0.0
ATLANTIC	**25**						**100**	**0.0**
MSF099-3	25						100	0.0
MSG227-2	25						100	0.0
ND2470-27	25						100	0.0
NDTX4930-5W	25						100	0.0
SNOWDEN	**25**						**100**	**0.0**
W1201	25						100	0.0
W1355-1	25						100	0.0
MSH095-4	24	1					96	0.0
ND5822C-7	24	1					96	0.0

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2003 On-Farm Potato Variety Trials

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

Introduction

On-farm potato variety trials were conducted with 13 farms in 2003 at a total of 14 locations. Eight of the locations evaluated processing entries and six evaluated fresh market entries. The processing cooperators were Crooks Farms Inc. (St. Joseph / Montcalm) counties, L. Walther & Sons, Inc. (St. Joseph), Lennard Ag. Co. (Monroe), 4-L Farms, Inc. (Allegan), Main Farms (Montcalm) and Townview Farms (Montcalm). The 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), Fedak Farms (Bay), Horkey Bros. (Monroe) and M.J. Van Damme Farms (Marquette).

Procedure

There were two types of processing trials conducted this year. The first type contained nine entries which were compared with check varieties Atlantic, Snowden and Pike. This trial type was conducted at Main Farms, Lennard Ag. Co., 4-L Farms, and L. Walthers & Sons. Varieties in these trials were planted in 100' strip plots. Seed spacing was grower dependent, but in general ranged from 9 to 13 inches. The Walther trial was planted in four replicated plots and harvested at three harvest dates of 89, 112 and 142 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 seven to nine 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.

Within the fresh market trials, there were 27 entries evaluated. There were 12-21 lines planted at each of the following locations; Bay, 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 6 to 14 inches depending upon grower production practices and variety.

Results

A. Processing and "Select" Processing Variety Trial Results

A description of the processing varieties, their pedigree and scab rating 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 L. Walther & Sons in St. Joseph County is shown separately in Table 3 (first harvest, 89 days), Table 4 (second harvest, 112 days) and Table 5 (third harvest, 142 days). The overall averages of the "Select" processing trial, which are averaged across two growers, two counties and a total of three locations, are in Table 6.

Processing Variety Highlights

MSF099-3, an introduction from the Michigan State University Potato Breeding Program was the top yielder having a 411 cwt/A US#1 yield with a three year US#1 yield average of 371cwt/A. MSF099-3, an oval to oblong round white, with excellent chip processing quality continues to perform well in state and regional trials. Specific gravity has generally been acceptable and internal defects low. Common scab susceptibility continues to be a shortfall of this variety. In some cases the tubers have been so infected that they were classified as unmarketable.

UEC a variety that continues to show commercial potential was the second highest yielder in this years trial at 404 cwt/A US#1 yield with a 375 cwt/A US#1 yield over three years of testing. Internal quality and chip quality are good. Specific gravity has tended to be on the margin of acceptability at 1.078 to 1.082.

Other lines that are showing some traits of interest are W1201, with the ability to bulk early and the potential for above average US#1 yields along with some common scab tolerance. MSG227-2 has scab tolerance and good chip quality with a nice appearance. Liberator has good chip quality out of the field and from long term storage, as well as, good size distribution, scab tolerance and an average yield potential. MSJ461-1 has a competitive yield, good chip quality and excellent late blight tolerance.

B. SFA / USPB Chip Trial Results

The Michigan location of the SFA / USPB chip trial was on the V & G Farm in Montcalm county again this year. Table 7 shows the yields, size distribution and specific gravity of the entries when compared with Atlantic and Snowden. Table 8 shows the chip quality evaluations from samples processed and scored by Jays Foods, LLC, Chicago.

C. Fresh Market and "Select" Fresh Market Variety Trial Results

A description of the fresh pack varieties, their pedigree and scab rating are listed in Table 9. Table 10 shows the overall average of six locations; Bay, Marquette, Monroe, Presque Isle and Washtenaw counties.

Fresh Market Variety Highlight

Marcy (NY112), a Cornell University selection that has previously been in our chip processing trial was the top yielder in the Fresh pack trial for 2003. Marcy had a 451 cwt/A US#1 yield of round, netted tubers. Oversize and "a" size tubers accounted for 94% of the production with minimal internal defects (2 hollow heart in 60 tubers). This variety has a tolerance to common scab and a fresh pack gravity from 1.072-1.080 in Michigan. Black spot susceptibility has been noted for this variety as well.

MSJ461-1, a dual purpose round white with strong foliar late blight resistance was second highest in US#1 yield at 421 cwt/A with a 1.079 average gravity over six locations. Internal quality is excellent, but susceptibility to common scab has been noted.

Keystone Russet, a Colorado russet introduction, which performed well last year in our On-farm trials was the fourth highest yielder over 6 locations. Yield and quality were nice, but availability of nematode free seed is an issue for further commercialization.

Other varieties of interest were Keuka Gold having a 395 cwt/A US#1 yield with nice size and appearance and no internal defects. Keuka Gold has a nice yellow flesh comparable to Yukon Gold. An MSU selection, MSI005-20Y, was also a nice yellow flesh potato with an above average yield and no internal defects. MSH031-1 is a bright skinned round white that has no internal defects. This variety had a 348 cwt/A US#1 yield over two years.

Table 1.

2003 MSU Processing Potato Variety Trials

Entry	Pedigree	Scab Rating**	Characteristics
Atlantic (B6987-56)	Wauseon X Lenape	3.0	Early maturing, high yield check variety.
Alturas (A82360-7)	A77182-1 X A75188-3	1.3	Very high yield, high specific gravity, late maturing, high tuber number per hill, oblong, light russet, scab tolerant.
Liberator (MSA091-1)	MS702-80 X Norchip	0.3	Full season maturity, average yield, tubers round with some tendency to form Norchip off-types, chips best from 50 °F, good from long-term storage.
Pike (NYE55-35)	Allegany X Atlantic	1.5	Early maturing, early storage check variety.
Snowden (W855)	B5141-6 X Wischip	3.0	Late maturing, late season storage check variety.
B0766-3	B0243-18 X B9792-157 (Coastal Chip)	1.5	Mid season maturity, high yield, uniform size, scab tolerant, round to oval shape, good chip quality until early March from 50 °F.
MSF099-3	Snowden X Chaleur	3.7	Oval to oblong and slightly flattened, average yield: low internal defects and excellent chip color from 50 °F in May.
MSG227-2	Prestile X MSC127-3	0.5	Average yield potential: flattened round shape, shallow eyes, low internal defects, chip color variable in storage.
MSH094-8	MSE251-1 X W877	2.3	Mid season maturity, cold chipping potential 42 °F, very low internal defects.
MSH095-4	MSE266-2 OP	2.0	Mid-season maturity, bruise susceptibility equal to Snowden.
MSH228-6	MSC127-3 OP	1.3	Mid-season maturity, slightly flatted tubers, shallow eyes, intermediate specific gravity.
MSJ080-1	MSC148-A X S440	2.5	Mid-season maturity, yield similar to Atlantic, low internal defects, intermediate specific gravity.

Entry	Pedigree	Scab Rating*	Characteristics
MSJ461-1	Tollocan X NY88	2.7	Maturity slightly earlier than Snowden, round tubers with bright skin, low defects, strong foliar late blight resistance, chipped well 2003 Demo Storage, intermediate specific gravity.
Monticello (NY102 or K9-29)	Steuben X Kanona	3.0	Mid-season maturity, average yield, high specific gravity, good storability, low internal defects.
UEC*	Unknown	1.5	Early maturity, high yield, some heat stress tolerance.
W1201	Wischip X FYF 85	1.3	Late maturing, high yield, cold chipper 45 °F, deep eyes.
W1368	W831 X S459	-	Medium late maturity, average yield, high specific gravity, smooth round to oval shape.

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

*Unknown Eastern Chipper (UEC) 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 currently unknown. UEC seed that is represented in this summary 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.

Table 2.

2003 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
Atlantic	**432**	**472**	**91**	**8**	**84**	**7**	**1**	**1.082**	**1**	**3**	**1**	**0**	**1**	**30**	**Pitted & Surface Scab**	**349**
MSF099-3	411	468	88	11	86	2	1	1.076	1	0	0	0	1	30	SL Pitted Scab, Pear Shapes	371
UEC	404	420	97	3	74	23	0	1.078	1	2	1	0	0	30	SL Pitted & Surface Scab	375
Alturas	402	521	76	24	75	1	0	1.084	2	0	2	0	0	30	TR Scab, GC	-
W1201	397	423	94	5	80	13	1	1.090	1	0	2	0	0	30	SL Pitted Scab	351*
MSG227-2	393	434	91	9	91	0	0	1.079	1	0	0	0	0	30	TR Surface Scab	300
MSJ461-1	338	419	81	19	79	2	0	1.075	1	0	0	0	0	30	SL Pitted & Surface Scab	-
Liberator	338	389	88	12	86	2	1	1.082	1	0	2	0	0	30	TR SED	290*
MSH095-4	332	367	90	9	80	10	1	1.084	2	0	1	0	0	30	Deep Eyes, SL Pitted Scab	310
Snowden	**314**	**352**	**90**	**10**	**86**	**3**	**0**	**1.077**	**1**	**0**	**2**	**0**	**0**	**30**	**SL Pitted Scab**	**310**
MSH094-8	312	344	90	8	88	2	1	1.083	1	0	1	0	0	30	SL Pitted & Surface Scab, Oblong	274
Pike	**234**	**285**	**84**	**16**	**82**	**1**	**0**	**1.084**	**1**	**0**	**0**	**0**	**0**	**30**	**TR Pitted Scab, SL Internal Necrosis**	**225**
MEAN	359	408	88					1.081								

[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

GC = (Growth Crack)
SL = (Slight)
SED = (Stem End Defect)
TR = (Trace)

Table 3.

2003 Processing Potato Variety Trial
L. Walther & Sons, Inc. (Three Rivers, MI)

First Harvest[1] August 25, 2003 (89 Days)

	CWT/A		PERCENT OF TOTAL[2]						Number of	Total
			US#1		Small	Large			Internal	Chip
LINE	US#1	TOTAL	As	Bs	As	As	SP GR	HH[3]	Discolorations[3]	Defects[4]
Atlantic	**350**	**382**	**92**	**8**	**77**	**15**	**1.090**	**2.0**	**0.3**	**6.3**
Snowden	**333**	**394**	**85**	**15**	**77**	**8**	**1.084**	**1.3**	**0.0**	**2.0**
MSH095-4	329	368	89	11	57	32	1.081	0.5	0.3	8.5
UEC	318	348	91	9	57	34	1.080	3.3	0.0	3.7
W1201	303	340	88	12	78	10	1.090	0.5	0.0	0.0
MSF099-3	290	362	79	21	77	2	1.086	1.3	0.3	0.0
MSG227-2	273	347	78	22	76	2	1.078	2.3	0.5	2.2
MSJ461-1	248	325	77	23	71	6	1.073	0.8	0.0	5.0
Liberator	244	295	83	17	74	9	1.078	0.3	0.0	2.7
MSH094-8	224	294	75	25	72	3	1.084	0.5	0.0	0.0
Pike	**223**	**283**	**79**	**21**	**68**	**11**	**1.081**	**1.3**	**0.0**	**1.1**
Alturas	163	294	56	44	56	0	1.078	0.0	0.0	2.4
AVERAGE	275	336		19	70	11		1.2	0.1	
LSD (0.05)	94	N.S. (113)		7	8	9		1.8	N.S. (0.4)	
CV (%)	23.7	23.3		24.7	8.3	58.8		111.1	290.5	

[1]All data presented is based on an average of four replications

[2]Percent of Total (Size)
US#1: 2 - 4 in.
Large As: 3 - 4 in.
Small As: 2 - 3 in.
Bs: < 2 in.

[3]Based on 10 tuber raw sample

[4]Total Chip Defects is a percentage of the total sample comprised of; undesirable color, greening, internal defects and external defects.

Planted May 28, 2003 9" seed spacing Vine Kill: None

Table 4.

2003 Processing Potato Variety Trial
L. Walther & Sons, Inc. (Three Rivers, MI)

Second Harvest[1] September 17, 2003 (112 Days)

	CWT/A		PERCENT OF TOTAL[2]						Number of	Total
			US#1		Small	Large			Internal	Chip
LINE	US#1	TOTAL	As	Bs	As	As	SP GR	HH[3]	Discolorations[3]	Defects[4]
UEC	458	499	95	5	48	47	1.082	4.3	0.0	3.1
Atlantic	**403**	**456**	**92**	**8**	**68**	**24**	**1.090**	**5.0**	**0.0**	**9.7**
MSG227-2	400	473	88	12	79	9	1.079	4.0	0.0	4.4
Liberator	356	427	87	13	69	18	1.083	0.3	0.0	8.0
MSH095-4	321	380	90	10	53	37	1.084	0.3	0.0	0.0
MSJ461-1	313	402	82	18	64	18	1.071	0.3	0.5	0.0
Pike	**313**	**380**	**86**	**14**	**69**	**17**	**1.089**	**1.0**	**4.0**	**10.8**
MSH094-8	304	389	82	18	77	5	1.083	0.5	1.5	7.9
Snowden	**297**	**368**	**85**	**15**	**77**	**8**	**1.086**	**1.0**	**0.0**	**8.1**
W1201	294	356	87	13	68	19	1.090	0.5	0.3	2.5
MSF099-3	285	371	81	19	79	2	1.084	1.5	0.0	16.3
Alturas	218	352	66	34	65	1	1.081	0.5	0.0	2.4
AVERAGE	330	404		15	68	17		1.6	0.5	
LSD (0.05)	67	74		6	7	7		1.9	1.3	
CV (%)	14.1	12.8		26.7	7.2	29.6		82.6	169.4	

[1]All data presented is based on an average of four replications

[2]Percent of Total (Size)
US#1: 2 - 4 in.
Large As: 3 - 4 in.
Small As: 2 - 3 in.
Bs: < 2 in.

Planted May 28, 2003

[3]Based on 10 tuber raw sample

[4]Total Chip Defects is a percentage of the total sample comprised of; undesirable color, greening, internal defects and external defects.

9" seed spacing

Vine Kill: None

Table 5.

2003 Processing Potato Variety Trial
L. Walther & Sons, Inc. (Three Rivers, MI)

Third Harvest[1] October 17, 2003 (142 Days)

	CWT/A		PERCENT OF TOTAL[2]						Number of	Total
			US#1		Small	Large			Internal	Chip
LINE	US#1	TOTAL	As	Bs	As	As	SP GR	HH[3]	Discolorations[3]	Defects[4]
Atlantic	**446**	**468**	**95**	**5**	**55**	**40**	**1.092**	**3.0**	**2.5**	**28.2**
MSH095-4	414	453	93	7	57	36	1.085	1.5	1.5	22.2
UEC	388	404	96	4	46	50	1.085	2.8	0.8	40.5
Liberator	383	423	90	10	66	24	1.092	1.0	3.0	41.5
MSJ461-1	376	440	85	15	64	21	1.076	0.5	0.3	0.0
MSG227-2	353	413	85	15	68	17	1.077	3.5	1.0	68.3
Snowden	**346**	**399**	**87**	**13**	**74**	**13**	**1.084**	**0.8**	**1.5**	**49.5**
MSF099-3	330	387	85	15	85	0	1.088	1.5	0.5	98.3
Pike	**311**	**351**	**89**	**11**	**54**	**35**	**1.091**	**2.3**	**4.5**	**38.4**
MSH094-8	293	353	83	17	74	9	1.086	1.3	2.5	14.7
Alturas	275	337	81	19	79	2	1.078	0.5	0.8	0.0
W1201	259	295	88	12	67	21	1.091	1.5	3.0	33.4
AVERAGE	348	393		12	66	22		1.7	1.8	
LSD (0.05)	94	102		4	10	10		N.S. (2.4)	2.5	
CV (%)	18.8	18.1		23.3	10.7	32.7		100.1	93.8	

[1]All data presented is based on an average of four replications

[2]Percent of Total (Size)
US#1: 2 - 4 in.
Large As: 3 - 4 in.
Small As: 2 - 3 in.
Bs: < 2 in.

Planted May 28, 2003

[3]Based on 10 tuber raw sample

[4]Total Chip Defects is a percentage of the total sample comprised of; undesirable color, greening, internal defects and external defects.

9" seed spacing

Vine Kill: September 25, 2003 (121 Days After Planting)

Table 6.

2003 "Select" Processing Potato Variety Trial
Overall Average - Two Growers, Two Counties
Montcalm & St. Joseph 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	W1201	485	514	95	4	86	8	1	1.087	1	1	0	0	30	TR Surface Scab
3	MSJ461-1	434	497	87	13	84	3	1	1.076	0	0	0	0	30	TR Surface Scab
3	UEC	405	432	94	6	76	18	0	1.077	1	0	0	0	30	Surface and Pit Scab, Blocky
3	MSH228-6	390	417	94	6	79	14	0	1.081	0	1	0	0	30	SL Surface Scab, Flat, Oval
2	Snowden	398	424	94	6	77	16	0	1.079	1	1	0	0	20	Pitted Scab
2	W1368	378	469	81	19	81	0	0	1.087	0	0	0	0	20	Pitted Scab
3	MSH094-8	368	385	95	5	89	6	0	1.082	0	0	0	0	30	SL Pitted Scab, Blocky, Flat
2	MSH095-4	340	370	92	8	75	17	0	1.085	0	0	0	0	20	SL Pitted Scab, Deep Eyes
2	MSJ080-1	333	366	91	9	78	13	0	1.070	2	1	0	0	20	Flat
	MEAN	392	430	91					1.080						

[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 7.

SFA / USPB Potato Variety Trial
V & G Farms, Montcalm County, MI

September 17, 2003 (132 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]
ND5822C-7	567	601	94	3	66	28	3	1.089	1.0	7	0	0	3	30	1.7
MSF099-3	475	520	91	7	89	3	2	1.080	1.0	0	0	0	0	30	2.7
ATLANTIC	**454**	**496**	**92**	**6**	**77**	**14**	**3**	**1.080**	**1.0**	**4**	**0**	**2**	**0**	**30**	**2.3**
W1201	422	438	96	3	85	11	1	1.085	1.0	1	4	0	0	30	1.7
SNOWDEN	**416**	**460**	**90**	**10**	**90**	**1**	**0**	**1.086**	**1.0**	**0**	**3**	**0**	**0**	**30**	**2.4**
A91790-13	354	411	86	10	78	8	4	1.080	1.0	0	1	1	0	30	-
NDTX4930-5W	336	368	91	7	85	7	2	1.086	1.0	4	2	0	0	30	-
W1355-1	324	430	75	24	75	0	0	1.080	1.0	0	0	0	0	30	-
AF1424-7	299	333	90	9	88	2	1	1.082	1.0	0	0	0	0	30	-
MSG227-2	296	321	92	7	88	4	1	1.080	1.0	1	0	0	0	30	0.8
MSH095-4	288	321	90	6	68	22	4	1.080	1.0	0	1	0	0	30	1.7
ND2470-27	219	265	83	12	76	6	5	1.067	1.0	0	0	0	0	30	3.0
MEAN	371	414						1.081							

[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

[4]SCAB DISEASE RATING
0: No Infection
1: Low Infection <5%
3: Intermediate
5: Highly Susceptible

Planted: May 9, 2003 Seed Spacing : 9" Vine Killed August 30, and September 5, 2003 (121 After Planting)

Table 8.

SFA / USPB Potato Variety Trial
Post Harvest Chip Quality Evaluation*

September 17, 2003 (138 DAYS)

LINE	SPECIFIC GRAVITY	CHIP COLOR	PERCENT CHIP DEFECTS INTERNAL	EXTERNAL	TOTAL
ND5822C-7	1.089	63.2	0.0	2.1	2.1
MSF099-3	1.080	60.7	0.0	12.7	12.7
ATLANTIC	**1.080**	**64.0**	**0.0**	**17.3**	**17.3**
W1201	1.085	62.1	0.0	2.3	2.3
SNOWDEN	**1.086**	**62.6**	**0.0**	**15.0**	**15.0**
A91790-13	1.080	64.1	0.0	4.7	4.7
NDTX4930-5W	1.086	64.3	0.0	2.5	2.5
W1355-1	1.080	64.1	0.0	2.0	2.0
AF1424-7	1.082	64.1	0.0	3.6	3.6
MSG227-2	1.080	63.2	0.0	1.4	1.4
MSH095-4	1.080	63.6	0.0	4.4	4.4
ND2470-27	1.067	62.5	0.0	15.5	15.5

*Samples processed and scored by Jays Foods, LLC. Chicago September 29, 2003

Table 9.

2003 MSU Freshpack Potato Variety Trials

Entry	Pedigree	Scab Rating*	Characteristics
Chieftain (Iowa 57410)	La 1354 X Ia 1027-18	1.5	Mid-season maturity, high yielding, red skin check variety.
Dakota Pearl (ND2676-10)	ND1118-1 X ND944-6	1.0	Early maturing, low internal defects, average yield, cold chipping potential at 42 °F.
Dakota Rose (ND3574-5R)	ND1196-2R X NorDonna	2.0	High yield, nice appearance, resistant to silver scurf, good size tubers, short dormancy, skinning
Eva (NY103)	Steuben X OP	2.8	Mid-season maturity, above average yield, round to oval appearance, resistant to PVX and PVY.
Fremont Russet (CO85026-4)	Century Russet X WNC630-2	0.7	Medium late maturity, oblong to long type, average yield and medium to high gravity, good storability.
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
Keuka Gold (NY101)	Steuben X Norwis	1.0	Full season maturity, high yield, pale yellow flesh, round to oval shape. Susceptible to internal heat necrosis
Keystone Russet (AC83064-1)	CalWhite X A7875-5	0.5	Mid-season maturity, high yield, good storability, good internals, resistant to black spot, short dormancy
Liberator (MSA091-1)	MS702-80 X Norchip	0.3	Full season maturity, average yield, tubers round with some tendency to form Norchip off-types, chips best from 50 °F, good from long-term storage.
Marcy (NY112)	Atlantic X Q155-3	1.8	Full season maturity, high yield, smooth round appearance.
Michigan Purple	W870 X Maris Piper	3.0	Mid-season, attractive purple skin, white flesh, high yield potential, low incidence of internal defects

Entry	Pedigree	Scab Rating*	Characteristics
NorValley (ND2417-6)	Norchip X ND860-2	3.5	Mid-season maturity, medium to high yield, round tubers, clean appearance, good storability.
Onaway	USDA X96-56 X Katahdin	1.7	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	2.5	Mid-season maturity, average yield, long to oval tubers, heavy russet, check variety
Silverton Russet (A083064-6)	CalWhite X A7875-5	0.0	Oblong to long, medium russet skin, medium to high yield.
AC89536-5 Rus	-	0.0	High yielding, average gravity,
AC92009-4 Rus	-	0.0	Average yielding, oblong russet, good storability, above average specific gravity.
MSE192-8 Rus	A81163 X Russet Norkotah	1.2	Long russet tubers, low internal defects, bright white flesh, good cooking quality, specific gravity similar to R. Norkotah.
MSF373-8	MS702-80 X NY88	2.8	High yield, large tubers, low internal defects, med. deep eyes.
MSH031-5	MSB110-3 X MSC108-3	2.7	Mid-season, average yield, nice appearance, res. to black spot
MSI005-20Y	MSA097-1Y X Penta	2.0	Mid-late maturity, high yielding, low internal defects, strong yellow flesh color.
MSI152-A	Mainestay X B0718-3	2.0	Mid-late maturity, bright skin, foliar late blight resistance.
MSJ461-1	Tollocan X NY88	2.7	Maturity slightly earlier than Snowden, round, bright skin, low defects, strong foliar late blight resistance, nice flavor, intermediate specific gravity.
ND3196-1R	ND2223-8R X ND649-4R	0.7	Early maturity, average yield, smooth round tubers, white flesh, shallow eyes, stores well.
W1836-3 Rus	ND14-1 Rus X W1005 Rus	0.0	Dual purpose, medium late maturity, long blocky, high yield, resistant to vert. wilt.

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

Table 10.

2003 Freshpack Potato Variety Trial
Overall Averages - Six Locations
Bay, Marquette, Monroe, Montcalm, Presque Isle, Washtenaw Counties

NUMBER OF		CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL		3-YR AVG US#1
LOCATIONS	LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	COMMENTS	CWT/A
6	Marcy (NY112)	451	480	94	5	72	22	1	1.079	2	0	0	0	60	SL Scab, Nice Type	-
3	**Reba**	**423**	**439**	**96**	**3**	**64**	**32**	**0**	**1.073**	**0**	**0**	**0**	**0**	**30**		**362***
6	MSJ461-1	421	488	86	13	83	3	0	1.079	0	0	0	0	60	Scab	-
2	Keystone Russet	402	472	86	11	74	12	4	1.080	0	0	1	0	20	Blocky to Long	379*
3	Keuka Gold	395	415	95	5	72	22	1	1.073	0	0	1	0	30	Nice Type, Good Flesh	-
6	MSI152-A	395	465	85	14	80	5	1	1.076	0	1	1	0	60	SL Scab	-
3	MSI005-20Y	324	377	87	13	84	1	1	1.078	0	0	0	0	30	SL Scab, Pear Shape, GC	-
6	MSH031-5	324	375	87	13	85	2	0	1.079	0	0	0	0	60	SL Scab, Long, Round, Flat	348*
5	NorValley	299	366	82	13	76	5	5	1.075	0	1	0	0	50	Pear Shapes, Surface Scab	-
3	Liberator	285	325	88	11	83	5	2	1.086	0	0	0	0	30	Good Appearance, Misshapen	261*
3	Eva	281	317	88	11	83	5	1	1.072	0	0	0	0	30	Oval, Round	-
2	**Onaway**	**267**	**293**	**91**	**8**	**83**	**9**	**0**	**1.072**	**0**	**1**	**0**	**0**	**20**		**363**
4	W1836-3Rus	258	341	76	22	73	3	2	1.082	1	0	0	0	40	GC, Misshapen	-
2	Michigan Purple	258	303	86	10	74	11	5	1.073	0	0	0	0	20	Scab, GC, Misshapen	370
6	ND3196-1R	246	302	82	12	81	0	7	1.069	0	0	0	2	60	Nice Color, Knobs, Butterflies	-
4	AC92009-4Rus	245	287	85	13	78	7	2	1.085	0	0	0	0	40	Nice Appearance	-
5	Dakota Pearl	244	288	85	13	84	1	3	1.076	0	0	0	0	50	Bright Appearance	276*
3	Silverton Russet	236	315	74	17	67	7	9	1.078	0	0	0	1	30	GC, Misshapen	268
4	AC89536-5Rus	213	349	60	37	58	2	3	1.085	2	1	0	0	40	Small Size, GC, Knobs	-
3	Dakota Rose	195	218	89	10	83	6	1	1.062	0	0	0	0	30	SL Scab, Nice Color, Wire Worm	258*
4	CO85026-4Rus	189	229	78	18	76	2	4	1.086	1	0	0	0	40	GC, Misshapen, Small Size	-
2	**Russet Norkotah**	**182**	**273**	**68**	**29**	**64**	**3**	**3**	**1.071**	**0**	**1**	**0**	**0**	**20**	**Small Size**	**214**
2	MSE192-8Rus	179	236	74	26	72	1	0	1.070	0	0	0	0	20	Small Size	199
	MEAN	292	346	83					1.076							

[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

* Two-Year Average

GC = (Growth Crack)
SL = (Slight)

Funding: Industry

POTATO (*Solanum tuberosum* L.>Pike=)
Black scurf and stem canker*; Rhizoctonia solani*

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Seed treatments, in-furrow and seed plus foliar treatments for control of potato stem canker and black scurf, 2003.

Potatoes infected with R*hizoctonia solani* (black scurf), 2- 5% tuber surface area infected, were selected for the trials. Potato seed was prepared for planting by cutting and treating with fungicidal seed treatments seven days prior to planting.. Seed were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 5 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. Dust formulations 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. Fungicides applied as pre-planting potato seed liquid treatments were applied in water suspension at a rate of 0.02pt/cwt onto the exposed seed tuber surfaces, with the entire seed surface being coated in the Gustafson seed treater. In furrow applications were made over the 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. 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 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). Severity of stem canker was estimated as the percentage of stems per plant with greater than 5% girdling caused by *R. solani*, measured 70 days after planting (5 plants per sample were destructively harvested and total stem number and number affected was counted). Vines were killed with Reglone 2EC (1 pt/A on 20 Sep). Plots (25-ft row) were harvested on 29 Oct and individual treatments were weighed and graded. Samples of 50 tubers per plot were harvested 14 days after desiccation (approximately 135 DAP). Tubers were washed and assessed for black scurf (*R. solani*) incidence (%) and severity 40 days after harvest. Severity of black scurf was measured as an index calculated by counting the number of tubers (n = 50) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >16%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.

No seed treatment (ST) or fungicide applied at planting in-furrow (IF) was significantly different from the untreated control or from the Maxim MZ 0.5 lb (ST) commercial standard treatment in terms of the final plant stand (98 - 100%), relative rate of emergence (RAUEPC)]or rate of canopy formation (RAUCPC). Seed treatments and in-furrow applications of fungicides were not phytotoxic. All treatments significantly reduced the percentage of stolons with greater than 5% girdling due to *R. solani* in comparison with the untreated control but there was no difference among treatments. All treatments significantly reduced the percent incidence of black scurf on tubers in comparison with the untreated control except treatments 2 and 7. All treatments significantly reduced the severity of tuber black scurf in comparison with the untreated control. There was no significant difference in the index of severity of black scurf between treatments with indices between 14.4 [Quadris 2.08SC 0.05 fl.oz/1000 ft (IF)] to 24.4, the commercial standard [Moncoat MZ 0.75 lb (ST)]. There were no significant differences between any treatments in terms of marketable or total yield.

Treatment and rate/cwt (seed treatment) rate/A (in furrow)	Application timing[z]	Plant number (%) emerged 29 days after planting		Emergence (RAUEPC)[y]		Canopy development (RAUCPC)[x]	
1 Moncut 70DF 0.79 oz/1000 ft	IF.........	98.5	a	0.27	a	0.54	a
2 Moncut 70DF 1.18 oz/1000 ft	IF.........	99.5	a	0.27	a	0.52	a
3 Maxim 4 FS 0.04 fl. oz	ST........	97.5	a	0.26	a	0.55	a
4 Maxim 4 FS 0.08 fl. oz	ST........	100	a	0.27	a	0.53	a
5 Maxim 4 FS 0.04 fl. oz +	ST........	98	a	0.26	a	0.55	a
Quadris 2.08SC 0.05	IF.........						
7 Moncoat MZ 0.75 lb	ST........	100	a	0.27	a	0.52	a
8 Tops MZ 0.75 lb	ST........	100	a	0.27	a	0.54	a
9 Quadris 2.08SC 0.05	IF.........	99	a	0.26	a	0.53	a
10 Untreated	NA........	96.5	a	0.25	a	0.55	a

Treatment and rate/cwt (seed treatment) rate/A (in furrow)	Application timing[z]	Percent stolons with greater than 5% girdling due to *R. solani*[v]		Incidence of black scurf on tubers (%)[u]		Index of severity of black scurf on tubers (%)[t]		Yield cwt/A			
								Marketable (US1)[s]		Total[r]	
1 Moncut 70DF 0.79 oz/1000 ft	IF.........	15.4	b	42.5	bc	14.7	c	287	a	305	a
2 Moncut 70DF 1.18 oz/1000 ft	IF.........	12.1	b	61.3	abc	21.6	bc	262	a	288	a
3 Maxim 4 FS 0.04 fl. oz	ST........	17.8	b	32.5	bc	10.9	c	272	a	314	a
4 Maxim 4 FS 0.08 fl. oz	ST........	15.9	b	41.3	bc	13.8	c	292	a	317	a
5 Maxim 4 FS 0.04 fl. oz +	ST........										
Quadris 2.08SC 0.05	IF.........	18.2	b	47.5	bc	20.6	bc	276	a	306	a
7 Moncoat MZ 0.75 lb	ST........	14.6	b	65.0	ab	24.4	bc	289	a	327	a
8 Tops MZ 0.75 lb	ST........	19.9	b	57.5	bc	21.6	bc	274	a	332	a
9 Quadris 2.08SC 0.05	IF.........	14.2	b	36.3	bc	14.4	c	275	a	322	a
10 Untreated	NA........	44.5	a	100.0	a	50.3	a	225	a	295	a

[z] Application type, seed treatment (ST), in-furrow at planting (IF), untreated (NA).
[y] RAUEPC (max = 100), relative area under the plant emergence progress curve calculated from the day of planting to full emergence at 29 days after planting.
[x] RAUCPC (max = 100), relative area under the canopy development curve calculated from day of planting to key reference point, 50 days after planting (about 100% canopy closure).
[w] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).
[v] Percentage of stems with greater than 5% girdling caused by *R. solani*, average of 5 plants taken 70 days after planting.
[u] Percent incidence of tubers with sclerotia of *R. solani* from sample of 50 tubers per replicate.
[t] Severity of black scurf (index calculated by counting tuber number (n = 50) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15%; 4 >16%surface area. Indices of 0 - 25 cover the range 0 - 5%; 26 - 50 cover the range 6 - 10%; 51 - 75 cover the range 11 - 15% and 75 - 100 >15% surface area of tuber with sclerotia.
[s] Marketable yield, tubers greater than 2.5" in any plane (US1 grade).
[r] Total yield, combined total of US1 grade and tubers less than 2.5" in any plane.

Funding: MPIC

POTATO (*Solanum tuberosum* L.>Pike=)
Fusarium dry rot*; Fusarium sambucinum*

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Control of seed-borne Fusarium dry rot with seed treatments and in-furrow applied fungicides in potatoes, 2003.

Potato seed cv. Pike was prepared for planting by cutting and inoculating with *Fusarium sambucinum* (dry rot) and treating with fungicidal seed treatments 2 days prior to planting. Two controls, either inoculated with *F. sambucinum* or non-inoculated were included in the trial. Potatoes free from dry rot were selected for the trials and disinfested by immersion in a 3% Clorox (sodium hypochlorite) solution for 30 min. The seed potatoes were cut into two pieces and inoculated with an aggressive isolate of *F. sambucinum* which was grown on potato-dextrose agar for 14 days. Conidia were harvested from the plates and concentration, determined by hemacytometer was adjusted to 3.4 x 10^3 conidia/fl.oz.. The seed pieces (160/treatment) were sprayed with 4 fl.oz. of the pathogen suspension, for a final dosage of about 0.03 fl.oz. applied per tuber. 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. Fungicides applied as pre-planting potato seed liquid treatments were applied in water suspension at a rate of 0.02pt/cwt onto the exposed seed tuber surfaces, with the entire seed surface being coated in the seed treater. In furrow applications were made over the seed at planting, applied with a single nozzle R&D spray boom delivering 5 gal/A (50 p.s.i.) and using one XR11003VS nozzle per row. Seed was planted at the Michigan State University Montcalm Potato Research Farm, Edmore, MI on 15 May 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 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 (eight applications), starting after 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 Dual 8E at 2 pt/A 10 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 fl. oz/A 48 DAP. Seed-piece samples from each treatment (n = 25) were incubated at 50^{o}F (95% RH) in controlled environment chambers for 14 days and the total number of healthy and dry rot affected sprouts was calculated in addition to the development of dry rot on the seed piece measured as percent decay. 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 relative area under the plant emergence curve (RAUEPC; max=100) from the day of planting until 22 days after planting. The rate of canopy development was measured as the, relative area under the canopy development curve (RAUCDC; max = 100) calculated from day of planting to a key reference point taken as 58 DAP (about 100% canopy closure), (max = 100). Vines were killed with Reglone 2EC (1 pt/A on 5 Sep). Plots (40-ft row) were harvested on 9 Oct and individual treatments were weighed and graded. Maximum and minimum air temperature (^{o}F) were 91.7 and 60.9 (Jun), 89.8 and 69.4 (Jul), 93.8 and 64.8 (Aug) and 85.5 and 61.7 (Sep). Maximum and minimum soil temperature (^{o}F) were 82.3 and 70.1 (Jun), 79.9 and 73.3 (Jul), 82.7 and 75.4 (Aug) and 77.4 and 68.4 (Sep). Precipitation was 0.8" (Jun), 0.37" (Jul), 0.56" (Aug) and 0.98" (Sep).

There was no significant difference among treatments and inoculated/non-treated control (positive control) or the non-inoculated/non-treated (negative control) in total number of developing sprouts per tuber. All treatments had significantly fewer diseased sprouts per tuber than the positive control except treatments 6 and 8 which received no seed treatment. All other treatments were not significantly different from the negative control. All treatments had significantly less seed piece decay than the positive control except treatment 6 and 8 which received no seed treatment. All other treatments were not significantly different from the negative control. Treatments with 79% or greater plant stand were not significantly different from the negative control and those with less than 79% were not significantly different from the negative control. There was no significant difference among treatments in terms of final percent plant stand. Treatments with RAUEPC values 4.65 or greater plant stand were not significantly different. Treatment 6 had the lowest RAUEPC value (4.38) and emerged at a significantly lower rate than treatment 7. All treatments had a significantly greater rate of canopy closure (RAUCC) than the positive control except treatment 6. No treatments had a significantly different rate of canopy closure (RAUCC) than the negative control except treatment 6 and the positive control. There were no differences in marketable yield among any treatments. The negative control had a significantly greater total yield than the positive control but there were no differences in total yield among any other treatments.

Treatment rate/cwt (seed treatment) rate/1000 ft. row (in furrow)		Total number of developing sprouts[a]		Diseased sprouts (%)[b]		Seed piece decay (%)[c]		Final plant stand (%)		Rate of emergence RAUEPC[d]		Rate of canopy closure RAUCDC[e]		Yield (cwt/A) US1[f]		Yield (cwt/A) Total	
1 Maxim MZ 0.5 lb	ST[g]	4.16	a[h]	7.3	a	0.6	c	79	abc	5.78	ab	34.1	a	350	a	378	ab
2 None (inoculated, positive)	NA	4.64	a	57.4	c	18.3	a	64	bc	4.65	abc	13.4	b	295	a	317	b
3 None (non-inoculated, negative)	NA	3.52	a	0.0	a	0.7	c	96	a	6.84	ab	34.1	a	384	a	411	a
4 Moncoat MZ 0.5 lb	ST	4.04	a	9.3	a	1.8	c	95	a	6.79	ab	35.4	a	349	a	372	ab
5 Headsup 3WDG 0.1 lb	ST	3.32	a	4.8	a	0.6	c	71	abc	4.38	bc	14.3	b	338	a	365	ab
6 Moncut 70DF 1.18 oz/1000 ft	IF	4.36	a	44.9	bc	16.7	ab	91	ab	6.58	ab	35.8	a	329	a	355	ab
7 Maxim 4 FS 0.08 fl.oz	ST	3.64	a	2.1	a	0.7	c	94	a	7.25	a	33.0	a	345	a	369	ab
8 Scholar 3.4 oz/1000 ft	IF	4.36	a	41.1	bc	14.3	ab	93	a	6.06	ab	33.9	a	363	a	389	ab

[a] Total number of developing sprouts per seed piece (n = 20) after 14 days incubation at 50°F.

[b] Percentage dry rot affected sprouts per seed piece (n = 20) after 14 days incubation at 50°F.

[c] Percentage development of dry rot on the seed piece (n = 20) after 14 days incubation at 50°F.

[d] RAUEPC, relative area under the plant emergence progress curve calculated from the day of planting to full emergence at 29 days after planting (max = 100).

[e] RAUCPC, relative area under the canopy development curve calculated from day of planting to key reference point taken as 50 days after planting (about 100% canopy closure)

[f] Marketable yield, tubers greater than 2.5" in any plane (US1 grade).

[g] Application type, ST = seed treatment; 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. Fungicides applied as pre-planting potato seed liquid treatments were applied in water suspension at a rate of 0.02pt/cwt onto the exposed seed tuber surfaces. IF = In-furrow applications, made over the seed at planting, applied with a single nozzle R&D spray boom delivering 5 gal/A (50 p.s.i.) and using one XR11003VS nozzle per row.

[h] Means followed by same letter are not significantly different at P = 0.05 (Tukey multiple comparison method).

Funding: MPIC/Industry

POTATO (*Solanum tuberosum* L.'FL1879')

Pink rot; *Phytophthora erythroseptica*
Pythium leak; *Pythium ultimum*
Late blight; *Phytophthora infestans*

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Evaluation of fungicides applied at planting and to foliage for potato pink rot and Pythium leak control, 2003.

Soil was inoculated with mefenoxam-sensitive *Pythium ultimum* and *Phytophthora erythroseptica* at the Michigan State University Botany Farm, East Lansing, MI on 11 May 2000 and again on 17 May 2001; no further inoculum was applied in 2002 but was applied on 10 May 2003. Potatoes (cut seed) were planted at the Michigan State University Botany Farm, East Lansing, MI on 17 May into four-row by 50-ft plots (34-in. row spacing) replicated three times in a randomized complete block design. The four-row beds were separated by a five-foot unplanted row. Plots were irrigated at planting and soil moisture was monitored with a Campbell soil moisture probe linked to a CR10X data logger. Water was applied when soil moisture dropped below 20% water content with seep-hose to maintain soil moisture at a minimum of 80% field capacity. After desiccation, plots were continuously watered to encourage tuber disease development caused by the inoculated pathogens. Plots were hilled immediately before foliar sprays began. Fungicides were applied in-furrow at planting at a rate of 5 gal/A (40 p.s.i.) applied at a rate using the conversion factor: Band rate per acre = [Band width (inches)/Row spacing (inches)] * Broadcast Rate per Acre. Thereafter fungicide treatments were applied as scheduled and late blight prevention maintenance treatments of Previcur 6SC 1.2 pt/A were applied weekly from 5 Jun to 15 Aug (10 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 28May) and Poast (1.5 pt/A on 17 Jul). Insects were controlled with Admire 2F (20 fl oz/A at planting on 17 May) and Sevin 80S (1.25 lb on 1 and 17 Jul). Plots were rated visually for percent emergence and percent canopy closure from planting to full emergence and full canopy closure respectively and a relative rate of development was calculated for both emergence and canopy formation. Prior to application of fungicides on 19 Jun, five plants were harvested from each replicate and the number of tubers greater than 0.25" (any plane) per plant was counted. Harvests were repeated on 16 Jul (Harvest 2); 14 Aug (Harvest 3) and11 Sep (Harvest 4) and tuber number and percent of tubers with symptoms of pink rot and/or Pythium leak were assessed. Symptomatic tubers were tested with Phytophthora and Pythium specific ELISA assays. Tuber number per plant and percentage of tubers per four-plant sample were compared using two-way ANOVA for comparison of treatments at individual harvest dates and two-way repeated measures ANOVA were used to compare if the metrics changed between harvests. Vines were killed with Reglone 2EC (1 pt/A on 5 Sep). Plots (50-ft row) were harvested on 5 Oct and individual treatments were weighed and graded (tubers less than 2.5 in width in any plane were discarded and only total marketable yield was reported). A further sub sample of 10 tubers per plot were challenge inoculated with each of *Pythium ultimum*, *Phytophthora erythroseptica*, *Phytophthora infestans*(all mefenoxam-sensitive isolates) or a sterile rye agar core by placing an 1/8" diameter core, taken from an axenic culture of each pathogen grown on rye agar, on the surface of the tuber at its apical end. The core was covered with a 1/4" diameter Eppindorf tube, the lid of which was cut off and dipped in petroleum jelly to adhere the tube to the tuber surface, to ensure a humid microenvironment. Tubers were cut open 28 days after inoculation and the percentage of tubers with symptoms of the diseases were calculated.

Taking 35 days after planting (DAP) as a key reference point, no fungicide applied in-furrow delayed emergence in comparison with treatments that were not applied in-furrow in terms of the RAUEPC. Canopy formation (RAUCDC) was not affected by any in-furrow application of any fungicide. The in-furrow applications of fungicides were not phytotoxic. At harvest 1, prior to applications of foliar fungicides, there were about 13.2 $\pm$ 1.05 (n = 270 plants) tubers per plant (greater than 0.25" any plane) and no significant differences between any treatments. The total number of tubers decreased in all treatments to 13.6 $\pm$ 1.76, 6.6 $\pm$ 1.92 and 5.9 $\pm$ 1.47 after harvests 1, 2 and 3, respectively (n = 270 plants, average of all treatments) , but there were no significant differences between treatments at harvests 1 to 3. At the final harvest (h4), only treatments 4, 5, 12 and 13 had significantly more tubers (>5.2 tubers/plant) than the untreated control (3.6 tubers/plant); all other treatments were not significantly different from the untreated control. Tuber number decline was compared within treatments. There was a significant decline in tuber number in all treatments from harvest 1 to 4. There was no significant difference between harvest 1 and 2 for any treatment in terms of tuber number per plant, except treatment 9 in which there was a significant increase in tuber number between h1 and h2. Between harvests 2 and 3 there was a significant decline in tuber number in all treatments. Between harvests 3 and 4, there was a significant decline in tuber number in treatments 14 and 15. The percentage incidence of tubers with symptoms of pink rot or Pythium leak increased to harvest 3 then decreased at harvest 4 in all treatments. At harvests 1 and 4, there was no significant difference in the incidence of diseased tubers among treatments. The untreated control had significantly more diseased tubers than all other treatments except treatments 6, 8 and 12 at harvest 2. The untreated control had significantly more diseased tubers than all other treatments except treatments 6, 7, 8, 12 and 14 at harvest 3. Percent incidence of diseased tubers was compared within treatments. A significant increase in percentage diseased tubers at harvest three occurred in treatments 6 and 8. The high incidence of diseased tubers at harvest three and subsequent decline at harvest 4 may have been a result of complete deterioration of infected tubers between the two harvests. Although a significant increase in incidence of diseased tubers was reported at harvest 3 within treatments, the overall incidence [average of the h1 - 4 within treatments, Table 2)] was significantly lower than the non-treated control for all treatments but there was no significant difference among treatments. Treatments 4, 5, 11, 12 and 13 had significantly greater marketable (>262.4 cwt/A) and total yield (>320.0 cwt/A) than the untreated control and treatment 2 [167.2 and 215 cwt/A, respectively (Table 3)]. Some disease developed in tubers challenge inoculated with each of *Pythium ultimum*, *Phytophthora erythroseptica*, *Phytophthora infestans* but no treatments had significantly different percentage incidence of diseased tubers in comparison with the nontreated control for any of the pathogens (Table 4).

Some Zoxamide-based products generally reduced the amount of tuber disease and tuber loss regardless of application timing or formulation type, however there was an apparent loss of disease control at the highest rate of application of Zoxium (treatment 6). Other products and programs e.g. treatment 9, reduced the amount of tuber loss and incidence of tuber disease. Tuber loss and incidence of tuber disease even in the best treatments in this trial, under highly conducive conditions for development of Pythium leak and pink rot, was still high with up to 60% tuber loss resulting in low yields. The use of mefenoxam or any product for control of Pythium leak and pink rot under highly conducive conditions remains an issue and recommendations for application of any products aimed at controlling these diseases remains speculative.

Table 1. Emergence and canopy development.

Treatment rate/acre (foliar applications) rate/acre [in-furrow banded applications (A)[z]]	Emergence and canopy development		
	% final[y]	RAUEPC[x]	RAUCDC[w]
1 Phostrol 4SC 10.0 pt (B,C,D) [z]………………………………………	92.5	0.40	0.34
2 Ultra Flourish 2EC 0.2 pt + Phostrol 4SC 1.44 pt (A)……….	93.3	0.37	0.34
3 Ultra Flourish 2EC 0.2 pt + Phostrol 4SC 1.44 pt (A) Phostrol 4SC 10.0 pt (B,C,D)……………………………………..	96.1	0.38	0.32
4 Zoxium 80WDG 0.21 lb (A)………………………………….	94.7	0.38	0.34
5 Zoxium 80WDG 0.41 lb (A)………………………………….	92.8	0.37	0.34
6 Zoxium 80WDG 0.83 lb (A)………………………………….	93.1	0.37	0.34
7 Gavel 75WDG 0.48 lb (A); 2.0 lb (B,C,F,H)………………...	93.6	0.38	0.33
8 Ridomil Gold 4EC 0.1 pt (A)………………………………………...	90.0	0.36	0.34
9 Ridomil Gold 4EC 0.1 pt + Quadris2.08SC 0.21 pt (A)……..	93.1	0.38	0.33
10 Dithane 75DF 1.75 lb (B,C,D,E,F,G,H)..……………………………	89.4	0.36	0.33
11 Gavel 75WDG 2.0 lb (B,C,F,G,H); Dithane 75DF 1.75 lb (D,E)………………………………….	94.2	0.34	0.33
12 Gavel 75WDG 2.0 lb + Zoxium 80WDG 0.21 lb (B,C,F,G,H); Dithane 75DF 1.75 lb (D,E)………………………………………….	95.6	0.37	0.32
13 Gavel 75WDG 2.0 lb (B,D,F,H); Dithane 75DF 1.75 lb (C,E,G)………………………………	92.2	0.37	0.33
14 Gavel 75WDG 2.0 lb + Zoxium 80WDG 0.21 lb (B,D,F,H); Dithane 75DF 1.75 lb (C,E,G)………………………………	93.3	0.37	0.34
15 Ridomil Gold Bravo 6WP 2.0 lb (B,D,F); Dithane 75DF 1.75 lb (C,E,G,H)……………………………	94.4	0.37	0.34
16 Summerdale I + II RATE 1 (A)………………………………	90.3	0.36	0.33
17 Summerdale I + II RATE 2 (A)………………………………	91.1	0.39	0.33
18 Untreated……………………………………………………...	92.5	0.37	0.33
sem P = 0.05[u]	2.06	0.013	0.007

[z] Application dates: A= 17 May (in-furrow at planting, Band rate per acre = [Band width (inches)/Row spacing (inches)] * Broadcast Rate per Acre) in 5 gal water/A; (foliar applications B - H), B= 5 Jun; C= 12 Jun; D= 19 Jun; E= 3 Jul; F= 17 Jul; G= 4 Aug; H= 15 Aug.

[y] Percent emergence calculated as percent of maximum possible emergence in 2 x 50' rows emergence [35 days after planting (DAP)] in untreated control (max = 1)..

[x] Relative Area Under the Emergence Progress Curve from planting until 95% emergence (35 DAP) in untreated control (max = 1).

[w] Relative Area Under the Canopy Development Curve from planting until 100% canopy cover (53 DAP) in untreated control (max = 1).

[u] Standard error of mean included if no significant difference was calculated in ANOVA.

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Evaluation of Tuber Late Blight Response of Advanced Breeding Lines from MSU Potato Breeding Program and Their Potential to Reduce Seed-Borne Epidemics of Late Blight Michigan State University 2002 – 2003

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Problem statement

Late blight of potato, caused by *Phytophthora infestans*, is a major worldwide threat to the production of high quality potatoes. Late blight is readily transmitted by seed-borne inoculum (Kirk et al. 1999) and consequently, immature stems and leaves may be exposed to late blight from infected seed pieces. Recent work has indicated that the new immigrant clones especially US 8 are more aggressive in tubers and sprouts. The new biotypes of late blight are 10 times more likely to produce infected sprouts than their predecessor, US-1 (Stevenson, 1993). Potato breeding efforts at MSU have resulted in varieties that are largely resistant to foliar late blight (Kirk et al 2001a) but not significantly less susceptible than other varieties in terms of tuber blight resistance (Kirk et al. 2001b). The transmission dynamics of late blight inoculum from seed to sprout and ultimately to the stem are still largely unknown and have been tested with only a limited number of varieties of potato and isolates of *P. infestans*. In this study, advanced breeding lines (MSU and other germplasm sources) will be evaluated for resistance to tuber blight. Subsequently, tubers will be under seed storage conditions and after storage prepared for planting by increasing temperature in the storage. Transmission of late blight from seed to foliage will be evaluated and potential risk measured. Potentially, the release of varieties with resistance to foliar and tuber blight will be of great economic benefit to the industry and to the environment and reduces the risk of threats to food security.

Objectives

1. Evaluate late blight response of tubers of advanced breeding lines from the MSU potato breeding program to a variety of *P. infestans* genotypes using multiple isolates.
2. Evaluate after storage and planting the potential for late blight to be transmitted from seed to foliage in advanced breeding lines from the MSU potato breeding program to a variety of *P. infestans* genotypes using multiple isolates.

Materials and methods

Tubers of for the experiments were obtained from the potato breeding program at MSU and stored at 38°F (3°C) in the dark at 90% relative humidity until used. Tubers for all the experiments were within the size grade range 50 - 150 mm diameter (any plane). Visual examination of a random sample of tubers from each from each entry (n = 2) for disease symptoms indicated that the tubers were free from late blight. The sample was further tested with the ELISA immuno-diagnostic Alert Multi-well kit (Alert Multiwell Kit - *Phytophthora sp.* Neogen Corporation, Lansing, MI, USA). *P. infestans* was not detected in any of the tubers.

Two inoculation/evaluation techniques were used in this study; a) tuber tissue inoculation, followed by storage at 50°F (10°C) and evaluation by an image analysis technique and b) inoculated onto a freshly cut tuber surface, incubated for 5 days at 50°F (10°C) then planted at the Muck Soils Research Farm, Laingsburg, MI and plant emergence evaluated. For both techniques, an isolate of *P. infestans* [*P.i.*-US8 (US8 biotype, PAI 95-7, phenylamide-insensitive, A_2 mating type, MI)] was used. Cultures of *P. infestans* were propagated on rye agar for 14 days in the dark at 15°C. Prior to inoculation, all tubers were washed in distilled H_2O to remove soil. The tubers were then surface sterilized by soaking in 2% sodium hypochlorite (Clorox 5.25%) solution for four hours. Tubers were dried in a controlled environment with continuous airflow at 15°C in dry air (30% relative humidity) for four hours prior to inoculation.

(a) Tuber tissue inoculation A; sporangia were harvested from the petri dishes by rinsing the mycelium/sporangia mat in cold (4°C) sterile, distilled H_2O and scraping the agar surface with a rubber policeman. The mycelium/sporangia suspension was stirred with a magnetic stirrer for 1 hour. The suspension was strained through four layers of cheesecloth and sporangia concentration was adjusted to about 1×10^6 total sporangia ml^{-1} (discharged and non-discharged) and measured with a haemacytometer. The sporangial suspensions were stored for 6 h at 4°C to encourage zoospore release from the sporangia. The washed, surface-sterilized tubers were inoculated by a sub-peridermal injection of a sporangia suspension of 2×10^{-5} ml (delivering zoospores released from about 20 sporangia inoculation^{-1}) with a hypodermic syringe and needle at the apical end of the tuber about 1 cm from the dominant sprout to a maximum depth of 1 cm. The non-inoculated control tubers were inoculated with cold (4°C) sterile distilled H_2O.

(b) Tuber tissue inoculation B; as (a) but a smaller number of cultivars were inoculated with different genotypes of *Phytophthora infestans*, US1, US6, US8, US11 and US14. he cultivars/ABL and genotypes were the same as those used in experiment (c).

(c) Transmission of late blight infection at seed cutting was simulated by cutting seed and immediately exposing the seed to late blight inoculum. The seed tuber was cut into two pieces with a sterile knife. The exposed cut surface was placed face down on a 14 day old, homogenized mixture of mycelium and sporangia of *P. infestans* in rye agar for 30 s, removed and incubated for 5 days at 50°F (10°C). The homogenate was prepared from 20 plate cultures (9 cm diameter x 15 mm depth petri plates). Each plate produced between 10^5 - 10^6 spores ml^{-1} from 50 ml of wash water. An estimate of the amount of mycelium from each plate was not attempted. Tubers were planted at the MSU Muck Soils research Farm on 5 Jun 2003 and irrigated with adequate moisture to allow emergence. Plant stand, rate of emergence and foliar late blight especially on stems, and immature foliage were evaluated.

For each experiment, tubers were incubated in a temperature-controlled environment chamber, 1.8 m^3 volume (Environmental Growth Chambers, Chagrin Falls Ohio, USA) at 50°F (10°C). Relative humidity was maintained at 90% within the chamber. Tubers were stored in the dark in net bags within ventilated plastic boxes (15 tubers/box). Disease development rates within tubers in relation to storage temperature were known from previous experiments and a single sampling date was selected about 30 days after inoculation (DAI). Sample size was n = 15 plus two control tubers per variety [experiment (a)], n = 10 per variety [experiment (b) which after tubers were cut into three slices yielded 45 and 30 estimates of tuber tissue infection, respectively. The tubers for the late blight transmission experiment were stored for five days prior to planting.

The tuber tissue inoculation experiment was conducted in December 2002 and again in January 2003. Tubers were dormant during the period between October and December. A digital image analysis technique was used to assess tuber tissue infection. Briefly, the scanned surface was the cut face of a sample tuber. A sharp knife was used to ensure a smooth cut face. Fresh-cut tuber sections were placed cut surface down on a glass plate, 40 x 30 cm and 2 mm thick. The glass plate was used to prevent surface contamination of the scanner glass and permitted multiple samples to be prepared and moved to the scanner for image production. The plate was transferred to a flatbed scanner (HP ScanJet 4c, Hewlett-Packard Co., Houston, TX) controlled by an IBM-compatible PC. A 486DX2-80 CPU and a RAM capacity of 32 MB, adequate for the image processing. Scanner control software (DeskScan II ver. 2.4, Hewlett-Packard, Co., Houston, TX), generated an image of the cut tuber surfaces against a black background. The image was formed from light reflected from the cut tuber surfaces.

The brightness value of the image controlled the light intensity of every pixel in the image. The contrast value controlled the differences between light and dark regions of the image. While the scanner control software was able to automatically adjust the brightness and contrast of the image by comparing the relative size of the pale tuber surfaces against the black background, the settings were manually set to 180 units (brightness) and 200 units (contrast) to ensure consistent readings. A photograph-quality image was taken and stored for analysis (e.g. Fig. 1). A typical image in Tagged Image Format (*.tif) occupies 1 megabyte. Typical ARI values for a range of infected and uninfected cut tuber surfaces were shown on Figure 1.

The image files created with the scanner software were loaded into the image analysis software (SigmaScan ver. 3.0, Jandel Scientific, San Rafael, CA). The black background has 0 light intensity units (LIU), while pure white has 255 LIU. Disease-free and blemish-free tuber tissue is pale. Diseased or blemished tuber tissue is darkened. The image of the cut tuber surface was selected for analysis, and isolated from the adjacent regions of the image. The image was carefully cropped for irregularly shaped tubers to remove the image of the adjacent tuber skin, and the image of the cut surface was unedited. The area was selected with the Afill@ tool, which encompassed all pixels within a given area brighter than the cut-off threshold. The area selection cut-off threshold was set to 10 LIU, effectively allowing the software to exclude all parts of the image darker than 10 LIU, e.g. the black background. The average reflective intensity (ARI) of all the pixels within the image gave a measurement of infection severity of the tuber tissue of each sample.

The ARI was measured in sections from the apical, middle and basal regions of the tuber, approximately 25% (apical), 50% (middle) and 75% (basal) of the length of the tuber (respectively) as measured from the apical end. The amount of late blight infected tissue per tuber was expressed as a single value (Mean ARI) calculated as the average ARI of the apical, middle and basal sections evaluated 30 DAI. The total number of images scanned per Mean ARI for tuber tissue inoculation experiments were = 45 (single isolate with multiple cvs plus 6 non-inoculated control images) and 30 for the multiple cultivar x multiple *P. infestans* genotype experiment.

Data Analysis. The presence of *P. infestans* in sample tubers was confirmed by ELISA (described above) and by isolating pure cultures of *P. infestans* from the infected tuber tissue and successful re-inoculation of potato tubers and leaves. Treatment effects were determined by ANOVA, and grouped as most susceptible within the parameters of the varieties sampled [NSD from Russet Norkotah (susceptible control) mean ARI], most resistant within the parameters of the varieties sampled (NSD from variety with highest mean ARI) and partially susceptible within the parameters of the varieties sampled (significantly different from variety with highest ARI and mean ARI of Russet Norkotah). For experiment (a) the mean ARI of individual tubers was compared to that of non-inoculated controls of the same variety/ABL. For experiment (b), comparisons were made among different genotypes within individual cvs./ABL. For experiment (c), the number of emerged plants was measured over a 25 day period after planting and the final plant stand and relative area under the emergence curve was calculated.

Results

The amount of development of *Phytophthora infestans* within tubers was moderate, in comparison with previous experiments, and mean ARI values in the susceptible cultivars/ABL were about 50 – 70 units lower than in previous experiments.

(a) Tuber tissue inoculation: cultivars/ABL with mean ARI 183.5 to 202.3 were not significantly different at P = 0.05 and were classified as resistant; those with mean ARI 159.2 to 180.9 were not significantly different from each other but were significantly different form the most resistant cultivar/ABL and from the most susceptible cultivar (Russet Norkotah) and were classified as moderately susceptible; those with Mean ARI 139.3 – 157.7 were not significantly different from the susceptible control and were classified as susceptible. When normalized against the non-inoculated controls, the rank order of the cultivars/ABL was similar but some cvs/ABL had proportionately lower levels of tissue discoloration when evaluated this way.

(b) Susceptibility of tubers of potato cultivars/ABL to different genotypes of *Phytophthora infestans*. The analyses of variance indicated that overall the US8 genotype was the most virulent and aggressive of those tested when compared across cvs/ABL, followed by the US14 genotype. The US6 genotype was virulent but was the least aggressive causing only moderate symptoms on susceptible cvs/ABL. Atlantic was susceptible to US8 and quite susceptible to US 14 and resistant to all other genotypes of *P. infestans*. Jacqueline-Lee was susceptible to US1, US8 and US14 and moderately susceptible to US6 and US11 genotypes of *P. infestans*. Pike was susceptible to US1, US8, US11 and US14 and moderately susceptible to US6 genotypes of *P. infestans*. Torridon, an internationally recognized foliar resistance standard cultivar, was susceptible to US8 and US14, moderately susceptible to US11 and resistant to US1 and US6 genotypes of *P. infestans*. FL1879 was susceptible to US8, quite susceptible to US14, moderately susceptible to US1 and resistant to US6 and US11genotypes of *P. infestans.* I157-A was susceptible to US1, US8 and US14, quite susceptible to US11 and moderately susceptible to US6 genotypes of *P. infestans*. J317-1 was susceptible to US8 and US14, quite susceptible to US1 and US11 and moderately susceptible to US6 genotypes of *P. infestans*. J319-7 was susceptible to US8 and US14, moderately susceptible to US6 and resistant to US1 and genotypes of *P. infestans*. J319-A was susceptible to US8 and US14, quite susceptible to US11 and moderately susceptible to US1 and US6 and genotypes of *P. infestans*. J319-A was susceptible to US8 and US14, quite susceptible to US11 and moderately susceptible to US1 and US6 genotypes of *P. infestans*. J453-4Y was quite susceptible to US8 and US14, moderately susceptible to US1 and resistant to US6 and US11genotypes of *P. infestans*. J456-Y was moderately susceptible to US1, US8, US11 and US14 and resistant to US6 genotypes of *P. infestans*. J461-1 was susceptible to US1 and US14, quite susceptible to US8, moderately susceptible to US11 and resistant to US6 genotypes of *P. infestans*.

(c) Survival after planting of potato cultivars and Advanced Breeding Lines inoculated with different genotypes of *Phytophthora infestans*. The results of this trial largely supported the results of the previous trial. The analyses of variance indicated that overall the US8 genotype was the most virulent and aggressive of those tested reflected by poor emergence across most cvs/ABL when compared across cvs/ABL, followed by the US14 genotype. The US6 genotype was rarely virulent and was the least aggressive causing only moderate reductions in emergence across cvs/ABL. In Atlantic, the RAUEPC was significantly lower after tubers had been inoculated with US8 and US 14 compared to the non-inoculated control but no other genotypes of *P. infestans* significantly affected emergence. The RAUEPC was significantly reduced in Jacqueline-Lee after inoculation with all genotypes of *P. infestans* except US6. In Pike the RAUEPC was significantly reduced by US1, US8, US11 and US14 but not US6 genotypes of *P. infestans*. Torridon was susceptible only to US8 and US14 and moderately susceptible to US11 genotypes of *P. infestans*. FL1879 was susceptible to US1, US8 and US14 and resistant to US6 and US11genotypes of *P. infestans.* I157-A was susceptible to US1, US8, US11 and US14 genotypes of *P. infestans*. J317-1was susceptible only to the US14 genotype of *P. infestans*. J319-7, J319-A and J453-4Y were susceptible to US8 and US14 genotypes of *P. infestans*. J456-Y was susceptible to the US8 genotype of *P. infestans*. J461-1 was susceptible to the US1, US8 and US14 genotypes of *P. infestans*.

There is a wide range in tuber susceptibility to US8 which is clearly a virulent and aggressive genotype of P. infestans. As U8 is the predominant genotype of *P. infestans* in North America it would be prudent to continue to screen and develop novel sources and of resistance including germplasm from other sources. However, as US8 suddenly appeared and quickly impacted potato production significantly during the 1990s, it would also be prudent to screen promising cultivars/ABL for their reaction to others of genotypes of *P. infestans* that have appeared in the northern production areas of the US and Canada. The field trials indicated that even when the tuber reaction was clear that inoculated plants can still emerge although at a reduced rate of emergence.

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Table 1. Susceptibility of tubers of potato cultivars/ABL to the US8 genotype of *Phytophthora infestans*. Experiment (a), MSU 2002/03.

	Mean ARI of inoculated tuber slices[b]										
Cultivar/ABL[a]	Inoculated tubers				Non-inoculated control			Percent ARI_{inoc}/ARI_{uninoc}[c]			
Russet Norkotah	139.3	2.56[d]	p[e]	S[f]	217.1	2.37	a	64.2	1.18	s	S
Snowden	140.3	3.65	op	S	209.3	2.47	a	67.1	1.74	rs	S
J462-AB	148.1	3.98	n-p	S	215.6	3.78	a	68.7	1.85	q-s	S
J453-4YA	151.5	4.06	m-p	S	204.0	4.94	a	74.3	1.99	l-r	M
J343-1	151.6	4.08	m-p	S	220.2	2.82	a	68.8	1.85	q-s	S
J317-1	152.1	3.13	l-p	S	211.6	3.64	a	71.9	1.48	o-s	S
J319-1	153.0	4.56	k-p	S	212.9	6.66	a	71.9	2.14	o-s	S
J438-2	153.7	4.44	k-p	S	203.4	2.21	a	75.6	2.18	k-r	M
J334-2Y	154.1	3.83	k-p	S	210.1	2.66	a	73.4	1.82	m-r	M
J319-7	154.7	4.18	k-p	S	217.3	5.38	a	71.2	1.92	p-s	S
K101-2	155.2	3.12	k-p	S	215.0	3.70	a	72.2	1.45	o-s	S
Atlantic	157.0	5.82	k-p	S	214.9	4.98	a	73.1	2.71	m-s	S
J453-4Y	157.1	3.69	k-p	S	215.6	3.78	a	72.9	1.71	n-s	S
J456-2Y	157.3	3.98	k-p	S	221.3	4.31	a	71.1	1.80	p-s	S
J462-A	157.5	2.79	k-p	S	209.3	3.57	a	75.2	1.33	l-r	M
K136-2A	159.2	3.02	k-o	M	211.9	4.13	a	75.1	1.43	l-r	M
AWN86514-2	159.7	5.34	k-o	M	203.1	8.72	a	78.7	2.63	h-p	M
J461-1	160.0	3.84	j-n	M	217.2	4.64	a	73.7	1.77	m-r	M
I157-A	162.7	2.36	i-n	M	212.9	3.06	a	76.4	1.11	j-q	M
WTS 1210-4	163.3	3.20	i-n	M	207.4	9.59	a	78.7	1.54	h-p	M
K136-2	164.0	3.01	i-n	M	209.8	3.34	a	78.2	1.43	i-p	M
J307-2	164.8	2.21	h-n	M	211.1	9.50	a	78.1	1.05	i-p	M
K 458-2	165.3	3.27	h-n	M	210.0	1.76	a	78.7	1.55	h-p	M
CIPLBR 50	165.4	2.49	h-n	M	211.6	4.70	a	78.2	1.18	i-p	M
Torridon	166.3	4.69	g-n	M	202.6	4.68	a	82.1	2.31	e-m	M
H026-3-rus	167.0	2.56	g-n	M	212.1	1.52	a	78.7	1.21	h-p	M
Jacquline Lee	167.7	3.03	g-m	M	209.7	2.71	a	80.0	1.44	g-p	M
CIPLBR 46	169.1	2.12	f-m	M	216.8	7.00	a	78.0	0.98	i-p	M
J457-2	169.3	3.59	f-m	M	210.2	4.79	a	80.6	1.71	g-o	M
J464-5	169.5	3.03	f-m	M	210.9	3.18	a	80.4	1.43	g-o	M
J456-4Y	170.1	2.82	f-m	M	208.2	2.27	a	81.7	1.35	f-n	M
KO34-1	171.1	2.42	e-l	M	214.4	3.95	a	79.8	1.13	g-p	M
CIPLBR 24	172.0	4.40	d-k	M	216.0	5.24	a	79.6	2.04	g-p	M
K128-1	179.2	3.90	c-j	M	215.0	4.72	a	83.4	1.81	d-l	M
BO718-3	180.9	3.60	b-i	M	214.3	3.77	a	84.4	1.68	c-k	M
CIPLBR 01	183.5	4.15	a-h	R	214.0	9.36	a	85.8	1.94	b-i	M
CIPLBR 33	184.2	4.08	a-h	R	217.9	3.73	a	84.5	1.87	c-k	M
CIPLBR 39	185.6	3.46	a-g	R	210.3	4.79	a	88.3	1.64	a-g	R
CIPLBR 07	188.3	4.04	a-f	R	221.8	2.15	a	84.9	1.82	b-j	M
A90586-11	190.0	2.97	a-e	R	210.8	4.08	a	90.1	1.41	a-f	R
CIPLBR 12	190.3	1.68	a-e	R	221.4	6.22	a	86.0	0.76	b-i	M
CIPLBR 08	190.9	1.84	a-d	R	207.9	10.39	a	91.8	0.88	a-d	R
CIPLBR 19	191.8	3.87	a-c	R	209.8	4.09	a	91.4	1.84	a-d	R
BO767-2	192.5	3.90	a-c	R	207.5	8.39	a	92.8	1.88	a-c	R
CIPLBR 02	194.6	2.15	a-c	R	220.7	3.97	a	88.2	0.98	a-g	R
CIPLBR 18	195.0	3.01	a-c	R	214.2	6.00	a	91.0	1.41	a-e	R
CIPLBR 05	195.9	3.88	a-c	R	213.4	3.67	a	91.8	1.82	a-d	R
CIPLBR 20	195.9	3.03	a-c	R	217.5	0.82	a	90.1	1.39	a-f	R
WTS 1217-7	196.3	2.10	a-c	R	224.1	2.43	a	87.6	0.94	a-h	R

Table 1. Cont.											
	Mean ARI of inoculated tuber slices[b]										
Cultivar/ABL[a]	Inoculated tubers				Non-inoculated control			Percent ARI_{inoc}/ARI_{uninoc}[c]			
CIPLBR 38	196.9	1.77	a-c	R	209.8	6.04	a	93.9	0.85	ab	R
CIPLBR 4	196.9	3.04	a-c	R	212.9	10.18	a	92.5	1.43	a-d	R
WTS 1217-3	198.7	1.81	ab	R	216.8	3.65	a	91.6	0.83	a-d	R
WTS 1212-6	201.8	1.76	a	R	211.0	2.04	a	95.7	0.83	a	R
LBR 9	201.9	1.40	a	R	223.3	6.38	a	90.5	0.63	a-f	R
LBR 8	202.3	1.72	a	R	211.7	3.86	a	95.6	0.81	a	R

[a] Advanced breeding line.
[b] Mean average reflective intensity of n = 15 tubers cut three times at apical, middle and basal region of inoculated potato tubers in light intensity units where LIU 0 = black and 255 = white.
[c] Normalized susceptibility score expressed as Mean ARI per inoculated sample/mean ARI of non-inoculated samples within a cultivar/ABL.
[d] Sample error of least square mean.
[e] Mean ARI within cultivar/ABL followed by the same letter are not significantly different at P = 0.05 (Tukey multiple comparison test).
[f] ARI values were clustered into three groups R = Resistant, ARI not significantly different (NSD) from most resistant line tested ; M = Moderately susceptible, mean ARI significantly different from most resistant line tested and most susceptible line tested (Russet Norkotah); S = Susceptible, mean ARI not significantly different (NSD) from most susceptible line tested (Russet Norkotah).

Table 2. Susceptibility of tubers of potato cultivars/ABL to different genotypes of *Phytophthora infestans*.

	Mean ARI of inoculated tuber slices[b]																	
Cultivar/ABL[a]	Non-inoculated			US1[c]			US6			US8			US11			US14		
Atlantic	212	a[d]	R[e]	213	a	R	214	a	R	122	c	S	214	a	R	185	b	Q
J-Lee	214	a	R	125	c	S	187	b	M	127	c	S	187	b	M	125	c	S
Pike	213	a	R	123	c	S	187	b	M	122	c	S	125	c	S	123	c	S
Torridon	212	a	R	212	a	R	213	a	R	123	c	S	184	b	M	125	c	S
FL1879	212	a	R	184	b	M	212	a	R	125	d	S	214	a	R	152	c	Q
I157-A	212	a	R	122	d	S	186	b	M	125	d	S	152	c	Q	124	d	S
J317-1	212	a	R	150	c	Q	185	b	M	124	d	S	151	c	Q	124	d	S
J319-7	213	a	R	213	a	R	188	b	M	123	c	S	215	a	R	125	c	S
J319-A	213	a	R	185	b	M	186	b	M	124	d	S	152	c	Q	123	d	S
J453-4Y	214	a	R	188	b	M	214	a	R	150	c	Q	212	a	R	151	c	Q
J456-Y	213	a	R	183	c	M	212	a	R	189	b	M	188	b	M	186	bc	M
J461-1	213	a	R	125	d	S	212	a	R	155	c	Q	184	b	M	123	d	S

[a] Advanced breeding line.
[b] Mean average reflective intensity of n = 20 tubers cut three times at apical, middle and basal region of inoculated potato tubers in light intensity units where LIU 0 = black and 255 = white.
[c] Genotype of Phytophthora infestans as defined by Goodwin et al., (1995).
[d] Mean ARI within cultivar/ABL followed by the same letter are not significantly different at P = 0.05 (Tukey multiple comparison test).
[e] ARI values were clustered into four distinct groups (Resistant); M = 180 - 209.5 (Moderately susceptible); Q = 150 - 179.5 (Quite susceptible); S = 120 - 149.5 (Susceptible).

Table 3. Survival after planting of potato cultivars and Advanced Breeding Lines inoculated with different genotypes of *Phytophthora infestans*.

	Mean RAUEPC[a] Genotype of *Phytophthora infestans*[b]											
Cultivar/ABL[c]	Non-inoculated control		US1		US6		US8		US11		US14	
Atlantic	72.1	a[d]	68.3	a	76.7	a	3.3	c	64.2	a	25.4	b
J-Lee	52.9	a	7.5	b	49.6	a	1.3	b	20.4	b	2.5	b
Pike	47.5	a	0.0	b	39.6	a	0.0	b	3.3	b	0.0	b
Torridon	63.3	a	68.8	a	70.4	a	1.7	b	40.0	ab	2.1	b
FL1879	69.2	a	37.1	bc	70.4	a	0.0	d	67.1	ab	13.3	cd
I157-A	51.7	a	8.8	c	44.2	ab	0.0	c	18.3	bc	0.0	cd
J317-1	48.8	a	12.5	ab	41.3	a	17.5	ab	22.1	ab	0.0	b
J319-7	66.7	a	60.8	ab	39.2	ab	21.7	ab	67.1	a	3.3	b
J319-A	54.2	a	48.8	a	30.0	ab	0.0	b	19.2	ab	0.0	b
J453-4Y	68.8	a	44.2	ab	64.6	a	2.1	c	62.9	a	19.2	bc
J456-Y	57.1	a	30.4	ab	58.3	a	0.0	b	34.2	ab	30.8	ab
J461-1	59.2	a	7.5	b	50.4	a	0.0	b	42.1	a	9.6	b

[a] RAUEPC, relative area under the percent plant emergence progress curve calculated from 0 - 25 days after planting [full final emergence (max = 100)].
[b] Genotype classification according to Goodwin et al. 1995.
[c] Advanced breeding line.
[d] Values followed by the same letter are not significantly different at P = 0.05 for comparisons of mean RAUEPC among different genotypes of *P. infestans* within each cultivar/ABL (Tukey Multiple Comparison).

Figure 1. Scanned images of blighted tubers with ARI values. Lower values indicate more darkening due to greater susceptibility to *Phytophthora infestans*.

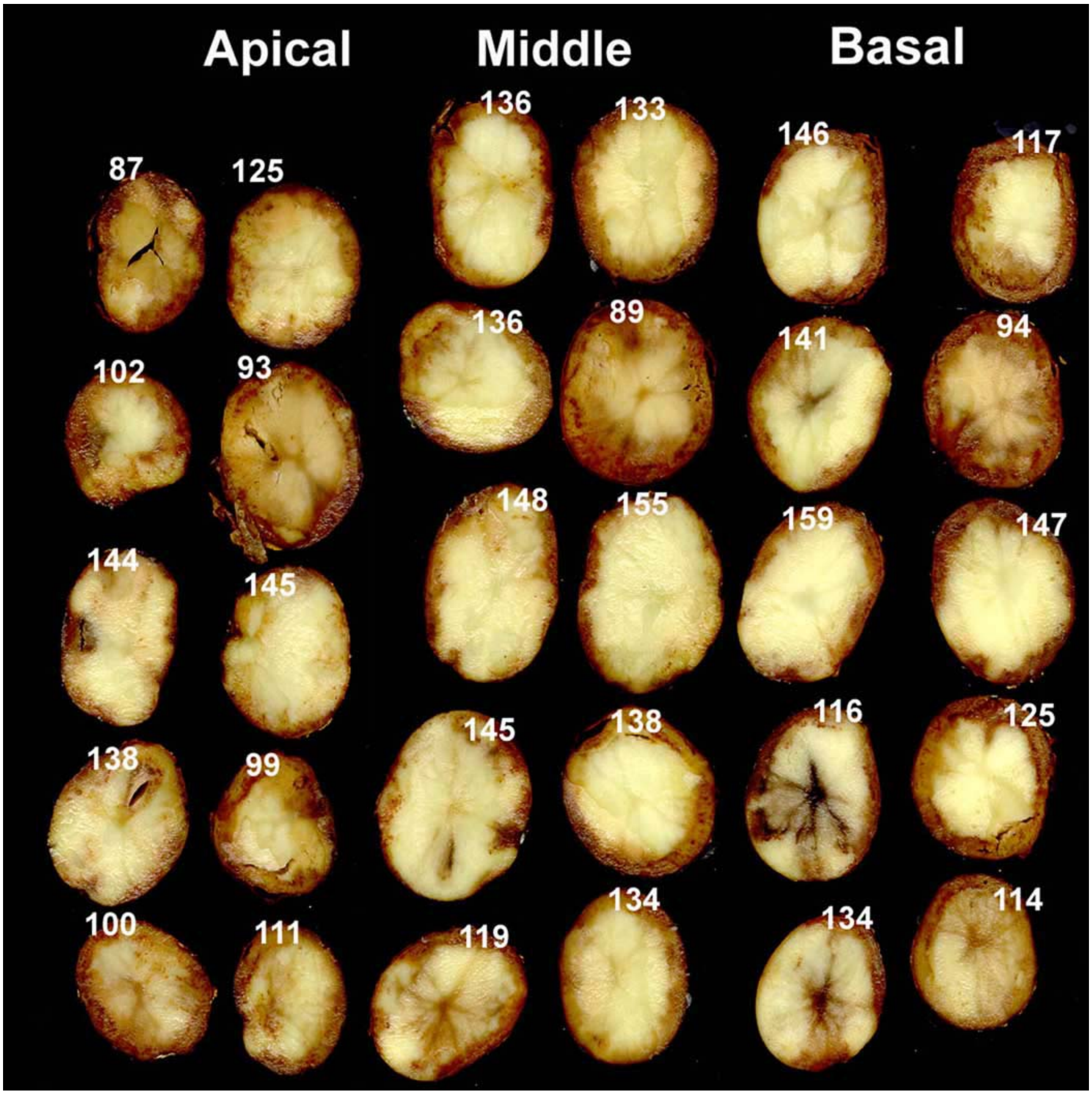
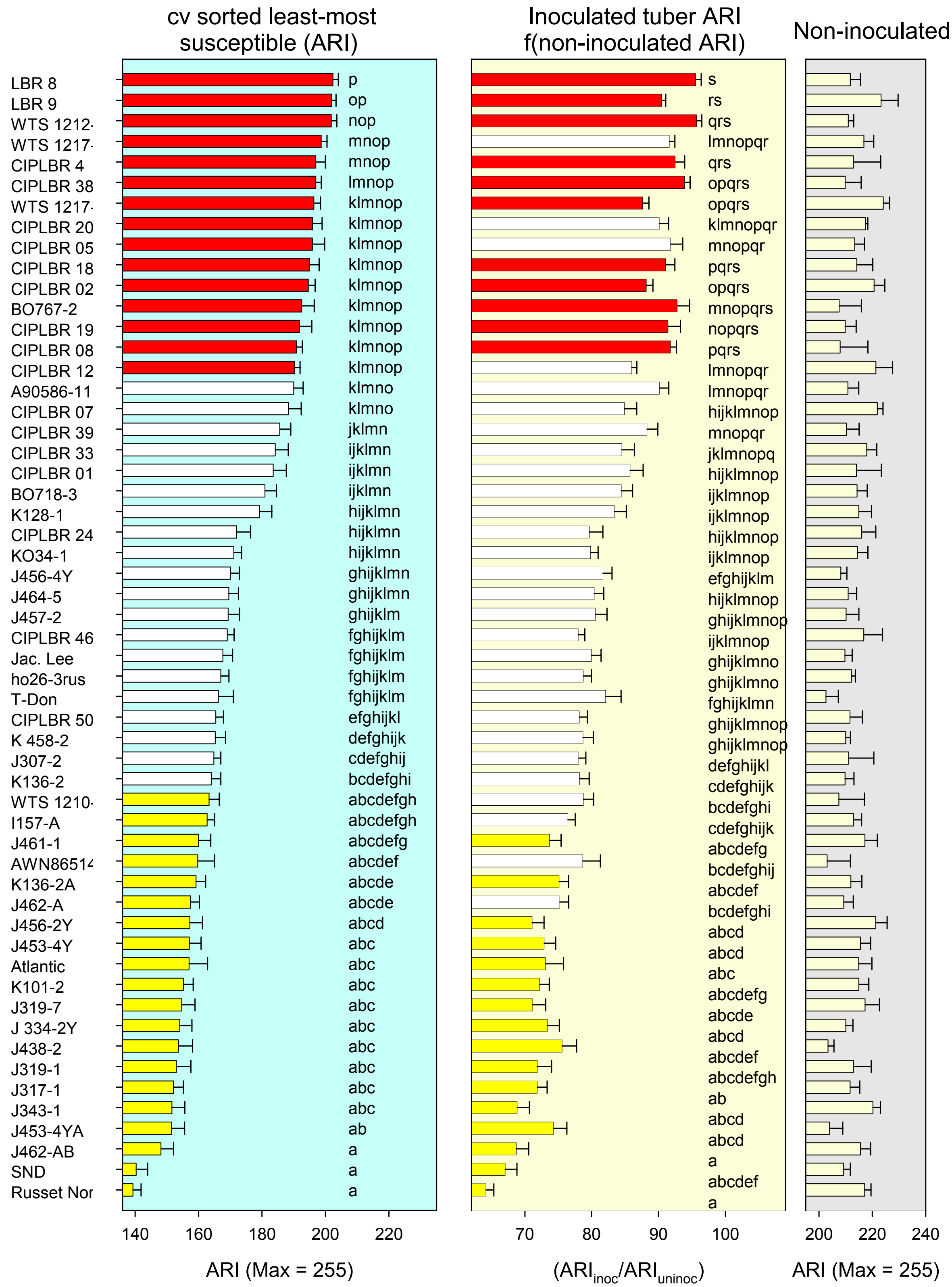


Figure 2. Susceptibility of cultivars/ABL to *Phytophthora infestans* ranked in order of decreasing Mean ARI. The second chart indicates the same data but expressed as function of the non-inoculated sample shown in the third chart.



Integrated Control of Common Scab (*Streptomyces scabies*) in Potato

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Introduction

The incidence and severity of potato common scab in North America is increasing due to the use of susceptible cultivars, increasingly conducive cultural and environmental factors, such as shorter rotations and fluctuating soil moisture. Common scab of potato is caused by several gram-positive filamentous species of *Streptomyces* (i.e. *S. acidiscabies, S. caviscabies*), but *Streptomyces scabies* is the predominant causal agent. *S. scabies* is an aerobic, ubiquitous soil-borne bacterium that causes a range of symptoms on the surface of potato tubers. The three lesion types are collectively known as common scab, and include the superficial corky lesions usually termed russet scab, erumpent or raised scab, and pitted lesions, which extend through the tuber periderm into the cortex and vascular storage parenchyma. This bacterium is the most important plant pathogen in the genus *Streptomyces* world wide, and common scab of potato ranks fourth in severity of potato diseases.

Although it rarely affects yield, it significantly reduces marketability. *S. scabies* is primarily spread by infested soil and infected seed potatoes. Rotation can reduce the amount of *S. scabies* in field, but once introduced into a field it survives indefinitely in soil, and can be dispersed easily by soil water, wind and farm equipment. *S. scabies* infects root crops such as radish, carrot, beets, turnip etc. and survives best in soils at pH 5.5 - 7.5, which is also the optimal pH for growing underground vegetable crops. Longer rotations between susceptible crops decrease the pathogen population and severity of the disease. Potato tubers are most susceptible to infection during early tuber development, since tubers are infected through stomata and immature lenticels yet to form a protective suberized barrier. Mature tubers with well-developed skin are not susceptible to infection (as long as the tubers are not damaged by insects). However, infections established when the tubers are immature, expand as the tubers enlarge and lesions increase in area and severity over the season. Common scab infection is favored by warm, dry soil at the time of tuber initiation.

Although the importance of resistant cultivars is well understood, the environmental influences on cultivar susceptibility to different strains are not well documented. Maintenance of adequate soil moisture is of the most important management strategies in controlling potato scab. Irrigation impacts control of plant pathogens through effects on the physical environment of the soil and the plant surface[1]. Irrigation may favor predation, antagonistic microorganisms or alter the metabolism of *S. scabies.* Although the mechanism is unknown, water applied early in the season to soil was shown to reduce common scab on susceptible cultivars[4]. Maintaining adequate soil moisture near field capacity during tuber initiation and early tuber development may aid in control. The interaction between irrigation practices and cultivar resistance on scab incidence and severity of tubers, and their affects on the population dynamics of the strains of the *Streptomyces* spp. in the soil is not well understood. Additionally, quantification of the pathogen in soils has not been determined in relation to inoculum densities associated with infection.

Although there are no effective chemicals available for controlling common scab, there are elicitors of systemic acquired resistance (SAR) documented with other plant-pathogen systems that have been effective in providing protection against infection by a broad range of pathogens. This phenomenon occurs when a plant is treated with an elicitor (i.e. natural chemical compound, incompatible pathogen, etc) and the plant is subsequently able to send signals to biochemical pathways that are related to plant defense. These signals allow the plant to produce non-specific antimicrobial compounds for additional protection against a broad range of pathogens as well as suppress pathogens by alteration of the chemistry of the plant cell wall and cuticle. SAR has been well documented in cucumbers with protection against a wide range of pathogens as well in the Solanaceous plant family, with protection of tobacco against tobacco mosaic virus[5]. It has not yet been determined if there are any SAR elicitors that may reduce the occurrence and severity of common scab of potato.

I. Objectives

1. Investigate the effect of varying soil moisture levels on scab incidence in relation to wetting and drying cycles during tuber development and severity of tubers in a controlled environment and the field.
2.

II. Objectives

1. Investigate the effect of four biological agents on common scab incidence and severity.
2. Investigate the effect of two different application methods of the biological agents on common scab incidence and severity.
3.

III. Objectives

1. Quantify the amount of pathogenic *S. scabies* in soil populations from agricultural soils.

Method and Materials

Soil Moisture Experiments

In greenhouse experiments, soil boxes compartmentalized into sections (1’x 2’x 3’) were filled with sand. The boxes were subjected to one of four soil moisture regimes varying from very low soil moisture to very high soil moisture, and two intermediate soil moisture treatments that were alternating wet/dry on a weekly basis in a completely randomized design. Soil was sterilized and subsequently inoculated with virulent *S. scabies* strains or treated with sterile water as a control prior to the experiment. Soil moisture probes, CS 615 Water Content Reflectometers (Campbell Scientific® Instruments), were used to measure soil moisture and the data was recorded with CR10X data loggers. The boxes were planted to a scab susceptible cultivar, Atlantic. Tubers were sampled after the skin had been fully developed for assessment of scab incidence and severity.

In the field experiment, potatoes (cut seed, cv. Atlantic) were planted at the Michigan State University Plant Pathology Farm, East Lansing, MI on 25 May into one-row by 120 ft-plots replicated 3 times and covered in black plastic to exclude additional rainfall. All rows were irrigated until emergence and were inoculated (17 fl oz/120-ft row) with a suspension of *Streptomyces* strains at 10^6 CFU/fl oz on 30 May and repeated on 1 July. After emergence, irrigation schedules were empirically optimized to match greenhouse experiment irrigation treatments and volumetric soil moisture was verified with CS 615 Water Content Reflectometers (Campbell Scientific® Instruments). Soil volumetric water content data was collected bi-weekly. Weeds were controlled by weeding, 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. Fungicides were applied weekly from 4 June to 7 September with an ATV rear-mounted R&D spray boom delivering 25 gal/A (80 psi) and using three XR11003VS nozzles per row. Fertilizer was drilled into plots before planting, formulated according to results of soil tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP (days after planting). Plots were harvested on 10 September and individual treatments were evaluated based on scab incidence and severity.

SAR experiments

Potatoes (cut seed; cv. Snowden) were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 4 June into two-row by 25-ft plots (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. All rows were irrigated until emergence and were inoculated (3.4 fl oz/25-ft row) with a suspension of *Streptomyces* strains at 10^6 CFU/fl oz on 12 June. The trial was maintained as described above. Applications of Messenger® (Eden® Bioscience), Elexa®4 (Glycogenesis, Inc.®), Myconate® (VAMTech, L.L.C. ®), and Heads Up® (Company ®) were applied according to specified labeled rate as in furrow and foliar treatment methods: In furrow applications of Messenger (0.42 lbs/A in 25 gal of water) were made over the 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. Foliar applications of Messenger (1.7 lbs/A in 25 gal of water) were made over the rows, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 p.s.i.) and using one XR11003VS nozzle per row weekly from 9 July to 30 July. In furrow applications of Elexa (11.83 pts/A in 25 gal of water) were made over the 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. Foliar applications of Elexa (47.3 pts/A in 25 gal of water) were made over the rows, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 p.s.i.) and using one XR11003VS nozzle per row weekly from 9 July to 30 July. Vines were killed with Reglone 2EC (1 pt/A on 20 September). In furrow applications of Myconate (0.08 lbs/A in 25 gal of water) were made over the 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. Foliar applications of Myconate (0.31 lbs/A in 25 gal of water) were made over the rows, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 p.s.i.) and using one XR11003VS nozzle per row weekly from 9 July to 30 July. In furrow applications of Heads Up (0.15 lbs/A in 25 gal of water) were made over the 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. Foliar applications of Heads Up (.0.60 lbs/A in 25 gal of water) were made over the rows, applied with a single nozzle R&D spray boom delivering 5 gal/A (80 p.s.i.) and using one XR11003VS nozzle per row weekly from 9 July to 30 July. Vines were killed with Reglone 2EC (1 pt/A on 28 August). Plots (25-ft row) were harvested on 15 September and individual treatments were evaluated based on scab incidence and severity.

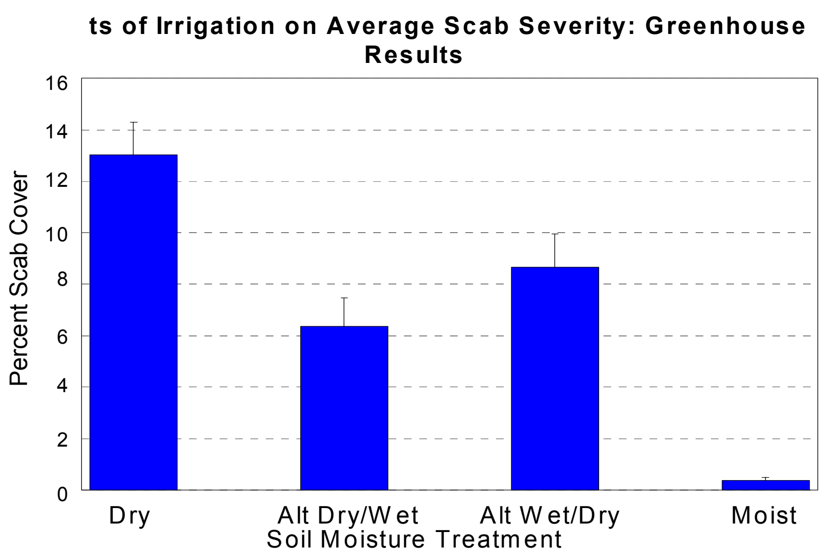
***S. scabies* population densities from agricultural soils.**

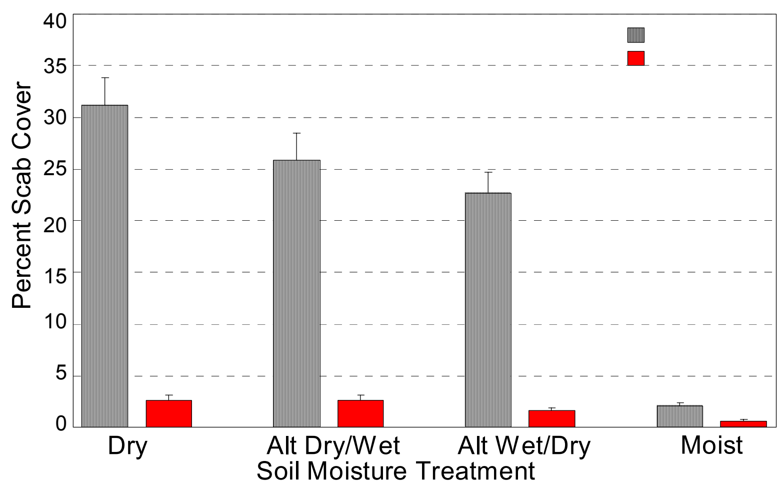
Soil samples (20 samples per field) were collected from the tuber zone depth of soil from three Michigan potato fields: one field was highly infected with scab, the second was scarcely infected with scab, and the third field had very little scab infection. Large stones and plant debris were removed from each sample and DNA was extracted directly from 1 g of soil by the method of McVeigh *et al*. Primers derived from *nec1*, a pathogenicity factor gene in *Streptomyces* spp., were developed using Primer Express® Software (Applied Biosystems®). Primer and template concentrations were empirically optimized with SYBR Green® PCR Master Mix and each sample was replicated 4 times and the trial was executed twice.

Results and Discussion

In the greenhouse experiment, potato cv. Atlantic grown under dry conditions (average VWC of 9%) produced on average, tubers with about 13% surface area covered with scab lesions (figure 1). When the soil moisture was increased 29% VWC, the infection was reduced to less than 2% surface area covered with scab lesions (Figure 1). The two alternating weekly wetting and drying cycles were 14 and 21% VWC, respectively. Although the weekly wetting and drying cycles reduced the average amount of scab severity of the tubers, percent surface area affected by common scab was about 6 and 8% surface area covered with scab lesions for the two alternating cycles, respectively.

1. Effects of weekly wetting and drying soil moisture treatments on average scab





The field trial that complemented the greenhouse experiment had more scab infection in inoculated plots than in the greenhouse. The volumetric water contents were similar to the greenhouse experiments as the four irrigation treatments were within 3 percent of the corresponding treatment. Atlantic had an average scab incidence of approximately 30% under the dry soil regime (10% VSM). When the soil moisture treatments alternated between 14 and 21 percent on a weekly basis, the average scab severity decreased to approximately 26% of the surface area of tubers covered with scab lesions and the tubers from the alternating 21 and 14% VSM had approximately 23% scab cover. Potatoes grown in the moist soil (field capacity) had less than 5% scab cover.

Figure 3. Effects of four plant defense compounds and in furrow application method on average severity of scab on susceptible cultivar Snowden.

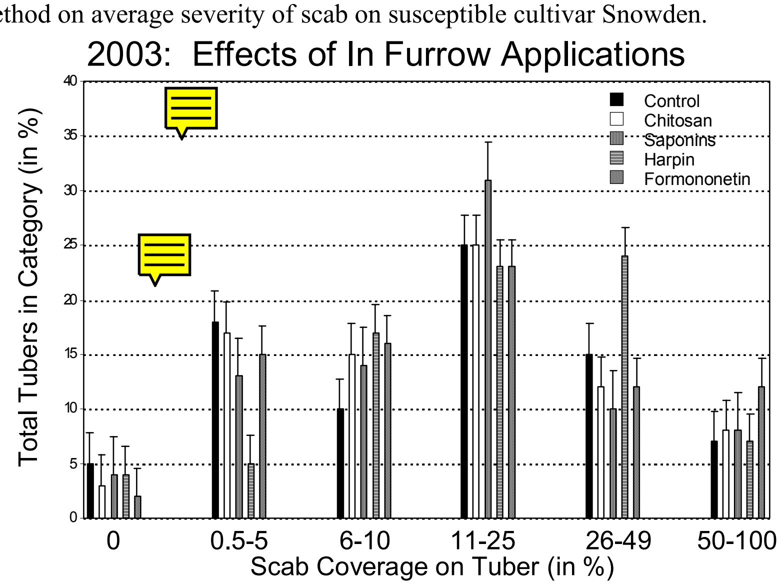
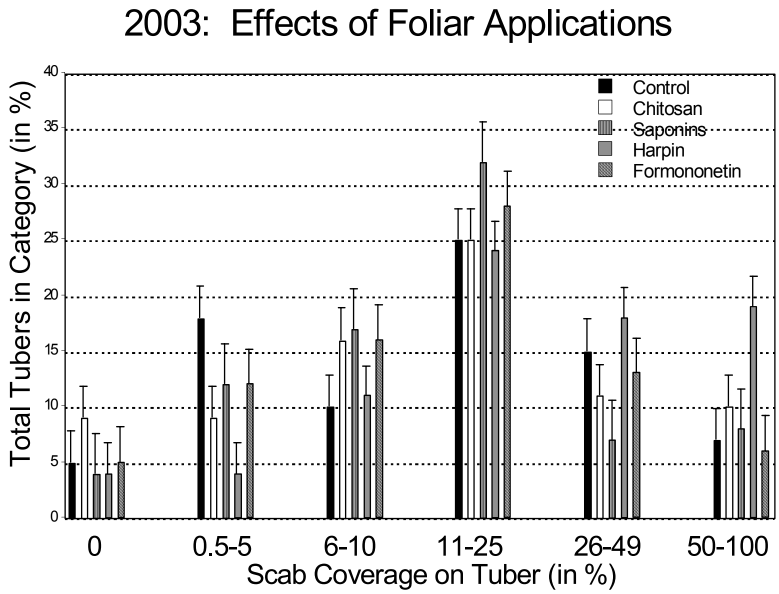


Figure 4. Effects of four plant defense compounds and foliar application method on average severity of scab on susceptible cultivar Snowden.



In the plant defense elicitor trial, the in furrow application methods for all four elicitors did not produce more disease free tubers than the control nor did any of the treatments produce more marketable tubers (5% or less scab coverage) (Figure 3). The severity categories ranging from 6 to 100 were not better than the untreated control. The foliar applications of Elexa, Messenger, and Myconate did not decrease scab incidence (Figure 4). The only category in which a treatment surpassed the performance of the control was the chitosan application on scab incidence. No other treatments reduced the severity of scab infection.

The preliminary results of quantification of pathogenic *Streptomyces scabies* from the Michigan agricultural soil samples taken from three potato fields showed that the samples corresponded with the amount of infection noted in each field. The highly infected field had 35% of tested samples with the pathogen present at varied amounts. The intermediately infected field only had 20% of the samples that tested positive for the pathogen in similar amount of inoculum per sample. The field with little infection only had 10% of the samples that tested positive and were at similar amounts of pathogen as the previous two fields.

Conclusion

The greenhouse experiment validates previous experiments, which indicated that irrigation provides an effective means to control potato common scab[4]. It is evident that applying soil moisture will reduce the infection by the pathogen (Figures 1 and 2). For both the greenhouse experiment and the field experiment, increasing the percentage of soil moisture reduced the infection. Also, it seems that the continuous irrigation is critical to allow soils to dry for a week may be enough time to allow for infections to occur. Field capacity was most effective in reducing scab infections in both the greenhouse and field experiment. At this time the interaction of genotype x environment has not yet been determined at what soil moisture the susceptible cultivar would become more susceptible to scab infection. Further experiments must be conducted to understand this phenomenon between the host, pathogen, and the environment. These must be continued in the controlled environment and also in the field to assure applicability to the industry.

The biological agents used in the field to induce resistance against the pathogen provided no protection. All types of application treatments of four natural elicitors did not prove to be effective and in fact, some non-treated controls had less scab infection than the biological treatments. Additionally, the effects of experiments using more frequent applications of biocontrol agents in conjunction with irrigation to suppress the pathogen have not been demonstrated. The preliminary quantification results suggest that the amount of pathogen in a field is not necessarily the largest indication of the amount of disease, perhaps due to disease escape, cultivar differences, cultural practices, etc. It seems rather that pathogen dispersal may be more important in determining the amount of infections in a given field. More studies are needed to further investigate this phenomenon.

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Michigan Potato Industry Commission 2003 Nematology Annual Report

George W. Bird, Professor
Michigan State University

The 2003 Michigan State University Potato Nematode Research Program consisted of the following three projects:

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

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

3. Identification of the impacts of alternate short-tem potato/vegetable cropping systems on soil quality as measured by nematode community structure analysis (MPIC funded).

A fourth project was initiated in 2003 at the MPRF. It is a soil quality restoration initiative designed to identify and demonstrate potato production practices that will eliminate risk to the Potato Early-Die Disease Complex. This will be presented as part of the 2004 Research Proposal to the Michigan Potato Industry Commission.

Potato Early-Die Disease Complex Tolerance

Twenty-nine potato lines and varieties were evaluated in 2003 at the Montcalm Potato Research Farm for tolerance to the Potato Earl-Die Disease Complex (PED) in fumigated (metham at 75 gallons per acre) and non-fumigated soil. Comparative tuber yields were assessed using a yield advantage equation ($Y_f - Y_{nf}/Y_{nf}$) 100 = % YA, where YA is the % yield advantage, Y represents tuber yield in cwt per acre, f represents fumigated soil and nf represents non-fumigated soil. Tuber yield advantages of <10% for A size tubers and normal reproduction of the root-lesion nematode (*Pratylenchus penetrans*) were classified as potentially tolerant lines (Table 1). Resistance is defined as lines with yield advantages of <10% and no root-lesion nematode reproduction. None were identified in 2003. Six lines, however, MSF373-8, MSE018-1, MSH095-4, MSF349-1RY, MSJ461-1 and MSJ316-A were identified in 2003 as potentially tolerant to PED. Three of these lines (MSF349-1RY, MSE018-1, and MSF373-8 had been identified as potentially tolerant or resistant in previous trials. MSF373-8 was recently released as Bolder (Douches *et al*., 2003, Am. J. Potato Res. 80:345-352). A summary of the results from the last five years of the PED Tolerance Identification Project is presented in Table 2.

Impact of Tillage on Tuber Yield and Nematodes

At the end of the first cycle of the potato, corn wheat rotation, both total tuber yield and yield or A-size tubers were significantly greater under the chisel plow system, compared to the mold board plow system (Tables 3 & 4). The impact of the mold board plow could be detected immediately in the spring of 2001 through an analysis of root-lesion nematode population densities (Table 5). In 2003 and 2003, early-season population densities of root-lesion nematode were lowest following potato. Mid-season population densities of root-lesion nematodes were always significantly lower on potato than on corn and almost always lower on potato than on wheat (Table 6). End-of season root-lesion nematode population densities in the soil were lowest in wheat (Table 7), but there were significant population densities in the wheat or clover associated with the previous crop of corn (Table 8).

Soil Quality of Short Term Potato/Vegetable Rotation Systems

Bacterial feeding nematodes associated with a conventional potato/wheat/rye cropping system were less than those associated with a more diverse potato/sweet corn/rye/hairy vetch/mustard cropping system during the 2002 cycle (Table 9). The same was observed for mycorrhizal fungi spores (Table 10).

Table 1. Potato tuber yield advantages and mid-season root-lesion nematode (*Pratylenchus penetrans*) population densities associated with 30 potato lines and varieties evaluated in 2003 at the Montcalm Potato Research Farm for tolerance or resistance to the Potato Early-Die Disease Complex.[1]

Treatment	Variety	Yield Advantage (YA) (A-sized)		Yield Advantage (YA) Total		Nematodes per 1.0 root tissue non-fumigated	Nematodes per 1.0 root tissue fumigated
11	MSF373-8	-33.8	a	2.2	ab	11.8	0.0
5	MSE018-1	-7.4	ab	9.6	abc	10.0	0.0
15	MSH095-4	0.4	abc	31.4	abcdef	8.0	0.0
10	MSF349-1RY	8.3	abcd	1.2	a	12.8	0.0
20	MSJ461-1	8.6	abcd	15.7	abcde	9.5	0.0
18	MSJ316-A	8.8	abcd	14.6	abc	16.3	0.0
2	B0766-3	12.8	abcde	13.3	abc	9.5	0.0
13	MSH067-3	16.0	bcde	15.0	abc	9.5	0.0
26	Snowden	18.7	bcdef	33.3	abcdefg	15.0	0.0
14	MSH094-8	19.7	bcdef	51.5	cdefg	32.5	0.0
29	W1836-3Rus	20.3	bcdef	15.6	abcde	15.5	0.0
4	Michigan Purple	21.7	bcdef	24.8	abcde	6.8	0.0
12	MSG227-2	22.0	bcdef	37.8	abcdefg	5.5	0.0
28	W1836-3Rus	24.0	bcdefg	32.0	abcdefg	5.3	0.0
22	NDTX4271-SR	26.5	bcdefgh	33.9	abcdefg	12.3	0.0
1	Atlantic	32.6	bcdefgh	23.6	abcde	4.5	0.0
3	Goldrush	38.2	bcdefgh	39.8	abcdefg	4.5	0.0
16	MS1005-20Y	38.6	cdefgh	33.7	abcdefg	29.5	0.0
21	MSK061-4	41.7	cdefgh	37.3	abcdefg	16.3	0.0
19	MSJ317-1	43.7	cdefgh	45.0	cdefg	13.8	0.0
6	MSE192-8Rus	45.8	cdefgh	40.2	abcdefg	17.3	0.0
9	MSF099-3	48.0	defgh	51.6	cdefg	11.0	0.0
17	MSJ167-1	53.0	defghi	44.0	bcdefg	10.0	0.0
8	MSE221-1	56.0	efghi	69.4	fg	23.0	0.0
7	MSE202-3R	62.1	fghi	57.8	efg	9.3	0.0
24	Russet Burbank	62.6	fghi	57.5	defg	21.8	0.0
23	Onaway	68.2	ghi	73.9	g	21.0	0.0
27	Superior	70.8	hi	73.8	fg	19.0	0.0
25	Russet Norkotah	94.5	i	70.8	fg	21.3	0.0
ANOVA		0.001		0.010		0.707	

[1]YA = $(Y_f - Y_{nf}/Y_{nf})$ 100, where YA is the % yield advantage, Y represents tuber yield in cwt per acre, f represents fumigated soil and nf represents non-fumigated soil.

Table 2. Summary of 1998-2003 Michigan State University Potato Early-Die Nematode Tolerance-Resistance Research conducted at the Montcalm Potato Research Farm.

Probable Resistance

High yield in presence of potato early-die conditions and limited root-lesion nematode reproduction.

MSF349-1RY (98, 00, 01, 02) (**identified as tolerant in 03**)
Rose Gold x WI 877. Plan to work with Dave Douches on the potentials of these lines since MSF349-1RY is highly susceptible to scab. It is possible that the extensive presence of the scab Actinomycetes could be related to the PED response.

Tolerant

High yield in presence of potato early-die conditions with normal root-lesion nematode reproduction

MSE228-1 (98, 99, 00, 01)
Four years of consistent data. Russet Nugget x Spartan Pearl. Need to work with Dave Douches in detail on the parents.

Probable Tolerance

One to three additional years of PED evaluation are needed for the following six potato lines/varieties.

MSF 373-8 (98, 00, 03)
MSF 018-1 (99, 00, 03)
MSH095-4 (03)
MSJ461-1 (03)
MSJ316-A (03)

Lines not evaluated in 2003

Bannock Russett (02)
W1201 (02)
NY120 (01, 02)
NY112 (01, 02)
MSG 227-2 (00 susceptible, 01 tolerant, 02 tolerant)

Table 2 (continued)

Probable tolerant lines/varieties not evaluated in 2003 (continued)

MSE028-1 (00)
MSE273-8 (00)
MSF060-6 (00)
MSH094-8 (01, 02)
MSH333-3 (01
W1431 (01)

Susceptible

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

Atlantic (97, 99, 00, 01, 02, 03))
MSE 149-5Y (98, 99, 00,01)
MSF 099-3 (99, 00, 01, 02)
Goldrush (02, 03)
Jacqueline Lee, MSG 274-3 (99, 00, 01, 02)
Liberator, MSA091 (01, 02)
Onaway (01, 02, 03)
Pike (02)
Russet Burbank (03)
Russet Norkotah (02, 03)
Snowden (97, 99, 00, 01, 02, 03)
Superior (01, 02, 03)
MSE202-3 Rus (00, 01, 02, 03)

Probable Susceptibility

BO766-3 (03)
MSH067-3 (03)
MSH094-8 (03)
W1836-3Rus (03)
MSG227-2 (03)
NDTX4271-SR (03)
MS1005-20Y (03)
MSK061-4 (03)
MSJ317-1 (03)
MSE192-8Rus (03)
MSF099-3 (03)
MSJ167-1
MSE221-1 (03)

Table 2 (continued)

Probable Susceptible Not Rested in 2003

MSB 076G-3 (01)
MSB 106-7 (00)
MSE 221-1 (00, 01)
MSG 015-C (01)
MSG 124-85 (00)
MSH 026-3 Rus (01)
MSP 81-11-5 (00)
W1368 (01)
W1386 (01)

Inconclusive

MI Purple (00 tolerant, 01 susceptible, 02 tolerant, 03 susceptible)

Not evaluated in 2003

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)

Table 3. Influence of alternative tillage systems on potato tuber yield (cwt/acre).

Tillage	2001 Corn Potato Wheat	2002 Potato Wheat Corn	2003 Wheat Corn Potato	Mean
Chisel Plow	247	487	180	305
Mold Board Plow	196	382	134	237
T Test P Value	0.33	0.64	0.00	---

Table 4. Influence of alternative tillage systems on A-size potato tuber yield (cwt/acre).

Tillage	2001 Corn Potato Wheat	2002 Potato Wheat Corn	2003 Wheat Corn Potato	Mean
Chisel Plow	220	452	159	2775
Mold Board Plow	165	340	103	203
T Test P Value	0.31	0.23	0.00	---

Table 5. Early-season soil population densities of root-lesion nematodes (*Pratylenchus penetrans*)associated with alternative potato production till systems.

System	2001	2002	2003
Chisel plow			
Corn	102 c	160 c	76 b
Potato	131 bc	62 b	107 bc
Wheat	95 bc	6 a	6 a
Mold board plow			
Corn	42 a	78 b	124 b
Potato	43 a	124 bc	76 b
Wheat	67 ab	8 a	7 a

Table 6. 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
Chisel plow			
Corn	520 b	304 bc	145 a
Potato	169 a	46 a	125 a
Wheat	278 ab	132 ab	524 b
Mold board plow			
Corn	316 b	382 c	525 b
Potato	130 a	54 a	216 a
Wheat	270 ab	87 a	450 b

Table 7. End-of-season soil population densities of root-lesion nematodes (*Pratylenchus penetrans*)associated with alternative potato production till systems.

System	2001	2002	2003
Chisel plow			
Corn	284 a	328 c	
Potato	351 a	163 b	
Wheat	261 a	49 a	
Mold board plow			
Corn	99 a	208 b	
Potato	344 a	254 bc	
Wheat	185 a	27 a	

Table 8. End-of growing season (October 25, 2001) population densities of root-lesion nematodes (Pratylenchus penetrans) recovered from wheat and clover root tissue (1.0 grams of tissue).

Treatment	Nemataodes Recovered
Chisel Plow	
Clover	1730 a
Wheat	960 a
Mold Board Plow	
Clover	1550 a
Wheat	1820 a

Table 9. Impact of short-term potato/vegetable rotation systems on population densities of bacterial feeding nematodes during the 2002 cycle.

System	Bacterial feeding nematodes per 100 cm^3	
	Mid-season	Late-season
4. Potato/wheat/rye (conventional)	361	206
7. Potato/sweet corn/rye-hairy vetch-mustard	475	2,976

Table 10. Impact of short-term potato/vegetable rotation systems on population densities of mycorrhizal fungi during the 2002 cycle.

System	Mycorrhizal fungi spores per 100 cm^3	
	Mid-season	Late-season
4. Potato/wheat/rye (conventional)	21	40
7. Potato/sweet corn/rye-hairy vetch-mustard	208	603

Funding: USDA/MPIC

Potato Insect Biology and Management

Report to the Michigan Potato Industry Commission
January 15, 2004

Edward J. Grafius, Beth A. Bishop, Walter L. Pett, Adam M. Byrne, and Eric N. Bramble

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 mid-west and locations in the northeastern U.S.

II. Field insecticide evaluations of registered and experimental insecticides.

III. 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.

IV. Studies on the effectiveness of pymetrozine (Fulfill) on aphid feeding and survival were initiated.

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

Imidacloprid (Admire®, Provado®, Gaucho®, Genesis®) has been the predominant insecticide for Colorado potato beetle control since its registration in 1995. Such long term and widespread usage of one compound greatly increases the chances for resistance development. In 2002, thiamethoxam (Platinum®, Actara®), also a neonicotinoid, became available for commercial use. The similarities between these two compounds warrant careful scrutiny for resistance and cross-resistance development.

The objectives of this study were to: (1) continue gathering data on baseline susceptibility to imidacloprid and thiamethoxam in Colorado potato beetle populations collected from Michigan and other regions of the United States, (2) determine if susceptibility to thiamethoxam was correlated with susceptibility to imidacloprid. To accomplish these objectives, 15 Colorado potato beetle populations (3 Michigan populations, 6 populations collected in other states, and 6 laboratory populations) were bioassayed with imidacloprid and/or thiamethoxam.

Methods

During 2003, three Colorado potato beetle populations were collected from three different Michigan counties (Houghton, Montcalm, and Washtenaw). Syngenta representatives and other cooperators also provided one population each from Delaware and Wisconsin, and two populations from Massachusetts and Minnesota. Six strains maintained in the laboratory were also tested (Table I.1).

Colorado potato beetle adults were either kept at room temperature (25 ± 2^{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. The petri dishes were stored at 25 ± 2^{o} C and the foliage and filter paper were checked daily and changed as needed.

A preliminary screen was conducted on each population to determine relative susceptibility to imidacloprid and thiamethoxam by testing 10 beetles each with four 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 two to three dishes per concentration).

The responses of the beetles were 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 v8.01).

Results

The LD_{50} values for imidacloprid, 7 days post treatment, ranged from 0.012 µg/beetle (Hughes Farm) to 0.064 µg/beetle (Montcalm Farm) for Michigan populations and from 0.062 µg/beetle (Plover, WI) to 11.739 µg/beetle (Hadley, MA) for out-of-state populations (Table I.2). The values for the Michigan, Minnesota, and Wisconsin populations were consistent with those obtained for Colorado potato beetles from these areas in previous years. Resistance in the Hadley, MA population was 379 fold, compared to our susceptible laboratory strain (LD_{50} = 0.031) (Figure I.1). This is the highest level of resistance we have recorded outside of Long Island, NY; it should be noted that we had not tested beetles from this area prior to 2003. Laboratory strain LD_{50} values for imidacloprid ranged from 0.060 µg/beetle (S-Sel) to 3.108 µg/beetle (Fiesta).

LD_{50} values for thiamethoxam, 7 days post treatment, were 0.015 µg/beetle (Hughes Farm) and 0.049 µg/beetle (Montcalm Farm) for Michigan populations and ranged from 0.026 µg/beetle (Plover, WI) to 0.867 µg/beetle (Hadley, MA) for out-of-state populations (Table I.3). The LD_{50} value from Hadley, MA is much higher than the highest value previously recorded (0.468 µg/beetle from Deerfield, MA in 2002) and is 20 fold resistant compared to our susceptible laboratory strain (Figure I.2). All other field populations were consistent with results from previous seasons. Laboratory strain LD_{50} values for thiamethoxam ranged from 0.065 µg/beetle (S-Sel) to 0.455 µg/beetle (Fiesta).

The relative susceptibility to imidacloprid (as measured by LD_{50}) in Colorado potato beetle populations was highly correlated with relative susceptibility to thiamethoxam (Figure I.3). This result was also found in 1998, 1999, 2000, and 2002. This clearly shows that selection with imidacloprid over the past 9 years has also selected for resistance to thiamethoxam, although at a much lower level than imidacloprid resistance. The resistance to thiamethoxam in the Hadley MA population is likely due to previous selection with imidacloprid since thiamethoxam has only been used at this site for one year.

Evans is a Michigan strain selected with imidacloprid. It is 63-fold resistant to imidacloprid clearly showing that Michigan beetles have the genetic capacity to develop resistance. The Fiesta laboratory strain was originally collected from Long Island and has maintained a high level of resistance to imidacloprid since collection although it has only been selected with thiamethoxam; Jamesport, the parent colony of Fiesta, was kept without any selection and shows much less resistance to imidacloprid than when it was first collected. This demonstrates that during selection with thiamethoxam, resistance to imidacloprid does not decrease.

Resistance management programs will need to consider these results; alternations within the neonicotinoid group are not likely to be effective as a resistance management practice.

Table I.1. Colorado potato beetle populations bioassayed for susceptibility to imidacloprid and thiamethoxam in 2003.

Michigan populations
<u>*Hughes Farm*</u> Adults were received from an organic potato farm near Calumet, Houghton Co. on 15 July 2003.
<u>*Manchester*</u> Adults were collected from Manchester, Washtenaw Co. on 8 September 2003.
<u>*Montcalm Farm*</u> Adults were collected from the Michigan State University Montcalm Potato Research Farm in Montcalm Co. on 29 August 2003.
Out-of-state populations
<u>*Clear Lake, Minnesota*</u> Adults were collected by Brett Miller, Syngenta Crop Protection, Inc., from a commercial potato field near Clear Lake, MN on 30 July 2003.
<u>*Delaware, Delaware*</u> Adults were collected by Joanne Whalen, Extension IPM Specialist at University of Delaware, from a field near Little Creek, DE on 17 June 2003.
<u>*Glyndon, Minnesota*</u> Adults were collected by Don Carey, North Dakota State University, from untreated potatoes near Glyndon, MN on 19 August 2003.
<u>*Hadley, Massachusetts*</u> Adults were collected by J. Dan Smith, Syngenta Crop Protection, Inc., from a commericial potato field near Hadley, MA on 24 July 2003.
<u>*Northampton, Massachusetts*</u> Adults were collected by Mitchell Baker, University of Massachusetts, from a commercial field near Northampton, MA on 28 July 2003.
<u>*Plover, Wisconsin*</u> Adults were collected by Steve Sanborn, Syngenta Crop Protection, Inc., from a commercial field near Plover, WI on 11 August 2003.
Laboratory strains
Evans ***Collected from Montcalm Co., MI in summer 1997. Adults from each generation have been selected with imidacloprid doses targeting 60-80% mortality.***
<u>*Fiesta*</u> Collected near Jamesport Long Island and selected each generation with thiamethoxam doses targeting 60-80% mortality.
<u>*Jamesport*</u> Collected from Long Island, NY in August 1999. Maintained in the laboratory without selection.
Little Creek ***Collected from Little Creek, DE in summer 2002 and maintained in the laboratory without selection.***
NY-Sel ***Collected from Long Island, NY in 1997 and selected with imidacloprid doses targeting 60-80% mortality.***
S-Sel ***Collected from an organic farm near Calumet, MI in 1999. Adults from each generation were selected with thiamethoxam doses targeting 60-80% mortality.***

Table I.2. LD_{50} values (µg/beetle) and 95% confidence limits for Colorado potato beetle populations treated with imidacloprid.

Population	LD_{50}	95% confidence limits
Michigan populations		
Hughes Farm	0.012	0.006 - 0.020
Montcalm Farm	0.064	*
Manchester	0.086	0.065 - 0.105
out-of-state populations		
Clear Lake, MN	0.230	0.197 - 0.270
Delaware, DE	1.030	0.244 - 1.614
Glyndon, MN	0.078	*
Hadley, MA	11.739	8.298 - 26.572
Northampton, MA	1.176	0.622 - 5.157
Plover, WI	0.062	0.019 - 0.124
laboratory strains		
Evans	1.957	1.572 - 2.393
Fiesta	3.108	2.613 - 3.954
Jamesport	0.340	0.052 - 0.597
Little Creek	2.860	2.491 - 3.387
NY-Sel	2.814	1.618 - 3.759
S-Sel	0.060	0.046 - 0.100

* 95% confidence limits not available due to either low sample size or high heterogeneity

Table I.3. LD_{50} values (µg/beetle) and 95% confidence limits for Colorado potato beetle populations treated with thiamethoxam.

Population	LD_{50}	95% confidence limits
Michigan populations		
Hughes Farm	0.015	0.007 - 0.029
Montcalm Farm	0.049	0.038 - 0.060
out-of-state populations		
Clear Lake, MN	0.074	0.065 - 0.085
Delaware, DE	0.163	0.001 - 0.308
Glyndon, MN	0.033	0.028 - 0.038
Hadley, MA	0.867	0.695 - 1.071
Northampton, MA	0.160	0.127 - 0.212
Plover, WI	0.026	0.016 - 0.032
laboratory strains		
Evans	0.254	0.203 - 0.310
Fiesta	0.455	0.391 - 0.526
Jamesport	0.096	0.082 - 0.111
Little Creek	0.276	0.231 - 0.316
NY-Sel	0.182	0.111 - 0.238
S-Sel	0.065	0.057 - 0.074

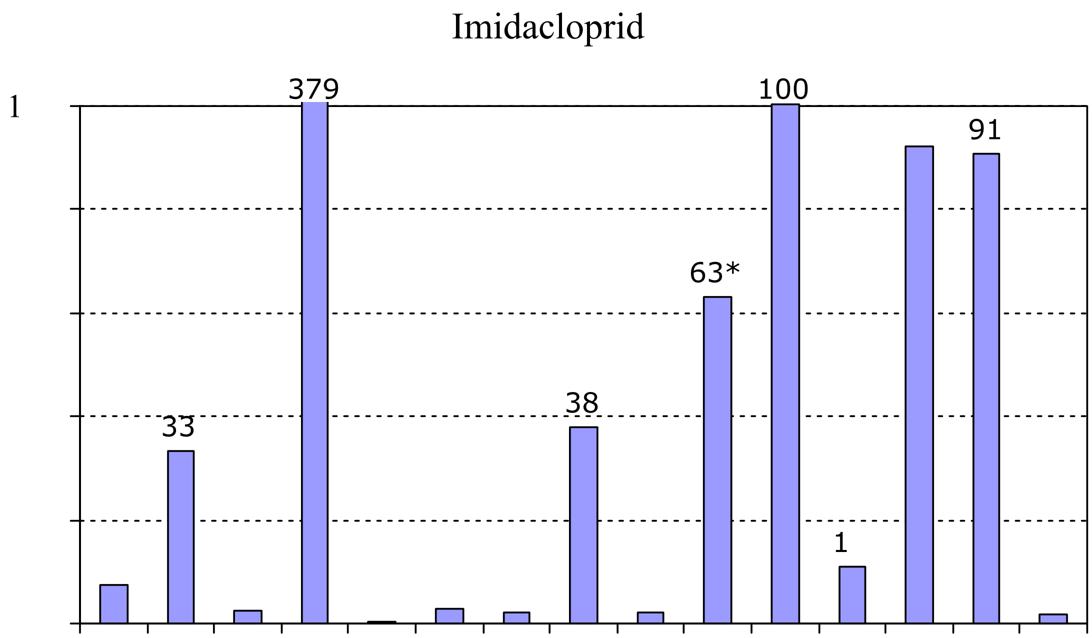

Figure I.1. Resistance ratios of Colorado potato beetle populations to imidacloprid compared to a susceptible laboratory strain (susceptible LD_{50} = 0.031 µg/beetle). *Evans is a lab colony started with Michigan beetles and selected with imidacloprid.

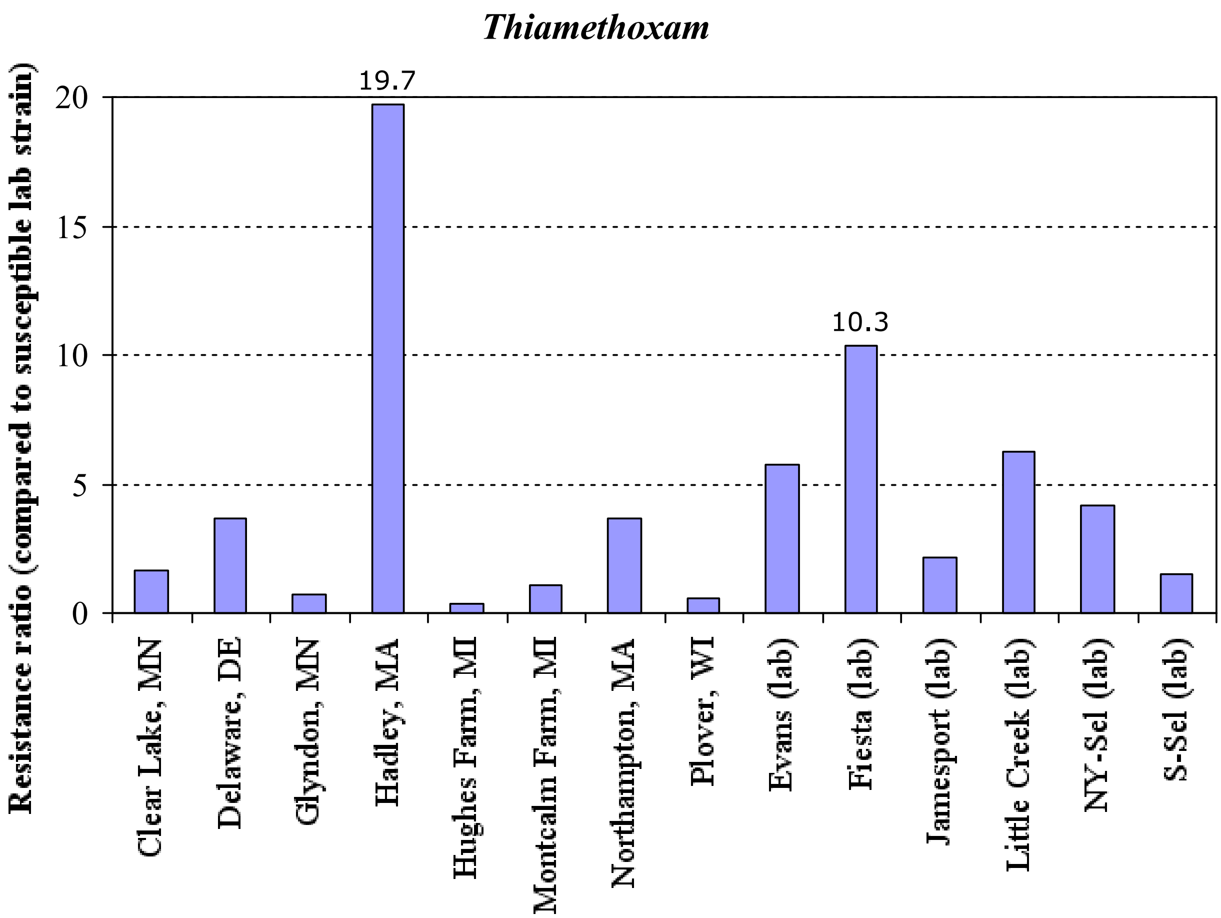

Figure I.2. Resistance ratios of Colorado potato beetle populations to thiamethoxam compared to a susceptible laboratory strain (susceptible LD_{50} = 0.044 µg/beetle).

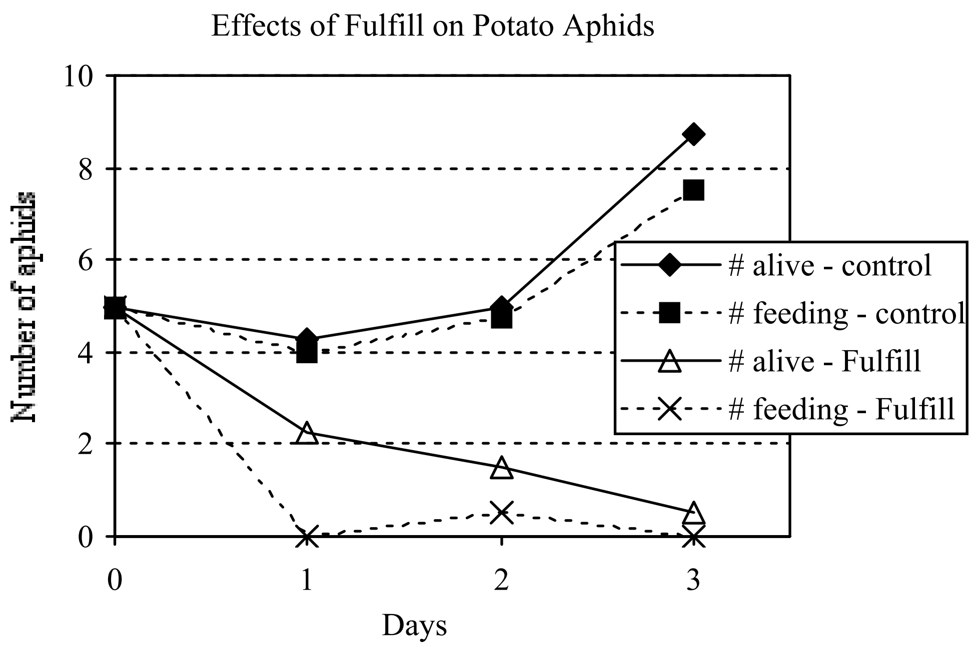

Figure I.3. Correlation between susceptibility to imidacloprid and for all field populations tested in 2003 (n=8).

II. Field insecticide evaluations of registered and experimental insecticides.

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

Methods.

Twenty-one treatments (Table II.1) were tested at the MSU Montcalm Research Farm, Entrican, MI for control of Colorado potato beetle. 'Atlantic' potatoes were planted 12 in. apart, with 34 in. between rows on 15 May. Treatments were replicated four times in a randomized complete block design. Plots were 40 ft long and three rows wide.

Fourteen treatments were applied at planting. Admire 2F, Platinum 2SC, and V10112 20SG were applied as in-furrow sprays using a single nozzle hand held boom (30 gpa, 35 psi). Tops-MZ-Gaucho was applied as a dust to seed pieces (in a plastic tub) prior to planting. Cruiser and Genesis were applied to seed pieces with 150 ml of water/40 seed pieces using a mist spray bottle, also prior to planting. Foliar treatments were first applied at approximately 80% Colorado potato beetle hatch on 24 Jun. Subsequent first-generation sprays for most treatments were applied on 1 Jul, 8 Jul, 22 Jul, and 29 Jul (depending on treatment, Table II.1).

Post-spray counts of adults and larvae (small and large) on five randomly selected plants from the middle row of each plot were made 2 d after each application. Defoliation ratings were taken on 8 Jul and 22 Jul by assessing five randomly chosen plants from the middle row of each plot and visually estimating defoliation on a scale of 1-5 (1=no defoliation, 5 = 76% to 100% defoliation). On 17 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 ($p = 0.05$).

Treatments generally all performed very well compared to untreated plots. There were significant differences between treated and untreated plots in the seasonal means of small larvae, large larvae, and adults (Table II.1). All treatments resulted in significantly fewer small and large larvae than in the untreated plots. All treatments also resulted in significantly higher yield than in untreated plots (Table II.2). Defoliation was significantly less than defoliation in untreated plots for all treatments except Tops MZ (Table II.2).

Surprisingly, the pyrethroid Baythroid gave very good control of Colorado potato beetle larvae under these conditions. Pyrethroid resistance at the Montcalm Research Farm had perhaps never been as severe as at some other locations – Asana plus PBO gave moderate control in research in the mid-1990s. Also, potato beetle pressure in this year's research was lower than usual. Nonetheless, Michigan growers may find that one or two applications of a pyrethroid or another older insecticide may give some level of control after 9 years of reliance on neonicotinoids.

Multiple applications however will likely return the situation rapidly back to high levels of resistance. Another concern is that the product Leverage includes both a pyrethroid (Baythroid) and a neonicotinoid (Provado). Leverage provides excellent control of potato leafhoppers but should never be used following the use of a neonicotinoid at planting because of the risk of increasing resistance to neonicotinoids.

Table II.1. Treatments and Colorado potato beetle eggs, larvae and adults per 5 plants.

Treatment/formulation	Rate	Application dates	Seasonal mean of 1st-generation CPB/5 plants: Egg Masses	Small Larvae	Large Larvae	Adults
Actara 25WG	1.5 oz./acre	24 Jun, 1 Jul	0.1	0.4a	0.3a	0.2a
Admire 2F[a]	13 fl. oz./acre	at planting	0.0	0.3a	0.2a	0.2a
Admire 2F[a]	16 fl. oz./acre	at planting	0.0	0.3a	0.4ab	0.2a
Admire 2F[a]	20 fl. oz./acre	at planting	0.1	0.5a	0.1a	0.1a
Admire 2F[a] + TOPS MZ[b]	13.8 fl. oz./acre 12 oz./cwt.	at planting	0.1	0.3a	0.3ab	0.2a
Assail 70W	1.7 oz./acre	24 Jun, 8 Jul	0.1	0.4a	0.1a	0.2a
Baythroid	2.0 fl oz./acre	24 Jun, 8 Jul	0.1	1.0ab	0.5ab	0.2a
Cruiser 5FS[c]	0.13 fl. oz./cwt.	at planting	0.1	1.1ab	1.7 b	0.2a
Genesis + TOPS MZ[b]	0.3 fl. oz./acre 12 oz./cwt.	at planting	0.1	0.5a	0.9ab	0.3a
Genesis + TOPS MZ[b]	0.4 fl. oz./acre 12 oz./cwt.	at planting	0.1	0.2a	0.8ab	0.1a
Genesis + TOPS MZ[b]	0.5 fl. oz./acre 12 oz./cwt.	at planting	0.1	0.7ab	0.9ab	0.1a
Leverage 2.7SE	3.75 fl. oz./acre	24 Jun, 8 Jul	0.1	0.7ab	0.1a	0.1a
Platinum FS[a]	6.5 oz./acre	at planting	0.3	0.6ab	0.6ab	0.2a
Platinum FS[a]	8.0 oz./acre	at planting	0.1	0.9ab	0.3ab	0.2a
V10112 20 SG[a]	17.6 oz./acre	at planting	0.1	0.6ab	0.7ab	0.2a
V10112 20 SG[a]	26.4 oz./acre	at planting	0.0	0.1a	0.2a	0.2a
V10112 20 SG[a]	35.2 oz./acre	at planting	0.1	0.5a	0.3ab	0.1a
V10112 20 SG	3.5 oz./acre	24 Jun, 2 Jul, 8 Jul, 22 Jul	0.2	2.1 bc	0.4ab	0.2a
V10112 20 SG	7.0 oz./acre	24 Jun, 2 Jul, 8 Jul, 22 Jul	0.2	1.2ab	0.2a	0.2a
V10112 20 SG	10.5 oz./acre	24 Jun, 2 Jul, 8 Jul, 22 Jul	0.1	0.2a	0.1a	0.1a
Tops MZ	12 oz./cwt.	at planting	0.1	3.1 cd	1.6 b	0.8 b
Untreated check			0.1	4.6 d	5.2 c	1.5 c
P=			0.10	0.0001	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] treatment applied to seed pieces as dust before planting

[c]treatment sprayed onto seed pieces with a spray bottle and 150 ml water before planting

Table II.2. Treatments, yield and defoliation ratings for field insecticide trials for control of Colorado potato beetle.

Treatment	Rate	Application dates	Yield (lb/40 row ft)			Defoliation rating[c]	
			Size A[d]	Size B[d]	Total	8 Jul	22 Jul
Actara 25WG	1.5 oz./acre	24 Jun, 1 Jul	90.1 cd	2.4	92.5 cd	1.0a	1.2abcd
Admire 2F[a]	13 fl. oz./acre	at planting	85.6 bcd	2.5	88.1 bcd	1.0a	1.0a
Admire 2F[a]	16 fl. oz./acre	at planting	90.2 cd	2.0	92.2 cd	1.0a	1.1ab
Admire 2F[a]	20 fl. oz./acre	at planting	95.7 d	2.3	98.0 d	1.0a	1.0a
Admire 2F[a] + TOPS MZ[b]	13.8 fl. oz./acre 12 oz./cwt.	at planting	95.4 d	2.6	98.0 d	1.0a	1.2abc
Assail 70W	1.7 oz./acre	24 Jun, 8 Jul	86.9 bcd	2.3	89.2 bcd	1.0a	1.0a
Baythroid	2.0 fl oz./acre	24 Jun, 8 Jul	84.3 bcd	2.8	87.1 bcd	1.0a	1.4 bcde
Cruiser 5FS	0.13 fl. oz./cwt.	at planting	87.8 cd	1.6	89.4 cd	1.0a	1.6 e
Genesis + TOPS MZ[b]	0.3 fl. oz./acre 12 oz./cwt.	at planting	72.8ab	1.8	74.6ab	1.0a	1.4 bcde
Genesis + TOPS MZ[b]	0.4 fl. oz./acre 12 oz./cwt.	at planting	85.2 bcd	2.3	87.5 bcd	1.0a	1.4 bcde
Genesis + TOPS MZ[b]	0.5 fl. oz./acre 12 oz./cwt.	at planting	85.9 bcd	2.4	88.3 bcd	1.0a	1.4 bcde
Leverage 2.7SE	3.75 fl. oz./acre	24 Jun, 8 Jul	83.4 bcd	2.5	85.9 bcd	1.0a	1.0a
Platinum FS[a]	6.5 oz./acre	at planting	88.5 cd	2.4	90.9 cd	1.0a	1.3abcde
Platinum FS[a]	8.0 oz./acre	at planting	86.4 bcd	2.1	88.5 bcd	1.0a	1.3abcde
V10112 20 SG[a]	17.6 oz./acre	at planting	81.8 bcd	1.6	83.4 bcd	1.0a	1.5 de
V10112 20 SG[a]	26.4 oz./acre	at planting	91.6 cd	2.4	94.0 cd	1.0a	1.1ab
V10112 20 SG[a]	35.2 oz./acre	at planting	90.8 cd	2.1	92.9 cd	1.0a	1.3abcde
V10112 20 SG	3.5 oz./acre	24 Jun, 2 Jul, 8 Jul, 22 Jul	81.9 bcd	2.3	84.2 bcd	1.2a	1.5 cde
V10112 20 SG	7.0 oz./acre	24 Jun, 2 Jul 8 Jul, 22 Jul	90.1 cd	2.0	92.1 cd	1.0a	1.3abcde
V10112 20 SG	10.5 oz./acre	24 Jun, 2 Jul 8 Jul, 22 Jul	95.5 d	2.1	97.6 d	1.0a	1.0a
Tops MZ	12 oz./cwt.	at planting	80.6 bc	2.3	82.9 bc	1.6 b	2.3 f
Untreated check			65.3a	2.3	67.5a	1.6 b	2.4 f
P=			0.027	0.899	0.026	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] treatment applied to seed pieces as dust before planting

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

[d] Size A = tubers greater than 2 in. Size B = tubers that are 2 in. or less

III. 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.

Seed of traditionally bred potatoes resistant to Colorado potato beetle was increased to levels sufficient for large plots in 2004. Treatments in 2003 included; Admire at planting (10 oz/A and 5 oz/A, to imitate potato beetle insecticide resistance), foliar applications of abamectin alternating with spinosad, and a non-treated control. The study was established on the newly acquired ground of the research farm. Due to low potato beetle populations throughout the farm and the new location on the west side of the farm, potato beetle numbers were too low and no significant differences in beetle numbers or defoliation were observed between treatments. In 2004 this research will be located on the east side of the farm and will include resistant varieties as well as low impact pesticides.

IV. Effects of Fulfill (pymetrozine) on feeding and reproduction of the potato aphid.

Potato plants were sprayed in the greenhouse with Fufill at the normal field rate (2.75 fl. oz./A) using a CO_2 pressurized sprayer. Non-winged adult potato aphids (*Macrosiphum euphorbiae*) were placed on foliage in the laboratory and observed for feeding behavior, survival and reproduction. Feeding stopped almost immediately after aphids were placed on the treated plants and the aphids' mouthparts were held out in front of the body instead of underneath. Almost no feeding or probing was observed and aphids did not reproduce on Fulfill treated foliage (Figure IV.1). This effect was true for foliage treated up to 9 days before introducing the aphids.

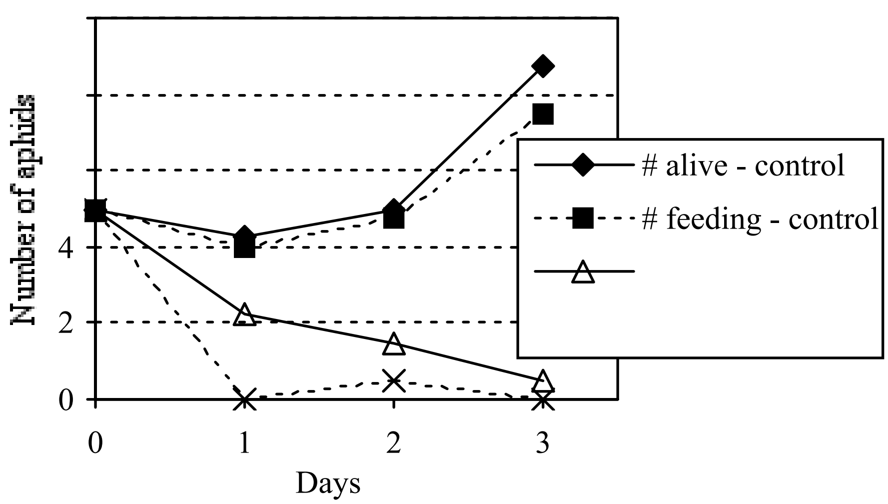

Figure IV.1. Effects of Fulfill on aphid survival, feeding and reproduction. This figure shows aphids placed on foliage immediately after spray dried. Similar results were observed for aphids placed on foliage up to 9 days after treatment.

Funding : MPIC

Nitrogen Source and Seed Spacing Effects on Tuber Yield and Quality of New Potato Varieties

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Introduction

Quantification of potato plant response to nutrient source and amount and to seed spacing is required for integration of new varieties into commercial production. This study examined the response of 5 new potato varieties, of interest to Michigan potato growers, and the Snowden variety to 3 nitrogen (N) sources, 2 N levels and 2 seed spacings.

Previous research findings have indicated that poultry manure may be supplying nutrients in a more efficient manner than conventional fertilizers. Poultry manure, in combination with reduced conventional fertilizer, has resulted in yield improvements when compared to conventional fertilizers alone. This experiment compares this manure and fertilizer combination with fertilizer alone and with slow-release formulations of N fertilizer, at recommended rates (180 lbs. N/acre), as well as with a higher-than-recommended rate of N fertilizer (270 lbs. N/acre). These comparisons will demonstrate whether yield improvements from poultry manure are related to N quantity or form of N supply.

Additionally, all potato varieties were planted at two seed spacings within each nitrogen treatment in this experiment. Tuber yield, size and quality results from this comparison will help growers to make wise choices about plant density.

Materials and Methods

A split-split plot experiment was designed and implemented to observe response profiles of 6 potato cultivars to N source and seed spacing treatments. Plots were established at the Montcalm Research Farm in Entrican, MI during 2003 on Montcalm/McBride sandy loam previously planted to wheat and clover. Potato varieties and seed spacing treatments are listed below:

Purpose	Variety	Narrow Spacing	Wide Spacing
Tablestock	Michigan Purple	8"	13"
"	MSE192-8Rus	10"	15"
Chipstock	MSG227-2	8"	13"
"	Snowden	8"	13"
"	UEC	8"	13"
"	W1201	8"	13"

Michigan Purple is a high yielding, purple skinned, white fleshed potato with excellent internal qualities. MSE192-8Rus, is a russet tablestock line with excellent internal quality and common scab tolerance. Snowden, a public variety, is a chip processing standard for Michigan. MSG227-2 is a cold storage (45 ºF) chipper with common scab resistance. W1201 is a chip processing selection from the University of Wisconsin with high yield potential, consistent processing gravity, common scab tolerance and good chip quality. UEC is an unknown east coast chip processing variety with high yield potential, moderate scab tolerance and good chip quality[1].

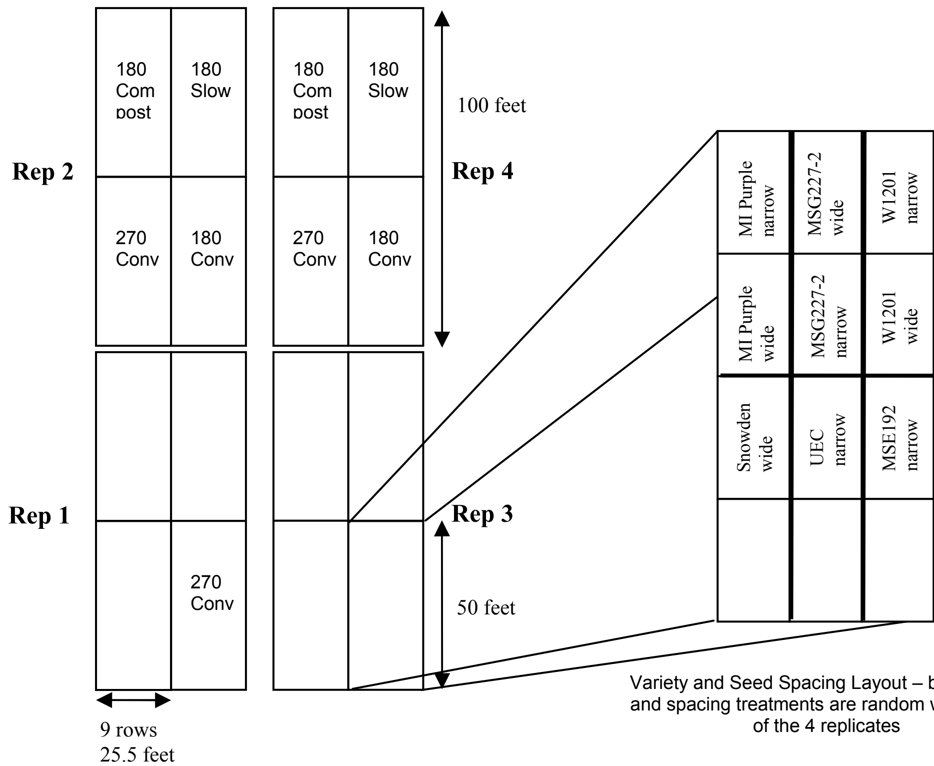
Four nitrogen schemes, described below, were tested in this experiment. Soil was prepared, plots were laid out, and pre-plant soil treatments of poultry compost and slow-release fertilizer were applied manually on May 7th 2003. Three-row x 25 ft. plots were planted by hand on 13 May 2003 to ensure accurate seed placement and spacing. Rows were opened and closed with a 2-row planter. All N treatment-variety-seed spacing combinations were replicated 4 times. 180 lbs. per acre is the recommended N for potatoes grown on mineral soils in Michigan. Nutrients were supplied before and during the growing season as follows:

	Nitrogen Treatment			
Fertilizer or Amendment	**180 lbs. Conventional**	**180 lbs. Manure**	**180 lbs. Slow-release**	**270 lbs Conventional**
	- - - - - (pounds per acre) - - - - -			
Potash (0-0-60, pre-plant)	250	250	250	250
Phosphorus (at planting)	35	35	35	35
Meister T10[2] (40% N, pre-plant)			350	
Poultry manure compost (50 lbs. N per acre credit, pre-plant)		5000		
Urea (46-0-0)				
- at planting – 13 May	91	91	91	91
- at hilling – 28 May	120	65		163
- 23 June	120	65		163
- 18 July	65	65		163
Total N	**182**	**182**	**182**	**268**

Plots were irrigated weekly, as needed, through an overhead pivot. Sencor and Dual were applied pre-emergence for weed control and Admire, Bravo, dimetholate and Polyram were used for disease and pest prevention throughout the growing season. Petiole and soil nitrate status were monitored in Snowden plots throughout the season. Petioles were sampled at 79, 86, 99 and 113 days after planting by selecting the 3rd petiole from the growing tip of the plant and stripping off the leaves. Ion exchange membranes (2 per plot) were inserted into the soil to a depth of 6" within the plots to monitor soil nitrate. Diquat was applied on 11 September for vine killing.

All plots (n=192) were harvested mechanically and manually weighed and graded on 9 and 10 October 2003. Tubers were washed and graded by size into 'A' (1 7/8" to 3 ¼" diameter), 'B' (smaller than 1 7/8" diameter), and 'Oversize' (greater than 3 ¼" diameter) categories and weighed. 'A' size tubers were also used for calculating specific gravity as (weight in air)/(weight in air – weight in water). Defective non-marketable tubers (misshapen, green, diseased, etc.) were also separated and weighed. From each plot sample, 10 tubers from the oversize and A size categories were sampled and cut in half lengthwise to inspect for hollow heart, vascular ring disease, internal brown spot, and brown center internal defects. 'A' size tubers were also subsampled, sliced and fried for chip color and defect comparisons. Soil was sampled to a depth of 20" in Snowden plots after tubers were removed.

Plot Map (Range Comden 9 NE @ MRF)



Variety and Seed Spacing Layout – both variety and spacing treatments are random within each of the 4 replicates

Results and Discussion

Seed spacing influenced both tuber yield and size distribution but did not affect specific gravity. Specific gravity of tubers averaged 1.080 for both wide and narrow spacing across variety. Narrow seed spacing increased yield for Michigan Purple, MSG227-2, UEC and W1201 varieties by an average of 43 cwt / acre but did not affect yield of Snowden or MSE192-8Rus. Narrow spacing also resulted in a slightly smaller tuber size distribution by increasing the proportion of B-size and decreasing the proportion of oversized tubers compared with the wide seed spacing treatment. The UEC variety produced nearly 40% oversized tubers; while MSE192-8Rus produced more than 15% B-size tubers, both significantly more than the other 5 varieties.

Overall U.S. No. 1 tuber yields were highest for Michigan Purple, MSG227-2 and UEC varieties compared with and MSE192-8Rus, Snowden and W1201. Highest tuber yields were associated with narrow seed spacing and large tubers. The high fertilization rate of 270 lbs. N / acre did not improve total tuber yield or yield of U.S. No. 1 tubers over the 180 lbs. / acre fertilization treatments.

The recommended N fertilization rate of 180 lbs. / acre appears to provide an optimal amount of N for all of the varieties included in this experiment. Application of 270 lbs. N / acre resulted in luxury consumption of nitrate by the plant during the growing season, reflected by petiole NO_3-N levels, and excess soil NO_3-N after potato harvest compared with all 3 180 lbs. N treatments.

The combination of poultry manure and conventional fertilizer generally produced high yields for all potato varieties except MSG227-2. Manure treatment did not influence tuber nutrient content. The slow release fertilizer formulation produced slightly smaller tubers and a slight, non-significant decrease in yield. None of the fertilizer or manure treatments in this experiment adversely affect chip color or defects at harvest. Snowden chips had the fewest defects but also the lowest Agtron color compared with MSG227-2, UEC and W1201.

Poultry manure shows promise as a soil treatment for potatoes. Application of 2.5 T / acre improved yield and did not affect size, quality or nutrient composition of tubers or chips. Responses to manure were not similar to responses for slow release N fertilizer or to high rates of N fertilizer and may be related to soil organic matter or another non-nutrient effect.

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[1] Unknown Eastern Chipper (UEC) 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. Previously, 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 currently unknown. UEC seed that was used in this nitrogen management experiment in 2003 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.

[2] Helena Chemical Co., Collierville, TN.

Table 1. Yield of U.S. No. 1 tubers and proportion of B- and over-sized tubers as a percentage of total tuber yield for 6 potato varieties. Different superscripts indicate significant difference (p≤.05)

	US No. 1 (cwt/acre)		B-size (% of total yield)		Oversize (% of total yield	
	Wide	**Narrow**	**Wide**	**Narrow**	**Wide**	**Narrow**
Michigan Purple	317.5^{a}	354.9^{b}	3.5	4.0	19.8	19.2
MSE192-8Rus	254.3	247.1	12.9^{a}	17.8^{b}	15.8^{a}	9.4^{b}
MSG227-2	337.3	364.9	3.8^{a}	5.0^{b}	8.3^{a}	4.7^{b}
Snowden	303.9	305.6	6.0	6.1	9.1	8.3
UEC	296.9^{a}	367.7^{b}	1.9	2.1	43.6^{a}	35.9^{b}
W1201	308.2^{a}	344.7^{b}	2.6^{a}	4.0^{b}	17.1^{a}	13.3^{b}
Average	303.0^{a}	330.8^{b}	5.1^{a}	6.5^{b}	19.0^{a}	15.1^{b}

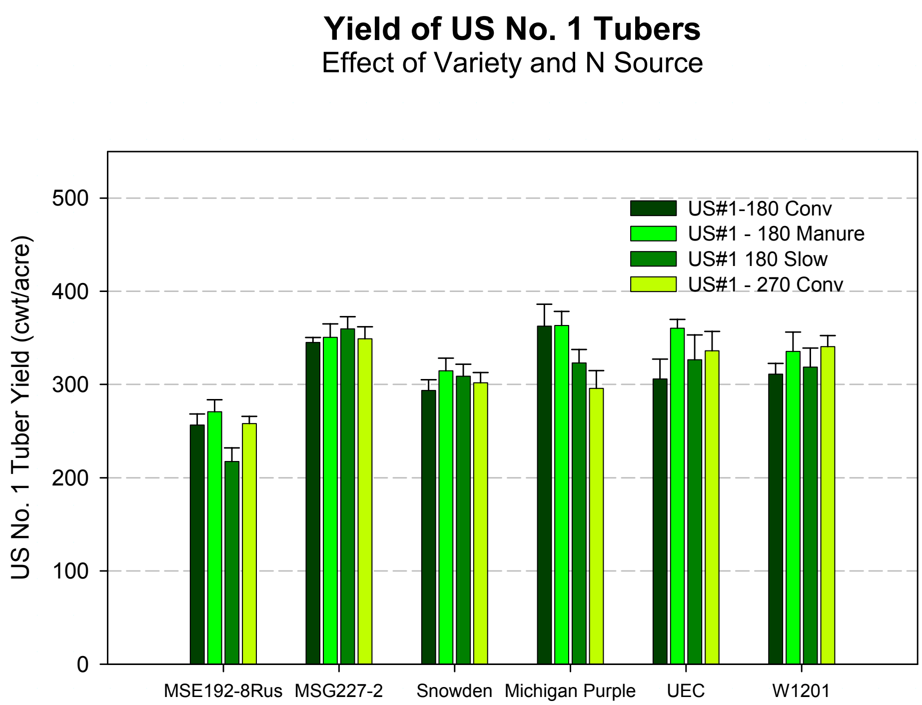
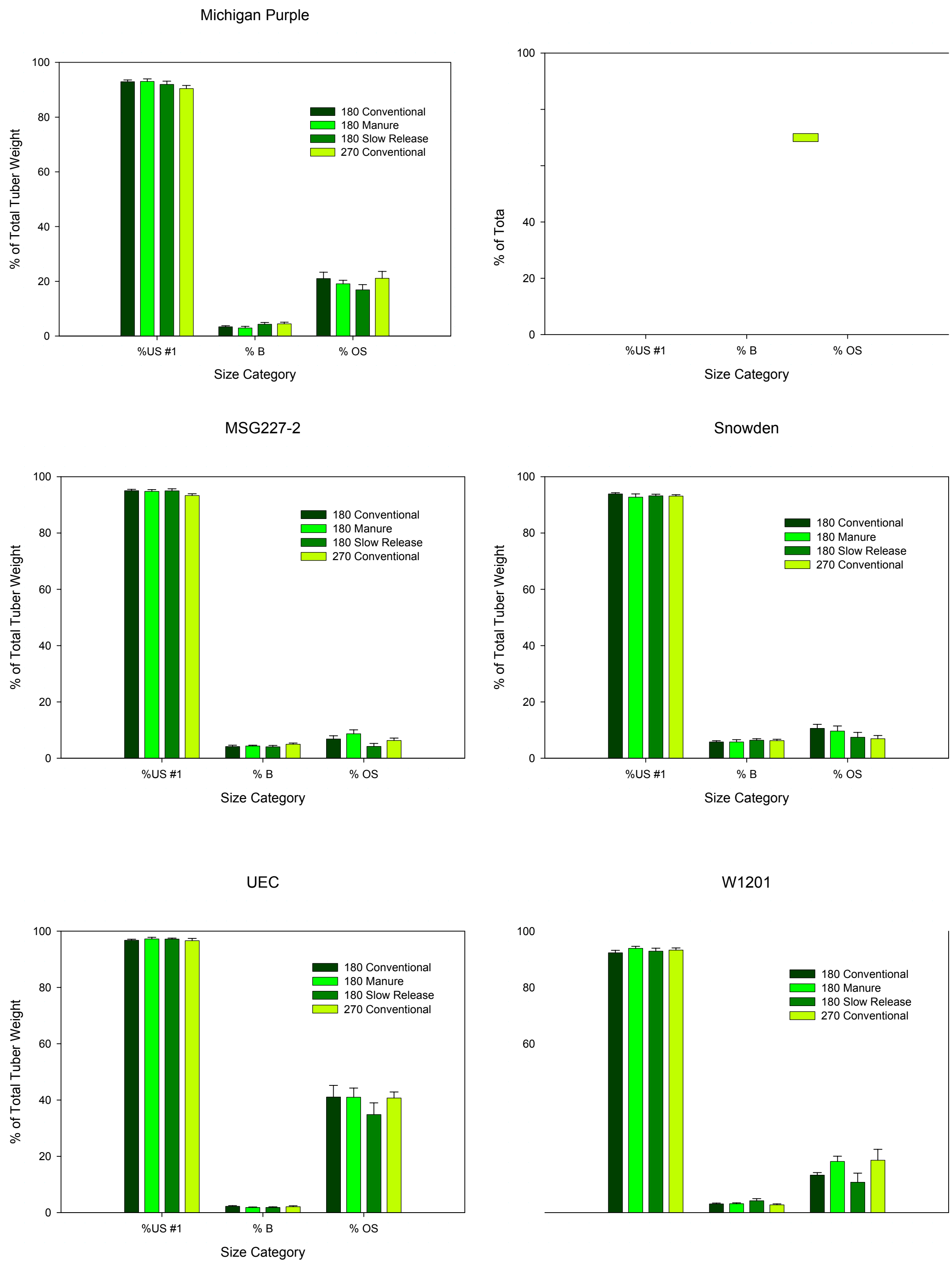


Figure 1. Yield of U.S. No. 1 tubers by variety for each of the 4 nitrogen fertilization treatments.



Figures 2a-f. Proportion of U.S. No. 1, B- and over-sized tubers as a percentage of total tuber yield by variety for each of the 4 nitrogen fertilization treatments.

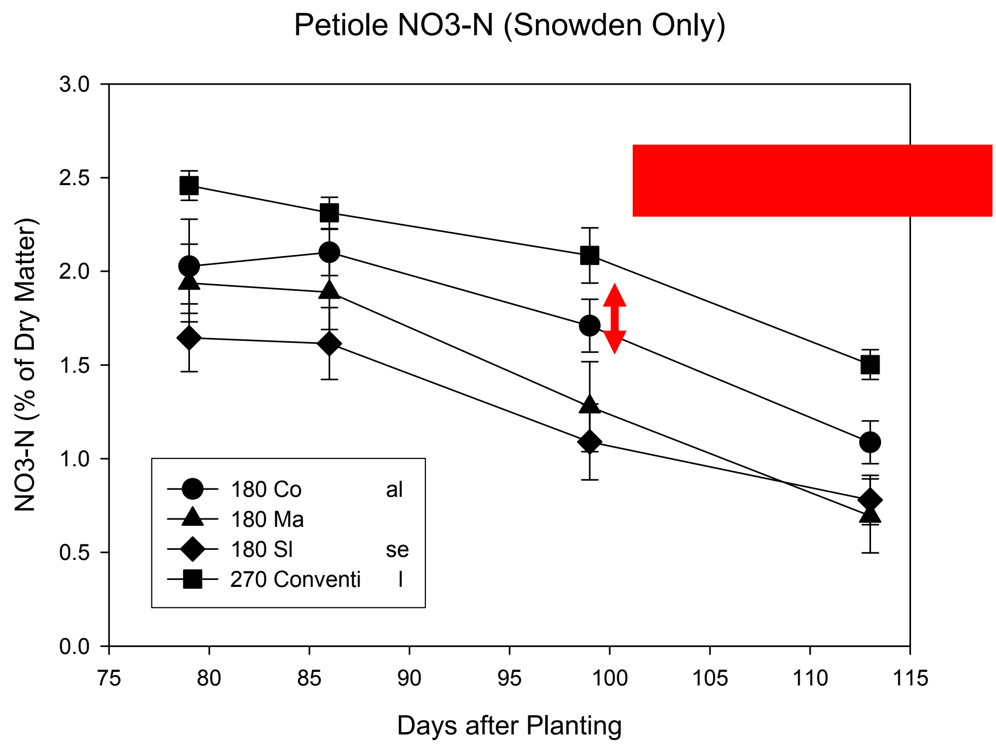


Figure 3. Petiole NO_3-N content during the growing season for Snowden plants seeded at wide spacing managed with one of four nitrogen fertilization treatments.

Table 2. Residual soil NO3-N and NH4-N at two depths in Snowden plots managed with one of four nitrogen fertilization treatments. Different superscripts indicate significant difference ($p \leq .05$)

Depth	**Nitrogen Treatment**	**NO_3-N (ppm soil)**	**NH_4-N (ppm soil)**
0-8"	180 Conventional	27.35^{a}	3.20
	180 Manure	27.45^{a}	4.30
	180 Slow Release	33.45^{ab}	3.40
	270 Conventional	46.03^{b}	3.33
		p=.0962	*p=.5426*
8-20”	180 Conventional	11.35^{a}	1.33
	180 Manure	13.10^{ab}	1.83
	180 Slow Release	12.23^{a}	1.48
	270 Conventional	18.35^{b}	1.20
		p=.0918	*p=.4848*

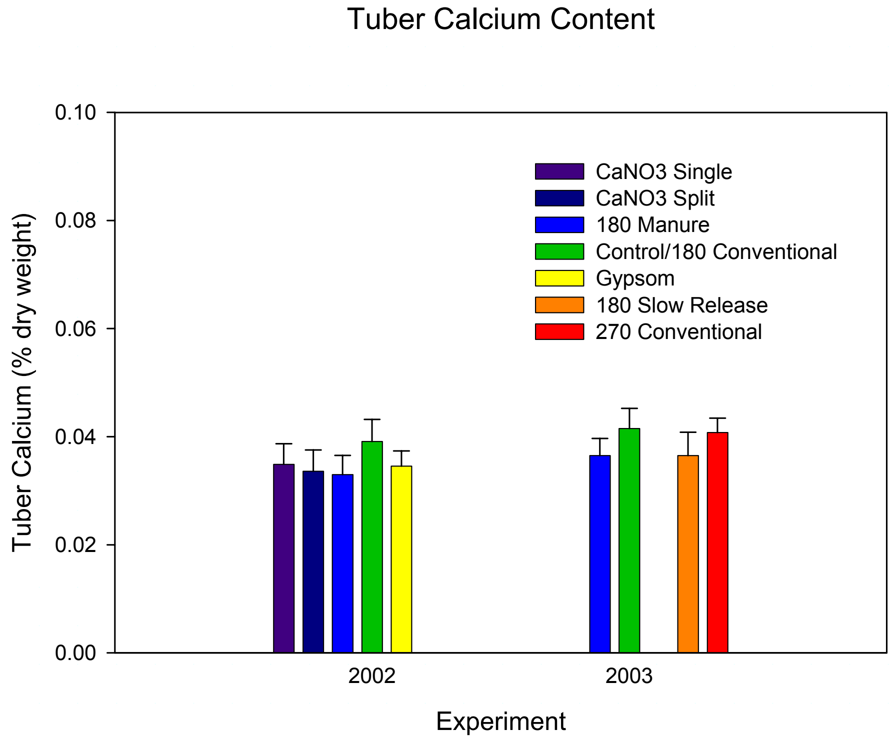


Figure 4. Tuber calcium content at harvest for Snowden variety across spacing treatment in 2003 and for Pike and FL1879 in 2002, managed with different fertilization treatments.

Table 3. Chip defects and Agtron color readings for each nitrogen fertilization treatment and chipstock variety. Different superscripts indicate significant difference (p≤.05)

	Defects (%)	**Agtron Color**
180# Conventional	17.2	59.01
180# Manure	16.7	59.10
180# Slow release	18.5	59.82
270# Conventional	13.2	59.94
	p=.1604	*p=.6999*
MSG 227-2	17.5^{b}	59.28^{ab}
Snowden	13.1^{a}	57.94^{a}
UEC	19.6^{b}	60.09^{b}
W 1201	15.5^{ab}	60.56^{b}
	p=.0330	*p=.0245*

Funding: Industry

POTATO (*Solanum tuberosum* L.>FL1879=)
Late blight; *Phytophthora infestans*

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Evaluation of fungicide programs for potato late blight control, 2003.

Potatoes [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 5 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 27 Jul. All fungicides in this trial were applied on a 7-day interval from 25 Jun to 20 Aug (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. Weeds were controlled by hilling and with Dual 8E (2 pt/A on 20 Jun), Basagran (2 pt/A on 20 Jun and 15 Jul) and Poast (1.5 pt/A on 28 Jul). Insects were controlled with Admire 2F (20 fl oz/A at planting on 15 Jun), Sevin 80S (1.25 lb/A on 1 and 28 Jul), Thiodan 3EC (2.33 pt/A on 1 and 21 Aug) and Pounce 3.2EC (8 oz/A on 28 Jul). Plots were rated visually for percentage foliar area affected by late blight on 27 Jul; 11, 18, 25 Aug and 4 [15 days after final application (DAFA), 41 days after inoculation (DAI)] and 11Sep (22 DAFA, 48 DAI) when there was 100% foliar infection in the untreated plots. The relative area under the disease progress curve was calculated for each treatment from date of inoculation, 25 Jul to 11 Sep, a period of 48 days. Vines were killed with Reglone 2EC (1 pt/A on 11 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 91.7 and 60.9 (Jun), 89.8 and 69.4 (Jul), 93.8 and 64.8 (Aug) and 85.5 and 61.7 (Sep). Maximum and minimum soil temperature (^{o}F) were 82.3 and 70.1 (Jun), 79.9 and 73.3 (Jul), 82.7 and 75.4 (Aug) and 77.4 and 68.4 (Sep). Precipitation was 0.8" (Jun), 0.37" (Jul), 0.56" (Aug) and 0.98" (Sep). The total number of late blight disease severity values (DSV) over the inoculation period was 126 and 39 (using 80% and 90% ambient %RH as bases for DSV accumulation), respectively. Plots were irrigated to supplement precipitation to about 1"/A/4 day period with overhead sprinkle irrigation.

Late blight developed slowly after inoculation then rapidly during Aug and untreated controls reached 100% foliar infection by 11 Sep. Taking 41 DAI as a key reference point, all fungicide programs reduced the foliar late blight significantly compared to the untreated control. Programs were not significantly different. Taking 48 DAI as a key reference point, there was almost complete defoliation of the untreated control due to late blight and all fungicide programs had significantly less foliar late blight than the untreated control. Programs with 23.8 - 32.5% foliar late blight; those with 15.8 to 23.8% foliar late blight; those with 8.8 to 17.8% foliar late blight; and those with 6.5 to 15.8% 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 48 DAI) compared to the untreated control. Application programs with RAUDPC values from2.09 to 4.78; those with RAUDPC values 1.65 to 4.36; and those with RAUDPC values 1.17 to 3.56 were not significantly different. Treatment 3 had significantly higher yield of US1-grade potatoes than the untreated control and programs with less than 298 cwt/A. Treatment 17 had significantly higher yield of US1-grade potatoes than programs with less than 282 cwt/A. There were no significant differences among any other treatments with respect to marketable yield. Treatment 3 had significantly higher total yield than programs with less than 298 cwt/A. Treatment 17 had significantly higher yield of US1-grade potatoes than programs with less than 335 cwt/A. There were no significant differences among any other treatments with respect to total yield. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar late blight (%) 41 DAI[a] 15 DAFA[b]		Foliar late blight (%) 48 DAI 22 DAFA		RAUDPC[c] Max = 100 0 - 48 DAI		Yield (cwt/A) US1		Yield (cwt/A) Total	
1 A13666 5.5SC 1.45 pt (A,C,E,G[d]); Bravo WS 6SC 1.5 pt (B.D,F,H)..	4.3	b[e]	11.8	de	1.98	cd	275	c	319	b
2 A13666 5.5SC 1.8 pt (A,C,E,G,); Bravo WS 6SC 1.5 pt (B.D,F,H)..	4.8	b	11.3	de	2.09	bcd	302	abc	354	ab
3 Quadris 2.08SC 0.4 pt + Bravo WS SC 1.5 pt (A,C,E,G); Bravo WS 6SC 1.5 pt (B.D,F,H)..	3.3	b	9.0	de	1.40	d	391	a	424	a
4 Amistar 80WDG 0.13 lb (A,C,E,G); Bravo WS 6SC 1.5 pt (B.D,F,H)..	12.5	b	22.0	c	4.36	bc	342	abc	392	ab
5 Polyram 80WP 2.0 lb (A,B,D,E) Acrobat 50WP 0.4 lb + Polyram 80WP 2.0 lb (C,F,H) Polyram 80WP 2.0 lb + Supertin 80WP 0.16 lb (G)………….....	4.3	b	11.3	de	1.82	cd	351	abc	410	ab
6 Dithane RS 75DF 1.5 lb (A,B,C,D,E,F,G,H)..............................	9.8	b	17.5	cd	3.56	bcd	357	abc	391	ab
7 Endura 70WDG 0.14 lb (A,C,E); Headline 2SC 0.77 pt (B,D); Bravo WS 6SC 1.5 pt (F,G,H)……...	8.0	b	17.8	cd	3.10	bcd	314	abc	366	ab
8 Endura 70WDG 0.14 lb (A,C); Headline 2SC 0.77 pt (B,E); Acrobat 50WP 0.4 lb + Polyram 80WP 2.0 lb (D); Bravo WS 6SC 1.5 pt (F,G,H)...	6.0	b	15.8	cde	2.53	bcd	309	abc	352	ab
9 Reason 500SC 0.34 pt + Bond 500SC 0.5 pt (A,B,C,D) Bravo WS 6SC 1.0 pt (E,F,G)...	11.5	b	32.5	b	4.74	b	336	abc	372	ab
10 Reason 500SC 0.51 pt + Bond 500SC 0.5 pt (A,B,C,D) Bravo WS 6SC 1.0 pt (E,F,G)...	4.5	b	7.3	e	1.65	cd	344	abc	385	ab
11 Previcur 500SC 0.7 pt + Bravo WS 6SC 1.0 pt (A,B,C,D,E,F,G,H)...................................	3.3	b	7.0	e	1.34	d	362	abc	413	ab
12 Previcur 500SC 0.7 pt + Bravo WS 6SC 1.0 pt (A,C,E,G); Bravo WS 6SC 1.5 pt (F,G,H)...	2.8	b	6.5	e	1.36	d	340	abc	397	ab
13 Previcur 500SC 1.2 pt (A,C,E,G); Bravo WS 6SC 1.5 pt (B,D,F,H)..	3.8	b	9.0	de	1.53	d	371	ab	423	a
14 Penncozeb 75DF 2.0 lb (A,B,C,D,E,F,G,H)................................	12.8	b	23.8	bc	4.78	b	339	abc	394	ab
15 Echo ZN 6SC 2.13 pt (A,B,C) Echo 720SC 1.5 pt + Gem 25DF 0.38 lb (D,E,F,G,H)…………	4.0	b	7.5	e	1.43	d	326	abc	377	ab
16 Echo ZN 6SC 2.13 pt (A,B,C,D,E,F,G,H)	2.5	b	7.0	e	1.17	d	336	abc	390	ab
17 Bravo WS 6SC 1.5 pt + Champ DP 4.6FL 2.67 lb (A,B,C,D) Dithane RS 75DF 1.5 lb + Champ DP 4.6FL 2.67 lb + Phostrol 53.6SC 8.0 pt. (E,F,G,H)………………………………	3.8	b	8.8	de	1.57	d	334	abc	382	ab
18 Bravo WS 6SC 1.5 pt + Champ DP 4.6FL 2.67 lb (A,B,C,D) Champ DP 4.6FL 2.67 lb + Phostrol 53.6SC 8.0 pt. (E,F,G,H)...	3.8	b	10.0	de	1.66	cd	336	abc	390	ab
19 Quadris 2.08SC 0.4 pt + Bravo WS SC 1.5 pt (A); Bravo WS 6SC 1.5 pt + Champ DP 4.6FL 2.67 lb (B,D); Acrobat 50WP 0.4 lb + Bravo WS SC 1.5 pt (C,G) Dithane RS 75DF 1.5 lb + Champ DP 4.6FL 2.67 lb + Agritin 80WDG 0.16 lb + Phostrol 53.6SC 8.0 pt. (E,F,H)........	3.3	b	9.5	de	1.52	d	305	abc	358	ab
20 Untreated...	62.5	a	100.0	a	20.21	a	282	bc	335	ab

[a] Days after inoculation with *Phytophthora infestans*, US8, A2.
[b] Days after final application of fungicide.
[c] RAUDPC, relative area under the disease progress curve calculated from day of inoculation to last evaluation of late blight.
[d] Application dates: A= 25 Jun; B= 2 Jul; C= 9 Jul; D= 16 Jul; E= 23 Jul; F= 30 Jul; G= 6 Aug; H= 13 Aug; I= 20Aug.
[e] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

Funding: Industry

POTATO (*Solanum tuberosum* L.'FL1879')	W. W. Kirk, R. L Schafer and D. Berry
Late blight; *Phytophthora infestans*	Department of Plant Pathology Michigan State University East Lansing, MI 48824

Evaluation of Ranman, EBDC and chlorothalonil-based programs for potato late blight control, 2003.

Potatoes [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 5 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 27 Jul. All fungicides in this trial were applied on a 7-day interval from 25 Jun to 20 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 20 Jun), Basagran (2 pt/A on 20 Jun and 15 Jul) and Poast (1.5 pt/A on 28 Jul). Insects were controlled with Admire 2F (20 fl oz/A at planting on 15 Jun), Sevin 80S (1.25 lb/A on 1 and 28 Jul), Thiodan 3EC (2.33 pt/A on 1 and 21 Aug) and Pounce 3.2EC (8 oz/A on 28 Jul). Plots were rated visually for percentage foliar area affected by late blight on 27 Jul; 11, 18, 25 Aug and 4 [15 days after final application (DAFA), 41 days after inoculation (DAI)] and 11Sep (22 DAFA, 48 DAI) when there was 100% foliar infection in the untreated plots. The relative area under the disease progress curve was calculated for each treatment from date of inoculation, 25 Jul to 11 Sep, a period of 48 days. Vines were killed with Reglone 2EC (1 pt/A on 11 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 91.7 and 60.9 (Jun), 89.8 and 69.4 (Jul), 93.8 and 64.8 (Aug) and 85.5 and 61.7 (Sep). Maximum and minimum soil temperature (^{o}F) were 82.3 and 70.1 (Jun), 79.9 and 73.3 (Jul), 82.7 and 75.4 (Aug) and 77.4 and 68.4 (Sep). Precipitation was 0.8" (Jun), 0.37" (Jul), 0.56" (Aug) and 0.98" (Sep). The total number of late blight disease severity values (DSV) over the inoculation period was 126 and 39 (using 80% and 90% ambient %RH as bases for DSV accumulation), respectively. Plots were irrigated to supplement precipitation to about 1"/A/4 day period with overhead sprinkle irrigation.

Late blight developed slowly after inoculation then rapidly during Aug and untreated controls reached 100% foliar infection by 11 Sep. Taking 41 DAI as a key reference point, all fungicide programs reduced the foliar late blight significantly compared to the untreated control. Programs with less than 8.5 - 13.0% foliar late blight; those with 6.5 to 11.8% foliar late blight; and those with 3.8 to 8.5% foliar late blight were not significantly different. Taking 48 DAI as a key reference point, there was almost complete defoliation of the untreated control due to late blight and all fungicide programs had significantly less foliar late blight than the untreated control. Programs with 23.8 - 26.3% foliar late blight; and those with 10.0 to 16.5% 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 48 DAI) compared to the untreated control. Application programs with RAUDPC values below 2.84 to 4.51; those with RAUDPC values 2.73 to 4.2; and those with RAUDPC values 1.88 to 2.86 were not significantly different. There were no significant differences among treatments with respect to marketable or total yield. Phytotoxicity was not noted in any of the treatments.

	Treatment and rate/acre	Foliar late blight (%) 41 DAI[a] 15 DAFA[b]		48 DAI 22 DAFA		RAUDPC[c] Max = 100 0 - 48 DAI		Yield (cwt/A) US1	Total
1	Bravo ZN 6SC 2.13 pt (A,B,C,D,E,F,G,H,I)[d]...	5.8	d[e]	13.0	c	2.43	d	372	410
2	Equus SC 1.5 pt (A,B,C,D,E,F,G,H,I)..	6.5	cd	12.5	c	2.73	cd	337	395
3	Ranman 40SC 0.13 pt + Silwet 6SC 0.1 pt (A,B,C,D,E,F,G,H,I)............	3.8	d	13.8	c	1.88	d	345	380
4	Dithane RS 75DF 1.5 lb (A,C,E,G,I); Ranman 40SC 0.17 + Silwet I-77 6SC 0.1 pt (B,D,F,H)..........................	13.0	b	26.3	b	4.51	b	334	383
5	Bravo WS 6SC 1.5 pt (A,C,E,G,I); Ranman 40SC 0.13 pt + Silwet 6SC 0.1 pt (B,D,F,H)............................	7.0	cd	16.3	c	2.79	cd	351	411
6	Bravo WS 6SC 1.5 pt (A,E); Headline 2SC 0.77 pt (B); Ranman 40SC 0.13 pt + Silwet 6SC 0.1 pt (C,F,H,I); Omega 5SC 0.5 pt (D,G)...	5.0	d	10.8	c	1.97	d	357	391
7	Bravo WS 6SC 1.5 pt (A,B,G,I); Omega 5SC 0.5 pt (C,E); Ranman 40SC 0.13 pt + Silwet6SC 0.1 pt (D,F,H)................................	5.0	d	10.0	c	1.93	d	302	336
8	Bravo WS 6SC 1.5 pt (A,B,C,D,E,F,G,H,I)..	7.3	cd	14.5	c	2.84	bcd	343	388
9	Gavel 75DF 2.0lb (A,B,F,G,H,I); Dithane RS 75DF 1.5 lb (C,D,E)........	8.5	bcd	16.5	c	2.86	bcd	334	382
10	Dithane RS 75DF 1.5 lb (A,B,C,D,E,F,G,H,I)...	11.8	bc	23.8	b	4.21	bc	336	390
11	Untreated..	76.3	a	100.0	a	22.83	a	305	358
sem P = 0.05[f]								19.7	21.3

[a] Days after inoculation with *Phytophthora infestans*, US8, A2.
[b] Days after final application of fungicide.
[c] RAUDPC, relative area under the disease progress curve calculated from day of inoculation to last evaluation of late blight.
[d] Application dates: A= 25 Jun; B= 2 Jul; C= 9 Jul; D= 16 Jul; E= 23 Jul; F= 30 Jul; G= 6 Aug; H= 13 Aug; I= 20Aug.
[e] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).
[f] Standard error of least squares mean at P = 0.05 if no significant difference among means.

Funding: Industry

POTATO (*Solanum tuberosum* L.'Russet Norkotah')
Brown spot; *Alternaria alternata*

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Evaluation of fungicide programs for control of brown spot, 2003.

Potatoes [cut seed, treated with Maxim MZ 0.5D (0.5 lb/cwt), unless stated] were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 5 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 25 Jun to 20 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 20 Jun), Basagran (2 pt/A on 20 Jun and 15 Jul) and Poast (1.5 pt/A on 28 Jul). Insects were controlled with Admire 2F (20 fl oz/A at planting on 15 Jun), Sevin 80S (1.25 lb/A on 1 and 28 Jul), Thiodan 3EC (2.33 pt/A on 1 and 21 Aug) and Pounce 3.2EC (8 oz/A on 28 Jul). Plots were rated visually for percentage foliar area affected by brown spot on 25 Aug and 1, 8 and 15 Sep [4, 11 and 18 days after final application (DAFA)] when there was 30% foliar infection in the untreated plots. Vines were killed with Reglone 2EC (1 pt/A on 15 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 91.7 and 60.9 (Jun), 89.8 and 69.4 (Jul), 93.8 and 64.8 (Aug) and 85.5 and 61.7 (Sep). Maximum and minimum soil temperature (^{o}F) were 82.3 and 70.1 (Jun), 79.9 and 73.3 (Jul), 82.7 and 75.4 (Aug) and 77.4 and 68.4 (Sep). Precipitation was 0.8" (Jun), 0.37" (Jul), 0.56" (Aug) and 0.98" (Sep). Plots were irrigated to supplement precipitation to about 1"/A/4 day period with overhead sprinkle irrigation.

Brown spot developed slowly during Aug and untreated controls reached 30% foliar infection by 4 Sep. Brown spot first appeared on 25 Aug and fungicide programs 2, 3, 4, 9, 10 and 11 reduced brown spot significantly compared to the untreated control. Other programs were not significantly different from the untreated control. By 1 Sep, 4 days after the final fungicide application (DAFA), all fungicide programs except treatment 8 had significantly less foliar brown spot than the untreated control. Treatment 8 was not significantly different from any other treatment. On 8 Sep, 4 DAFA, all fungicide programs except treatment 8 had significantly less foliar brown spot than the untreated control. Programs with less than 4% foliar brown spot (2, 3, 4, 9, 10 and 11) had significantly less brown spot than program 8 (11.3% foliar brown spot). At the final evaluation on 15 Sep (18 DAFA), all programs were significantly different from the untreated control. Programs 2, 3, 4, 9 and 10 had significantly less foliar brown spot than treatment 8 but were not significantly different from any other program. No treatments had significantly different yield from the untreated control but treatment 3 had significantly greater US1 yield than treatment 1. No programs had significantly greater total yield compared to the untreated control. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar Brown Spot (%)[a] 25 Aug		1 Sep 4 DAFA[b]		8 Sep 11 DAFA		15 Sep 18 DAFA		Yield (cwt/A) US1		Total	
1 Tanos 50WDG 0.25 lb + Manzate 200DF 1.5 lb (A,C,E,F[c]) ; Manzate 200DF 2.0 lb (B,D,G,H)..	0.4	ab[d]	1.0	b	4.0	bc	6.8	bc	258	b	319	c
2 Tanos 50WDG 0.25 lb + Manzate 200DF 1.5 lb (A,C,E,F); Bravo WS 6SC 1.5 pt (B.D,F,H)..	0.1	b	0.8	b	2.8	c	6.0	c	283	ab	354	abc
3 Tanos 50WDG 0.38 lb + Manzate 200DF 1.5 lb (A,C,E,F); Manzate 200DF 2.0 lb (B,D,G,H)..	0.0	b	0.3	b	1.8	c	4.8	c	367	a	424	ab
4 Tanos 50WDG 0.38 lb + Manzate 200DF 1.5 lb (A,C,E,F); Bravo WS 6SC 1.5 pt (B.D,F,H)..	0.0	b	0.5	b	3.0	c	5.3	c	321	ab	392	abc
5 Tanos 50WDG 0.5 lb + Manzate 200DF 1.5 lb (A,C,E,F); Manzate 200DF 2.0 lb (B,D,G,H)..	0.3	ab	1.0	b	4.0	bc	9.5	bc	329	ab	410	ab
6 KQ 667 68.75WDG 1.5 lb (A,C,E,F); Bravo WS 6SC 1.5 pt (B.D,F,H)..	0.5	ab	2.0	b	4.3	bc	8.8	bc	334	ab	391	abc
7 Quadris 2.08SC 0.4 pt (A,C,E,F); Bravo WS SC 1.5 pt (B.D,F,H)..	0.3	ab	1.5	b	4.5	bc	8.8	bc	296	ab	352	abc
8 Bravo WS 6SC 1.5 pt (A,B,C,D,E,F,G,H)..................................	0.8	ab	3.5	ab	11.3	ab	16.8	b	287	ab	345	bc
9 Headsup 100DF 0.0025 lb (ST)..	0.0	b	0.5	b	2.5	c	5.3	c	359	a	439	a
10 Headsup 100DF 0.0025 lb (ST) Headsup 100DF 0.21 lb (A)..	0.1	b	0.3	b	1.9	c	6.3	c	327	ab	398	abc
11 Headsup 100DF 0.21 lb (A)..	0.1	b	0.8	b	3.0	c	7.5	bc	330	ab	417	ab
12 Untreated...	1.3	a	7.0	a	16.3	a	30.0	a	298	ab	369	abc

[a] Percent foliar brown spot (rolling average through each plot, mean of 8 evaluations taken every 3 ft).
[b] Days after final application of fungicide.
[c] Application dates: A= 25 Jun; B= 2 Jul; C= 9 Jul; D= 16 Jul; E= 23 Jul; F= 30 Jul; G= 6 Aug; H= 13 Aug; I= 20Aug.
[d] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

Funding: MPIC

Summary Report for the 2002-2003 Dr. B. F. (Burt) Cargill Potato Demonstration Storage

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Introduction

This is a summary report of the 2002-2003 Dr. B.F. (Burt) Cargill Potato Demonstration Storage Annual Report Volume 2. This report is designed to provide a short summary of the 2002-2003 storage committee activities. To obtain a copy of the full 2002-2003 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.

Summary and Highlights

The 2002 growing season resulted in a lower than average specific gravity with some internal tuber defects such as stem discoloration in the finished product. The harvest season was generally dry and resulted in lower incidents of storage diseases being reported.

The 2002-2003 storage season was an opportunity for the Storage and Handling committee to continue the objectives established in 2001-2002. Liberator (MSA091-1), UEC* and W1201 were evaluated in a 500 cwt. bulk bin for the first time as a result of their performance in the box bins in 2001-2002. Liberator was shipped to Shearer's Food Inc., Brewster, Ohio on April 10, 2003. The chips scored a 57.1 Agtron, 5% total chip defects and 1.083 raw product gravity. Based on these results, two 500 cwt. bulk bins of Liberator will be evaluated in the 2003-2004 storage season. Each bin will have a different storage temperature profile. MSF099-3 was evaluated for a second time in a 500 cwt. bulk bin. Based on this variety's common scab susceptibility, progress has slowed in its' commercialization. UEC was quite surprising as the average yield for this variety in 2002 was 500 cwt./A over the two acres planted. The storage life of the tubers quickly ran out in late February and the tubers were sent to Herr Foods, Knotingham, PA. on March 4, 2003. Specific gravity was 1.078, which was lower than desired. The Agtron score was 64.5 with 7% minor defects present and some salt and pepper chip color noted, due to the mature nature of the tubers in storage. Overall, we are quite pleased with this variety and plan to have two 500 cwt. bulk bins in the 2003-2004 storage season to evaluate two separate planting / harvest dates. W1201 had an above average yield in 2002 at 425 cwt./A. This bulk bin was shipped to Utz Quality Foods Inc., Hanover, PA on April 10, 2003. The specific gravity was 1.087. The Agtron score was 63.9 with 0% chip defects. W1201 had a very nice gravity during a marginal gravity year in Michigan. This was encouraging to the committee. Seed availability has been a problem for us to move forward with this variety. W1201 is scheduled for the storage in 2003-2004.

The box bin storage has not revealed any new varieties that we want to move ahead with in 2003-2004. We will continue to evaluate new chip processing lines in 2003-2004 in hopes of finding something new for the 2004-2005 storage season.

Unknown Eastern Chipper (UEC)*

*Unknown Eastern Chipper (UEC) 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 currently unknown. **UEC seed that was tested in the 2001-2002 and 2002-2003 Cargill Potato Demonstration Storage Annual Report Volumes 1 and 2 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.