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Michigan State University

Agricultural Experiment Station

IN COOPERATION WITH THE MICHIGAN POTATO INDUSTRY COMMISSION

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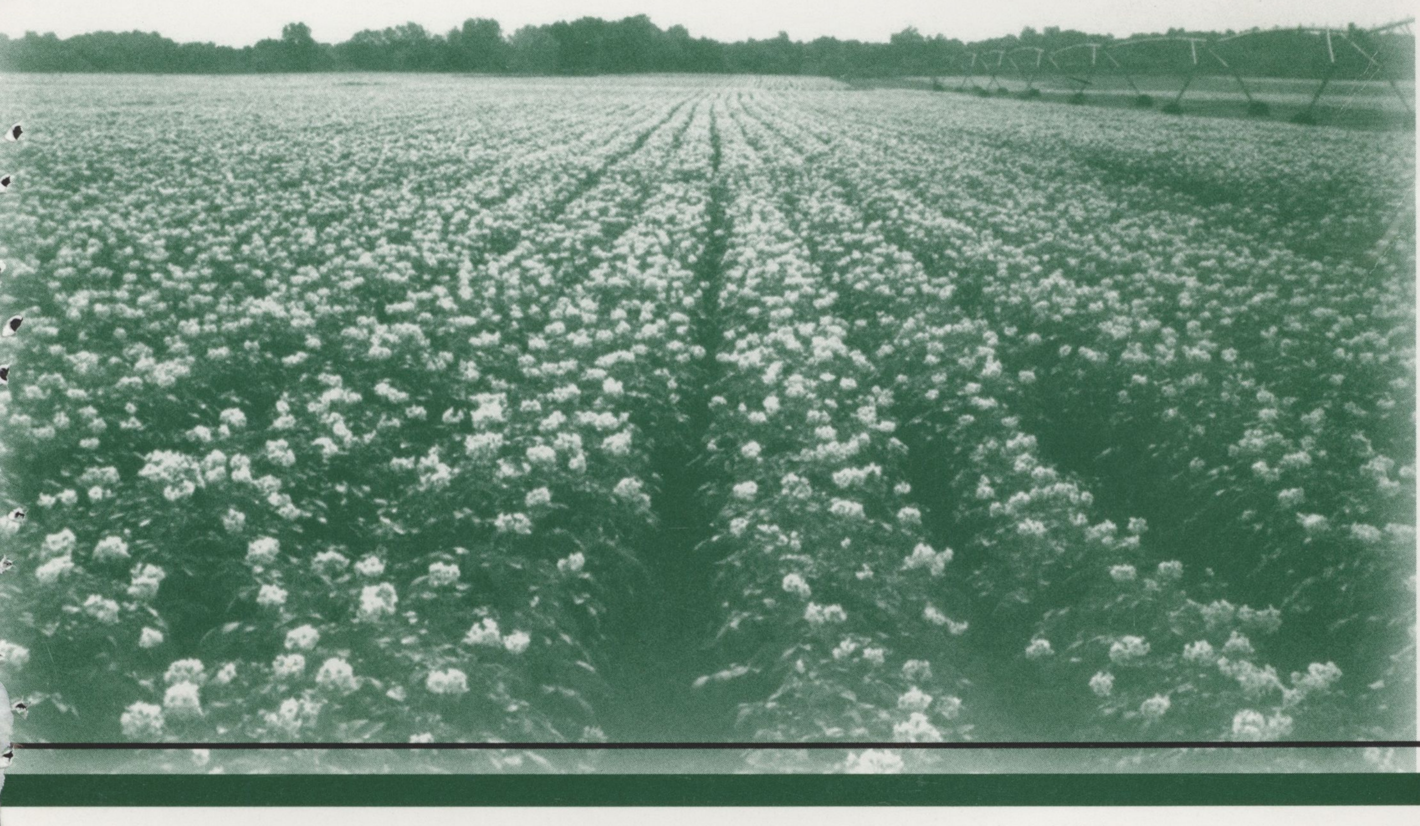
MICHIGAN POTATO RESEARCH REPORT

Volume 33



THE MICHIGAN POTATO INDUSTRY COMMISSION

February 1, 2002

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 2001 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 2001 season.

The Michigan Potato Industry Commission

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TABLE OF CONTENTS

PAGE

2001 MICHIGAN POTATO RESEARCH REPORT

C. M. Long, Coordinator

INTRODUCTION AND ACKNOWLEDGMENTS

The 2001 Potato Research Report contains reports of the many potato research projects conducted by MSU potato researchers at several locations. The 2001 report is the 33rd 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 Don Smucker, Montcalm CED for maintaining the weather records from the MRF computerized weather station. Also, we want to recognize Barb Smith at MPIC for helping with the details of this final draft.

WEATHER

On average, the weather during the 2001 growing season was warmer than 2000, but very close to the 15-year average (Table 1). There were 14 days that the temperature reached 90°F or above and 7 days in April that the temperature was below 32°F. The average minimum temperature in August, 2001 was 70 F. This would indicate that nighttime temperatures remained higher then desired during this period of tuber bulking possible resulting in a lower specific gravity at harvest.

Rainfall for April through September was 25.55 inches which is over 4.5 inches above the 15 year average (Table 2). Rainfall recorded during the month of May was the highest in 15 years. Irrigation at MRF was applied 12 times from June 19th to August 14th averaging 0.53 inches for each application. The total amount of irrigation water applied during this time period was 6.35 inches.

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

	April		May		June		July		August		September		6-Month Average	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1987	61	36	77	46	80	56	86	63	77	58	72	52	76	52
1988	52	31	74	46	82	53	88	60	84	61	71	49	75	50
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**
15 Year Average	56	34	69	45	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
1987	1.82	1.94	0.84	1.85	9.78	3.32	19.55
1988	1.82	0.52	0.56	2.44	3.44	5.36	14.14
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**
15 Year Average	3.04	3.29	3.50	3.22	4.79	3.09	20.92

GROWING DEGREE DAYS

Table 3 summarizes the cumulative, base 50°F growing degree days (GDD) for May through September. The total GDD for 2001 were 2,379, approximately 145 GDD higher than 2000, and slightly higher then the 10-year average.

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

	Cumulative Monthly Totals				
Year	May	June	July	August	September
1992	282	718	1210	1633	1956
1993	261	698	1348	1950	2153
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
10 Year Average	266	763	1355	1909	2233

*1992 data calculated from Vestaburg weather station in Montcalm County (Dr. Jeff Andresen, Geography). 1993-2001 data from the weather station at MSU Montcalm Research Farm (Don Smucker, Montcalm County Extension Director).

PREVIOUS CROPS, SOIL TESTS AND FERTILIZERS

The general potato research area was planted to rye in the fall of 1999 which was disked down in the spring 2000. Soybeans were grown during the summer. The area was fumigated in the fall. Rye was over seeded with a poor stand resulting in part to the fumigation. The rye was disked and the field fitted for potato planting spring 2001. Potato early die was not a problem in 2001 due in part to fumigation.

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

	lbs/A			
pH	P_2O_5	K_2O	Ca	Mg
6.1	480	290	947	250

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 ($N-P_2O_5-K_2O$)
Broadcast at plow down	0-0-60	200 lbs/A	0-0-120
At planting	16-22-0	18 gpa	32-44-0
At emergence	46-0-0	135 lbs/A	62-0-0
1st Early side dress	46-0-0	200 lbs/A	92-0-0
2nd Late side dress (late varieties)	46-0-0	200 lbs/A	92-0-0

HERBICIDES AND PEST CONTROL

Hilling was done in late May, followed by a pre-emergence application of Turbo 8EC at 2.5 pints/A.

Admire was applied at planting at a rate of 13.6 oz/A. Cygon was applied once in July at 1 pint/A. Fungicides used were Bravo ZN, Previcur and Polyram 80DF over 14 applications.

2001 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 at MSU research locations and on grower fields. Through conventional crosses, we develop new genetic combinations in the breeding program, 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. In addition, our program utilizes genetic engineering as a tool to introduce new genes to improve varieties and advanced germplasm. 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. 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, over 500 crosses are made using 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. Approximately 35,000 seedlings are grown annually for visual evaluation 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 for specific gravity and chip processing. These selections each represent a potential variety. This system of generating new seedlings is the initial step towards the development of new varieties and is an on-going process in the MSU potato breeding program. This step is followed by evaluation and selection at the 8-hill and 20-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.

II. Evaluation of Advanced Selections for Extended Storage

In 1999, the Michigan Potato Industry Commission constructed a demonstration storage facility, representing the latest in industry storage technology, to evaluate management systems to achieve extended storage of potatoes for chip-processing. We chose our advanced selections to be stored in this facility to evaluate chip-processing under commercial-type storage conditions. Tuber samples of our elite chip-processing selections were placed in the demonstration storage facility in October and were sampled monthly to determine their ability to chip-process from 42°F or 50°F storage.

III. Germplasm Enhancement

In supplement to the varietal breeding program, we have a "diploid" (2x 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. In general, diploid breeding utilizes haploids (half the chromosomes) from potato varieties, and diploid wild and cultivated tuber-bearing relatives of the potato. These represent a large source of valuable germplasm, which can broaden the genetic base of the cultivated potato and also provide specific desirable traits such as tuber dry matter content, cold chipping and dormancy, along with resistance to disease, insects, and virus. 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. The diploid breeding program germplasm base at MSU is a synthesis of six species: *S. tuberosum* (adaptation, tuber appearance), *S. phureja* (cold-chipping, specific gravity), *S. tarijense* and *S. berthaultii* (tuber appearance, insect resistance), *S. microdontum* (late blight resistance) and *S. chacoense* (specific gravity, low sugars, dormancy and leptine-based insect resistance).

IV. Integration of Genetic Engineering with Potato Breeding

Genetic engineering offers 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 is set up to use *Agrobacterium*-mediated transformation to introduce genes into important potato cultivars and advanced breeding lines. We presently have genes in vector constructs that confer resistance to PVY, Colorado potato beetle, potato tuber moth, broad-spectrum disease resistance via the glucose oxidase (GO) gene, late blight resistance with the resveratrol synthase (RS) and divinyl ether synthase (DES) genes, and cold/frost resistance (COR15). 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.

V. Variety Release

The MSU breeding program, under the direction of David Douches, 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.

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 2001 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. During the 2001 harvest, over 1500 selections were made from the 30,000 seedlings grown at the Montcalm Research Farm. 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 2002 directly out of 42°F and 50°F storage. This storage period allows enough time for reducing sugars to accumulate in these selections. 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 chipping potential. **Table 2** lists some of the potential lines for grower trials in year 2001.

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. 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. We have made various hybrid combinations with these parents from which to pyramid cold-chipping traits, and the hybrid populations have been grown out, selected and evaluated. We now have advanced into the crossing block these new MSU selections that have chip quality directly out of 42°F storage. Examination of pedigrees shows up to three different cold-chipping germplasm sources have been combined in these selections. Promising chip-processing lines are MSF099-3 (42°F chipper), MSG227-2 (scab resistant 45°F chipper), MSH095-4, MSH094-8 and MSH067-3. **Attachment 1** summarizes the most promising, advanced chip-processing selections in the MSU potato breeding program for which seed is available.

Tablestock

One of our objectives is also to develop improved cultivars for the tablestock industry. Efforts have been made to identify lines with good appearance, low internal defects, high marketable yield and resistance to scab. From our 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 selections that carry many of the characteristics mentioned above. We are also looking 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 2001, while others were tested under replicated conditions at the Montcalm Research Farm. Promising tablestock lines include MSF373-8, a high yielding line with large tubers that also chip out of the field. MSE221-1 is a scab resistant tablestock, while MSE018-1 is a high yielding tablestock with a large oval shape. MSE192-8RUS and MSE202-3RUS are two russet table selections that have excellent type and scab resistance. MSE149-5Y, MSI005-20Y and MSJ033-6Y are yellow-fleshed lines with smooth round appearance and high yield potential. **Attachment 2** summarizes the most promising tablestock selections in the MSU potato breeding program. 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.

Disease and Insect Resistance Breeding

Significant advancement has also been made in development of individuals with disease (scab and late blight) and insect (Colorado potato beetle) resistance. Results from the MSU scab nursery indicate that 13 of the 225 lines evaluated demonstrated strong resistance (no evidence of infection) to common scab in 2001. In addition, 11 other MSU breeding lines showed moderate scab resistance. 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.

Since the re-emergence of late blight in the mid-1990's the US breeding programs have directed efforts to identify sources of late blight resistance and use this resistance to develop late blight resistant varieties. At MSU, we have 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 five years the MSU breeding program has intensely evaluated over 500 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. As of 2001, based upon five years of inoculated field experiments, we have at least eight sources of foliar resistance to the US8 genotype of *Phytophthora infestans* (Mont.) that have different pedigrees from which their resistance is derived. In addition, these sources can be used via conventional crossing. 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.

We have been able to identify numerous selections that have resistance derived from different late blight resistance sources, potential chip-processing quality, and genetic variation for vine maturity. In 2001, the percentage of individuals with late blight resistance has increased from previous years. Strong late blight disease pressure from inoculated trials at the Muck Soils Research Farm yielded 21 early generation and up-and-coming MSU breeding lines (from over 200 lines tested in the trial) that demonstrated strong resistance to foliar infection. **Table 1** summarizes the preliminary agronomic performance of a group of selections that show late blight resistance based upon the early generation late blight trial at the Muck Soils Research Farm. We have identified 13 advanced selections with foliar late blight resistance and good agronomic performance. Seven of these late blight resistance lines have chip-processing potential. Five of the 13 lines have tuber resistance to late blight. In each of these lines, the resistance is based on a single resistance source. Our efforts are now focusing on pyramiding the different resistance sources.

Single-hill selections in 2001 also had an exciting number of individuals with pedigrees for potential late blight and Colorado potato beetle resistance and both. During January and February of 2002, we will be testing 357 lines for late blight resistance in the greenhouse chamber and 88 lines for resistance to feeding by Colorado potato beetle in detached-leaf bioassays. We also selected lines with potential resistance to both late blight and Colorado potato beetle.

II. Evaluation of Advanced Selections for Extended Storage

MSU Potato Breeding Chip-processing Results From the MPIC Demonstration Commercial Storage (November - June 2001)

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. This past fall we initiated 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 2000, tuber samples from eight lines in the Montcalm Research Farm trials were placed in the bin to be cooled to 42°F. Tubers from another 10 lines were placed in the Pike bin that was to be cooled then held at 52°F. The first samples were chip-processed at MSU in November and then, each month until June 2001. Samples were evaluated for chip-processing color and quality.

Table 3 summarizes the chip-processing color of select lines over the 8-month storage season. In the 42°F bin, Snowden was the check variety. In April the chip color of the Snowden chips went off-color. In contrast, MSF099-3, MSG227-2, MSH094-8, MSI111-A and NY112 maintained acceptable chip color until the June 2001 sampling.

Of these lines, MSF099-3 and MSH094-8 maintained the lightest chip color throughout the storage season. Chip-processing ability of MSF099-3, MSG227-2 and NY112 was also observed during the previous year's storage study in the inaugural year in the Demonstration Storage Facility. MSF099-3 and MSG227-2 are two MSU lines that are being considered for commercial release in 2002.

In the 52°F bin Atlantic and Pike were used as check varieties and both varieties chip-processed acceptably during the storage season. Of the eight advanced breeding lines evaluated, MSA091-1 (Liberator), MSE018-1, P83-11-5 and MSF373-8 chip-processed acceptably throughout the storage season. Pike and MSA091-1 had the most consistent and lightest chip color throughout the storage season.

We are excited by the results obtained from the Demonstration Storage bins. The results of this storage season concur with the previous year's data. MSF099-3 shows great promise because of its excellent chip color and low defects over extended cold storage. MSG227-2 combines strong scab tolerance with acceptable chip quality and low defects. MSA091-1 is being released as scab resistant chipper and is being named Liberator. MSH094-8 and MSI111-A are some recent selections that will continue to be evaluated.

III. Germplasm Enhancement

In 2001, about 10% of the populations evaluated as single hills were diploid. From this breeding cycle, we plan to screen the selections through the three-tier storage temperature evaluation for chip-processing. 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 late blight, potato early die, cold-chipping, and Colorado potato beetle. 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. In the fall of 2000, we made selections from 3,000 progeny that were segregating for leptine synthesis and day length adaptation and then evaluated processing quality of the selections and the leptine levels in the foliage (via HPLC analysis) during the winter.

These selections were then cycled into the crossing block for the winter 2001. Also added to the germplasm pool for crossing was a Verticillium resistant selection from *S. berthaultii*. This fall we were able to identify 10 selections that have chip-processing quality, late blight resistance and high tuber yields. These lines are also being added to the crossing block. This overall germplasm enhancement effort is the base from which long-term genetic improvement of the potato varieties in the MSU breeding program is generated.

Late Blight Breeding and Genetics:

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.

Mapping Late Blight Resistance and other Agronomic Traits in a {[(*Solanum tuberosum* x *S. chacoense*) x *S. phureja*] x *S. microdontum*} Population

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. The progeny of 110 clones and the parents were tested at the Muck Soils Research Farm, Bath, MI in 1999 and 2000 for foliar late blight reaction using a mixture of complex races of US8/A2 mating type of *P. infestans*. Disease severity was quantified as the relative area under the disease progress curve based upon the percentage of foliar infection over time. The same population was also evaluated at Montcalm Research Farm, Entrican, MI for maturity, tuber number and size, yield, tuber appearance, specific gravity, and chip color. This clone of *S. microdontum* transmitted high levels of resistance to late blight to a high percentage of the offspring. High phenotypic correlation ($r = 0.89$, $P < 0.0001$) was found for late blight reaction between years and no correlation was found between late blight with any other evaluated trait. A major QTL associated with foliar late blight resistance was located at the same position in linkage group 21 in both years of field testing. A QTL associated with vine maturity was mapped to linkage group 3. A QTL associated with tuber appearance was mapped to linkage group 1, one QTL associated with specific gravity was mapped to chromosome III and two QTLs associated with chip color were mapped to chromosomes VII and X. The major QTL associated with late blight resistance is suitable for marker-assisted selection to introgress a new source of resistance to *P. infestans* to the cultivated tetraploid germplasm of potato.

In addition, we are collaborating with the Scottish Crops Research Institute on this gene mapping project so that we can draw their expertise and experience in this area of research. During the summer of 2001, a trip to Scotland led to further AFLP marker analysis in the 4x late blight mapping population (MSG274-3 X MSG227-2). We are also continuing to use SSR markers. The advantage of the specific SSRs we are using is that they were previously identified to be linked to late blight resistance genes in other potato lines.

IV. Integration of Genetic Engineering with Potato Breeding

The program has been conducting transformations of potato to introduce a variety of transgenes. Currently we have genetically engineered plants that express the *Bt-cry3A* gene to control the Colorado potato beetle, the glucose oxidase and resveratrol synthase genes for disease resistance, and the AGPase gene for low sugars and high solids.

Assessment of Natural (Glandular Trichomes and Glycoalkaloid-Based) and Engineered (*Bt-cry3A*) Potato Host Plant Resistance Mechanisms for Control of Colorado Potato Beetle

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. Field studies were conducted in 2000 and 2001 to compare natural (glandular trichomes and glycoalkaloid-based), engineered (*Bt-cry3A*), and combined (glandular trichomes + *Bt-cry3A* and glycoalkaloids + *Bt-cry3A* transgenic potato lines) host plant resistance mechanisms of potato for control of Colorado potato beetle. Twelve different potato lines representing five different host plant resistance mechanisms were evaluated in a choice situation under natural Colorado potato beetle pressure at the Montcalm Research Farm in Entrican, Michigan and the Long Island Horticultural Research and Extension Center in Riverhead, New York. Treatment plots were planted in rows alternating between susceptible guard rows in a randomized complete block design consisting of four replications of ten plants each. 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 high glycoalkaloid line, all *Bt-cry3A* transgenic, and the combined resistance lines were effective in controlling feeding by Colorado potato beetle adults and larvae. Effectively no feeding was observed in the glycoalkaloid + *Bt-cry3A* transgenic line. The glandular trichome line suffered less feeding than the susceptible control. Based on these results, the *Bt-cry3A* transgenic, glandular trichome, and glycoalkaloid-based host plant resistance mechanisms are effective tools 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 this trial for Michigan and New York in 2001.

In 2000 and 2001, we had extensive field testing for agronomic performance in replicated trials of our most advanced *Bt-cry3A* transgenic lines. **Table 4** summarizes the results from the Advanced *Bt-cry3A* Breeding Line Preliminary Trial at the Montcalm Research Farm. In general, the *Bt-cry3A* transgenic lines had similar agronomic and tuber characteristics compared to the non-transgenic parental line. We have made selections among the lines and will continue to conduct further field trials in 2002.

Evaluation of Pyramiding Host Plant Resistance (Leptine Glycoalkaloids and *Bt-cry3A*) in Potato to Control Colorado Potato Beetle

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), is the most destructive insect pest of potato, *Solanum tuberosum* (L.) in eastern North America. The insect has adapted to every insecticide it has encountered. Host plant resistance offers an additional control tactic in an overall integrated pest management strategy, to decrease reliance on insecticides alone. Combing multiple host plant resistance factors into a single cultivar has been suggested as a means to extend the effective life of each individual resistance factor. The objective of this study was to evaluate if pyramiding of host plant resistance factors provides a better, more durable control. Four different potato lines with natural (leptine glycoalkaloids), engineered (*Bacillus thuringiensis-cry3A*), combined and no host plant resistance factors were evaluated in a no-choice detached leaf bioassay. The assays were performed on two Colorado potato beetle strains (susceptible or insecticide resistant) at each of the four instars to determine critical instar stage for resistance development. The defoliation, larval instar, weight and mortality were measured after five days. The combined host plant resistant (*Bt-cry3A* and leptine) line was the most effective control to deter feeding of Colorado potato beetle larvae at third and fourth instar stages.

Field Evaluation of Potato Tuber Moth Resistance of *Bt-cry5*-Spunta Potato Lines

The primary insect pest in Egyptian potato production, like many other countries in the Middle East, is the potato tuber moth, *Phthorimaea operculella* (Zeller). 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. We have been conducting on-going field trials in Egypt to evaluate our *Bt-cry5*-transgenic lines for resistance to Potato tuber moth damage. Our *Bt-cry5*-Spunta lines are strongly resistant to the potato tuber moth larvae in both field and ambient storage experiments. The incorporation of our *Bt-cry5*-transgenic potatoes into the Egyptian potato production system will reduce the need for insecticides in Egypt in the field and the storage, thus allowing for the production of a safer product for human consumption. In addition, we expect to see less storage losses due to tuber moth control. Also, potato production with less insecticide use will improve farm worker safety and have positive environmental benefits. These field evaluations have now been expanded to South Africa and we are looking to establish field trials in Mexico in 2002.

Transformation and Evaluation of Potato Cultivars with the *glgC16* (AGPase) Gene

The processing parameters are strictly defined for potato. For chip processing, a specific gravity of 1.080 is the threshold for processing cultivars. In addition, a low reducing sugar level must occur in the potato tuber at harvest and also during storage prior to processing. Potato breeding of improved cultivars for chip processing has had a low probability of success because of the need to combine numerous economic characteristics into one genotype. In some cases, the genotype may be suitable for chip-processing, but the tuber specific gravity falls below the 1.080 threshold. ADP glucose pyrophosphorylase is an enzyme, which uses the glucose 1-phosphate molecule as a substrate for the biosynthesis of starch. An ADP glucose pyrophosphorylase gene (*glgC-16*) has been isolated from *E. coli* and placed in a plant transformation vector under the control of the patatin promoter. One goal of this study is to examine the value of *glgC-16* to raise the dry matter content for potato tubers.

We have targeted transformation of with the AGPase gene towards lines that have below average solids content. In 2000, tissue culture transplants were grown of Atlantic (high solids control), Onaway, MSE149-5Y and their AGPase transgenic lines. The tuber appearance of the various AGPase lines was similar to non-transgenic Onaway and the MSE149-5Y lines. The two Atlantic-AGPase lines suffered from severe growth cracks.

For this reason, tubers from only the MSE149-5Y and Onaway lines were planted this year in replicated trials to further evaluate agronomic performance, specific gravity, chip-processing, and bruise susceptibility (**Table 5A and B**). Most of the MSE149-5Y and Onaway AGPase transgenic lines had similar yields, although slightly lower in some lines compared to the non-transgenic parents. In general, the tuber size distribution was quite comparable, although there was a reduction in the number of oversize (>3.25") tubers. The specific gravity for the Onaway and MSE149-5Y AGPase lines was higher than the non-transgenic parents in almost all cases. We also observed a higher incidence of internal defects, specifically hollow-heart, in these AGPase lines. Unfortunately, the results from the blackspot bruise susceptibility tests indicate that the transgenic lines that had higher specific gravities were also had higher blackspot bruise potential (ONAGP3, ONAGP1, ONAGP2, EAGP24, EAGP4, EAGP9, and EAGP3).

V. Variety Release

The MSU breeding program, under the direction of David Douches, 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 these three varieties to MPIC.

Seed Availability

The MSU Potato Breeding program is entering a new stage of development as we have released the first three potato varieties under the direction of Dave Douches. Design and implementation of a new system of seed increase and availability between the breeding program and the Michigan Certified Seed Foundation is a necessity to make seed from recently-released and advanced breeding lines available to interested growers. The first stages of this process have begun to take form, and **Table 6** lists the current seed availability for the recently-released and advanced breeding line introductions.

Jacqueline Lee: A Tablestock Late Blight Resistant Variety with Marketable Maturity

Jacqueline Lee is a new potato variety (*Solanum tuberosum* L.) that has been developed at Michigan State University that is resistant to the US8 genotype of late blight (*Phytophthora infestans* Mont. de Bary). Jacqueline Lee was evaluated as seedling number MSG274-3. It is a selection from a cross made in 1994 between the late maturing, late blight resistant variety Tollocan and the early maturing variety Chaleur for the purpose of breeding late blight resistant cultivars with marketable maturity. Jacqueline Lee is named for the daughter of the breeder.

Jacqueline Lee is an oval/oblong tablestock selection with a high tuber set. The tubers have a bright skin, and a smooth, attractive appearance with a yellow flesh that is typical of many European cultivars. The primary strength of this selection is its strong foliar resistance to the US8 genotype of late blight (as determined by four years of field testing) combined with a vine maturity that is similar to Snowden. Other strengths of

Jacqueline Lee are that the tubers have very low incidence of internal defects, excellent culinary quality and a long dormancy.

The seedling generation was grown in 1994, followed by two years of selection and seed multiplication at Lake City Experiment Station, Lake City, MI. Since 1997, it has been tested in replicated agronomic trials at the Montcalm Research Farm, Entrican, MI and in inoculated late blight trials at the Muck Soils Research Farm, Bath, MI. In 1999 it was entered into farm trials in Michigan as well as commercial seed production.

Liberator: A Round White Chip-processing Variety with Resistance to Scab

Liberator is a new round white chip-processing potato variety (*Solanum tuberosum* L.) that has been developed at Michigan State University that is resistant to scab (*Streptomyces scabies* Thaxter). Liberator was evaluated as seedling number MSA091-1. It is a selection from a cross made in 1988 between the moderately scab resistant breeding line MS702-80 and chip-processing variety Norchip for the purpose of breeding scab resistant chip-processing varieties. The name Liberator was chosen to acknowledge the resistance to scab in this round white chip-processing variety.

Liberator is a round white chip-processing variety with a medium set of bright-skinned tubers similar in appearance to Norchip. The tubers have a low level of internal defects. The primary strength of this variety is its strong resistance to scab combined with chip-processing quality. Another strength of Liberator is that the tubers have a level tolerance to fusarium dry rot similar to Snowden. Liberator was tested in the North Central Regional Trials and the National Snack Food Trials. Under irrigated conditions the yield and specific gravity are similar to Snowden and Atlantic with vine maturity similar to Snowden.

The seedling generation was grown in 1988, followed by two years of selection and seed multiplication at the Clarksville Horticultural Experiment Station, Clarksville, MI. Since 1992, seed increase was relocated to the Lake City Experiment Station. Since 1993, it has been tested in replicated agronomic trials at the Montcalm Research Farm, Entrican, MI and in the scab nursery at the Michigan State University Soils Farm, East Lansing, MI. In 1997 it was entered into farm trials in Michigan and then in 1999 was placed into commercial seed production.

Michigan Purple: A Purple-Skinned Tablestock Variety

Michigan Purple is a new round-ovoid shaped, purple-skinned tablestock potato variety (*Solanum tuberosum* L.) developed at Michigan State University. It has a medium set of bright, purple-skinned tubers similar in shape to Norland. The tubers have a white flesh with a low level of internal defects. Because of its unique appearance it was tested as the name Michigan Purple during variety trials. Under irrigated conditions the yield is high and specific gravity intermediate. The vine maturity of Michigan Purple is slightly later than Norland.

The cross was made in the greenhouse in 1993. The seedling generation was grown in field in 1994, followed by two years of selection and seed multiplication at the Lake City Experiment Station. It was placed into tissue culture and, since 1997, it was used as a plot marker in the breeding program. Because of interest by the local community in Michigan Purple, this line was advanced to variety testing status. Since 1999, it has been tested in replicated agronomic trials at the Montcalm Research Farm, Entrican, MI and in the scab nursery at the Michigan State University Soils Farm, East Lansing, MI. In 1999 Michigan Purple was placed into commercial seed production.

Attachment 1

MSU Processing Advanced Breeding Lines

Chip-processors:

Liberator (MSA091-1): A round-white with strong resistance to scab combined with chip-processing quality. Under irrigated conditions, the yield and specific gravity are similar to Snowden and Atlantic with vine maturity similar to Snowden. We regard this as a potential Atlantic replacement.

MSF099-3: A high yielding, high solids selection with excellent chip color from 42-46°F storage. It produces oval to oblong, slightly flattened tubers that have low internal defects. One bin in the Commercial Demonstration Storage is filled with this line.

MSG227-2: A selection with strong resistance to scab and excellent chip-processing quality from 48°F storage. Tubers have a slightly flattened shape with shallow eyes and low incidence of internal defects. This line is being considered for release after the 2002 season.

MSH094-8: A new chip-processing selection with cold-chipping potential from 42°F storage. This line also has a low incidence of internal defects and mid-season maturity.

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 in 2001 at the Montcalm Research Farm. It was in the on-farm trials for the first time in 2001.

MSF373-8: A very 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. Scab tolerance is intermediate. It showed promise as an out-of-the-field chipper in Florida and Wisconsin in 2001. This selection also has tablestock potential.

MSH067-3: A new chip-processing selection with cold-chipping potential. It has mid-season maturity and intermediate scab tolerance. The tubers are flattened and round.

Attachment 2

MSU Tablestock Advanced Breeding Lines

Round-whites:

MSF313-3: A high yielding selection with acceptable specific gravity for chip-processing. It has cold-chipping (45°F) potential. The tubers have a bright, attractive appearance and have excellent internal quality. Scab resistance is above average. We regard this as a potential Onaway replacement.

MSF373-8: A very 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. Scab tolerance is intermediate. This selection also has tablestock potential. We regard this as a potential Onaway/Ontario replacement.

MSF060-6: A high yielding selection with scab resistance that produces large tubers that have excellent internal characteristics, and a smooth round shape.

MSE018-1: A very high yield potential, high specific gravity, and moderate tolerance to scab. It has a late maturity, large vine and some reduced susceptibility to late blight. Tuber appearance is bright and smooth with a round-oval shape. We regard this as a potential Katahdin replacement (baker).

MSE221-1: A high yielding selection with scab resistance and a moderately early vine maturity. Tubers are netted with an attractive appearance. The internal qualities of the tubers are excellent. We regard this as a potential Superior replacement.

MSG004-3 - a MSU tablestock selection. It has average yield potential and produces bright attractive tubers with good internal quality.

Yellow-flesh:

Jacqueline Lee (MSG274-3): An oval/oblong table stock 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.

MSE149-5Y: A light yellow-fleshed selection with smooth, round tubers that have a bright appearance. Specific gravity is low but the selection has high yield potential. Internal qualities are excellent and the vine maturity is medium-early. We regard this as a potential Norwis replacement.

Long, Russet-types:

MSE192-8RUS: A russet tablestock selection. The tubers are long with an attractive russet appearance like Russet Norkotah. In comparison to Russet Norkotah it has a bright white flesh, a good taste and expresses PVY symptoms. Its strengths are scab resistance, low incidence of internal defects, and bruise resistance. The vines have early-mid season maturity. We view this as a potential Russet Norkotah replacement.

MSE202-3RUS: A russet tablestock selection. The tubers are long with a lighter russet appearance. The tubers are smooth shaped and attractive with high yield potential. It has a full season maturity.

MSB106-7: A high yielding, long white type. Internal quality is excellent with a bright white flesh, however, specific gravity in only 1.070. It has performed well in Louisiana and Nebraska. We regard this as a niche variety.

Red-Skin/Specialty:

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

Table 1. ADVANCED MSU SELECTIONS WITH LATE BLIGHT RESISTANCE

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL				PEDIGREE	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	LB[6]	FEMALE	MALE
MSJ317-1 *	486	521	93	5	87	6	2	1.074	1.5	0	0	0	0	20	2.0	4.0	LBR	PRESTILE	B0718-3
MSK034-1 *	446	505	88	8	79	9	4	1.072	1.0	1	0	0	0	20	2.0	3.5	LBR	B0718-3	H133-2
MSI152-A	416	482	86	11	67	19	3	1.062	-	1	0	0	0	20	1.7	2.5	LBR	MAINESTAY	B0718
MSJ453-4Y	416	541	77	19	74	3	4	1.084	2.0	5	6	5	1	40	2.3	5.0	LBR	TOLLOCAN	A091-1
MSJ456-4	397	490	81	18	79	2	1	1.077	-	1	1	2	2	20	1.0	3.3	LBR	TOLLOCAN	CONESTOGA
MSK128-1	367	396	93	6	71	21	2	1.075	1.5	1	0	0	7	20	3.0	1.5	LBR	G274-3	H094-3
MSJ319-1 *	356	458	78	22	73	4	1	1.084	1.0	0	0	0	0	20	0.5	2.8	LBR	B0718-3	W870
MSJ456-2Y	342	470	73	17	70	3	10	1.076	2.5	1	1	0	0	40	2.7	3.1	LBR	TOLLOCAN	CONESTOGA
MSJ461-1	300	451	66	33	66	0	1	1.067	1.0	0	0	0	0	40	1.0	3.1	LBR	NY88	TOLLOCAN
MSK136-2 *	299	376	79	20	78	2	1	1.078	-	0	0	0	0	20	1.0	3.0	LBR	GRETA	B0718-3
MSJ334-1Y *	293	370	79	15	64	15	6	1.075	-	0	1	1	0	20	1.5	3.5	MR	D040-4	BRADOR
MSJ319-7	286	330	87	12	74	13	2	1.068	-	0	1	0	0	40	1.7	3.6	LBR	B0718-3	W870
MSK101-2Y	247	304	81	14	80	2	5	1.072	1.5	0	0	0	0	20	1.5	1.5	LBR	F059-1	G274-3

[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 September 4, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

[6]LATE BLIGHT RATING: Reaction to foliar *Phytopthora infestans*; LBR: Resistant; MR: Moderately Resistant; RS: Reduced Susceptibility; S: Susceptible.

* These lines have also demonstrated tuber resistance to Late Blight in the laboratory.

Table 2. Potential Lines for 2002 On-Farm Grower Trials

Line	Pedigree: Female	Pedigree: Male	Comments
Tablestock			
JACQUELINE LEE	Tollocan	Chaleur	Late blight resistant
MICHIGAN PURPLE	W870	Maris Piper	
MSE018-1	Gemchip	W877	Also storage chipper
MSE221-1	Superior	MS700-83	Scab resistant
MSF060-6	Stueben	MS702-80	Scab resistant
MSF313-3	Spartan Pearl	NY88	Bright skin
MSF373-8	MS702-80	NY88	Chips out of the field
MSG004-3	AF 1060-2	MS702-80	Bright skin
MSH031-5	MSB110-3	MSC108-2	Bright skin
MSE192-8RUS	A8163-8	Russet Norkotah	Scab resistant
MSE202-3RUS	Frontier Russet	A8469-5	Scab resistant
MSB106-7	LA01-38	Lemhi Russet	
MSI005-20Y	MSA097-1Y	Penta	Yukon appearance
Processing			
LIBERATOR	MS702-80	Norchip	Scab resistant
MSG227-2	Prestile	MSC127-3	Scab resistant
MSH095-4	MSE266-2	OP	
MSH094-8	MSE251-1	W877	
MSF099-3	Snowden	Chaleur	
MSF373-8	MS702-80	NY88	Chips out of the field
MSE018-1	Gemchip	W877	Storage chipper
MSI002-4	MSA091-1	MSF134-1	
MSI083-5	MSC135-5	B0718-3	Limited seed availability

Table 3. 2000-2001 DEMONSTRATION STORAGE CHIP RESULTS
Chip Scores represented using SFA Scale†

POTATO LINE	2000 DOH* CWT/A US#1	2000 DOH* CWT/A TOTAL	2000 DOH* SP GR	2000 SCAB[††] RATING	Sample Dates: 11/3/00	12/6/00	1/15/01	2/9/01	3/1/01	4/2/01	5/4/01	6/1/01	6/15/01
					Bin Temperature (°F)								
[42F] BIN					58F	51F	46F	42F	42F	42F	42F	53F	55F
MSF099-3	385	435	1.083	2.0	1.0	1.0	1.5	1.0	1.0	2.0	1.5	1.0	1.0
MSG227-2	439	484	1.080	0.8	1.0	1.0	1.5	1.0	2.0	2.0	2.0	2.0	2.5
MSH094-8	429	472	1.080	2.0	1.0	1.5	2.0	1.0	1.5	1.5	1.5	1.0	2.0
MSI111-A	-	-	-	-	1.5	1.0	2.0	1.5	2.0	1.5	1.5	1.5	1.5
NY112	520	550	1.075	2.2	1.5	2.0	2.0	2.0	2.0	2.0	1.5	2.0	1.5
SNOWDEN	**371**	**417**	**1.085**	**3.0**	**1.5**	**1.0**	**1.5**	**1.5**	**2.0**	**2.5**	**2.0**	**2.0**	**1.5**
[52F] BIN					58F	51F	53F	53F	54F	50F	51F	53F	55F
MSA091-1	405	471	1.081	0.5	1.0	1.5	1.5	1.0	1.5	1.5	1.0	1.0	1.5
ATLANTIC	**418**	**481**	**1.086**	**3.3**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.0**	**2.0**	**2.0**
MSE018-1	533	600	1.086	2.2	1.5	1.5	2.0	1.5	1.5	1.5	1.0	1.5	1.5
MSF373-8	517	550	1.076	2.1	1.5	1.5	2.0	1.0	1.5	1.5	1.5	1.5	2.0
P83-11-5	428	521	1.083	2.0	2.0	1.5	1.0	1.5	1.0	1.5	1.0	2.0	2.0
PIKE	**335**	**370**	**1.087**	**1.8**	**1.0**	**1.5**	**1.5**	**1.0**	**1.5**	**1.0**	**1.0**	**1.5**	**2.0**
$LSD_{0.05}$	78	72	0.003										

†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 25, 2000.

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

Table 4. 2001 MSU ADVANCED *Bt-cry3A* SELECTIONS PRELIMINARY TRIAL

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT
MSE018-1	**524**	**634**	**83**	**17**	**75**	**7**	**0**	**1.080**	**0**	**2**	**1**	**0**	**20**
E08.08	505	593	85	15	78	7	0	1.082	0	0	1	0	20
E08.02	498	576	86	13	76	11	1	1.079	1	1	0	0	20
E08.10	491	547	90	10	81	8	0	1.081	0	0	0	0	20
MSG274-3	**287**	**591**	**49**	**51**	**49**	**0**	**1**	**1.075**	**0**	**0**	**0**	**0**	**20**
G38.04	244	568	43	55	43	0	2	1.072	0	0	0	0	20
G38.03	231	530	44	56	44	0	0	1.073	0	0	0	0	20
Lemhi Russet	**481**	**559**	**86**	**10**	**71**	**15**	**4**	**1.077**	**4**	**0**	**1**	**0**	**20**
LR8.3	353	479	74	23	72	1	3	1.076	0	0	0	0	20
ND8.01	306	335	91	6	69	22	3	1.079	1	0	0	0	20
ND8.04	303	347	87	10	80	8	3	1.080	2	0	0	0	20
ND5873-15	**274**	**311**	**88**	**7**	**67**	**22**	**5**	**1.077**	**2**	**0**	**0**	**0**	**20**
NO8.02	410	429	96	4	62	34	1	1.060	0	0	0	0	20
NO8.03	381	428	89	11	81	8	0	1.060	0	1	1	0	20
Norwis	**379**	**402**	**94**	**6**	**82**	**12**	**0**	**1.059**	**1**	**0**	**0**	**0**	**20**
NO8.28	372	415	90	10	81	9	0	1.062	0	0	0	0	20
NO8.08	328	354	93	7	80	13	1	1.063	1	0	0	0	20
NY123	**424**	**508**	**83**	**12**	**83**	**0**	**5**	**1.080**	**0**	**0**	**0**	**0**	**20**
NY8.02	404	508	79	11	78	2	9	1.074	0	0	1	1	20
NY8.05	349	419	83	12	81	3	5	1.074	0	0	0	0	20
NY8.10	328	424	77	15	77	1	7	1.074	0	0	0	0	20
Onaway	**526**	**587**	**90**	**5**	**71**	**19**	**5**	**1.060**	**0**	**1**	**0**	**0**	**20**
ON8.06	376	455	83	15	76	7	2	1.056	0	0	0	0	20
ON8.22	304	364	83	10	81	3	7	1.056	0	0	0	0	20
NYL235-4	**436**	**533**	**82**	**11**	**80**	**2**	**7**	**ND***	**0**	**0**	**0**	**0**	**20**
L28.3	316	432	73	24	73	1	3	ND	0	0	1	0	20
L28.5	308	455	68	32	67	1	0	ND	0	0	0	0	20
L28.2	294	385	77	21	77	0	3	ND	0	0	0	0	20
SP8.12	377	434	87	7	67	19	6	ND	2	1	2	2	20
SP8.3	332	423	79	17	61	18	4	ND	0	2	0	1	20
Spunta	**292**	**334**	**87**	**7**	**61**	**26**	**5**	**ND**	**2**	**0**	**1**	**2**	**20**
YG8.26	345	406	85	15	82	3	0	ND	0	0	2	0	20
Yukon Gold	**315**	**350**	**90**	**8**	**75**	**15**	**2**	**ND**	**4**	**0**	**0**	**0**	**20**
YG8.12	265	307	86	14	86	0	0	ND	0	0	0	0	20
YG8.8	251	305	82	18	82	0	0	ND	1	1	1	0	20
YG8.3	247	271	91	8	88	4	0	ND	1	0	2	0	20
ATLNewLeaf	**468**	**501**	**93**	**7**	**79**	**14**	**0**	**1.084**	**4**	**0**	**1**	**0**	**20**
RBNewLeaf	**51**	**258**	**20**	**79**	**20**	**0**	**2**	**1.075**	**0**	**0**	**0**	**0**	**20**

[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.

*ND: No Data

Table 5A. 2001 AGPase AGRONOMIC TRIAL, Moncalm Research Farm.

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT
						ONAWAY							
ONAWAY	**423**	**496**	**85**	**6**	**62**	**23**	**8**	**1.059**	**0**	**0**	**0**	**0**	**40**
ONAGP2	349	414	84	10	72	12	6	1.069	3	0	0	1	40
ONAGP3	311	373	84	14	80	3	3	1.071	1	0	1	0	40
ONAGP1	301	360	84	8	68	15	8	1.068	2	0	1	2	40
MEAN	346	411						1.067					
$LSD_{0.05}$	33	51						0.002					
						MSE149-5Y							
E149-5Y	**457**	**509**	**90**	**10**	**74**	**15**	**0**	**1.063**	**0**	**0**	**3**	**0**	**40**
EAGP20	431	502	86	14	78	8	0	1.062	1	0	1	0	40
EAGP15	419	481	87	13	83	4	0	1.063	0	0	0	0	40
EAGP4	376	425	89	11	85	4	0	1.069	13	0	0	0	40
EAGP8	360	452	80	20	76	4	0	1.064	0	0	0	0	40
EAGP9	331	369	90	10	81	8	0	1.070	29	0	0	0	40
EAGP3	331	372	89	11	83	6	0	1.065	38	1	0	0	40
EAGP24	295	347	85	15	84	1	0	1.070	4	0	0	0	40
MEAN	375	432						1.066					
$LSD_{0.05}$	59	53						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.
Planted May 1, 2001
Harvested September 27, 2001 (150 DAYS)

Table 5B. 2001 AGPase BLACKSPOT BRUISE SUSCEPTIBILITY TEST

LINE	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
					ONAWAY				
ONAWAY	**17**	**7**	**1**				**25**	**68**	**0.36**
ONAGP2 *	5	8	5	3	3	1	25	20	1.76
ONAGP1 *	5	2	9	5	2	2	25	20	2.12
ONAGP3 *	2	1	4	2	1	15	25	8	3.76
					MSE149-5Y				
EAGP15	16	8	1				25	64	0.40
EAGP8	15	9	1				25	60	0.44
E149-5Y	**16**	**6**	**2**		**1**		**25**	**64**	**0.56**
EAGP20	11	8	4	2			25	44	0.88
EAGP3	6	4	3	4	1	7	25	24	2.44
EAGP9 *	4	4	6	3	1	7	25	16	2.56
EAGP4 *	2	2	6	3	2	10	25	8	3.24
EAGP24 *	4	1	3	3	4	10	25	16	3.28

Simulated bruise samples were prepared as follows: A-size tuber samples were collected at harvest, held at 50 F at least 12 hours, placed in a six-sided plywood drum, and rotated ten times to produce simulated bruising. Samples were abrasive-peeled and scored on October 29, 2001. The table is presented in ascending order of average number of spots per tuber.

*These transgenic lines had higher solids than their non-transgenic parental line.

Table 6. MSU ADVANCED BREEDING LINE SEED INVENTORY
2001 Availability of Certified Seed for MSU Breeding Program Introductions

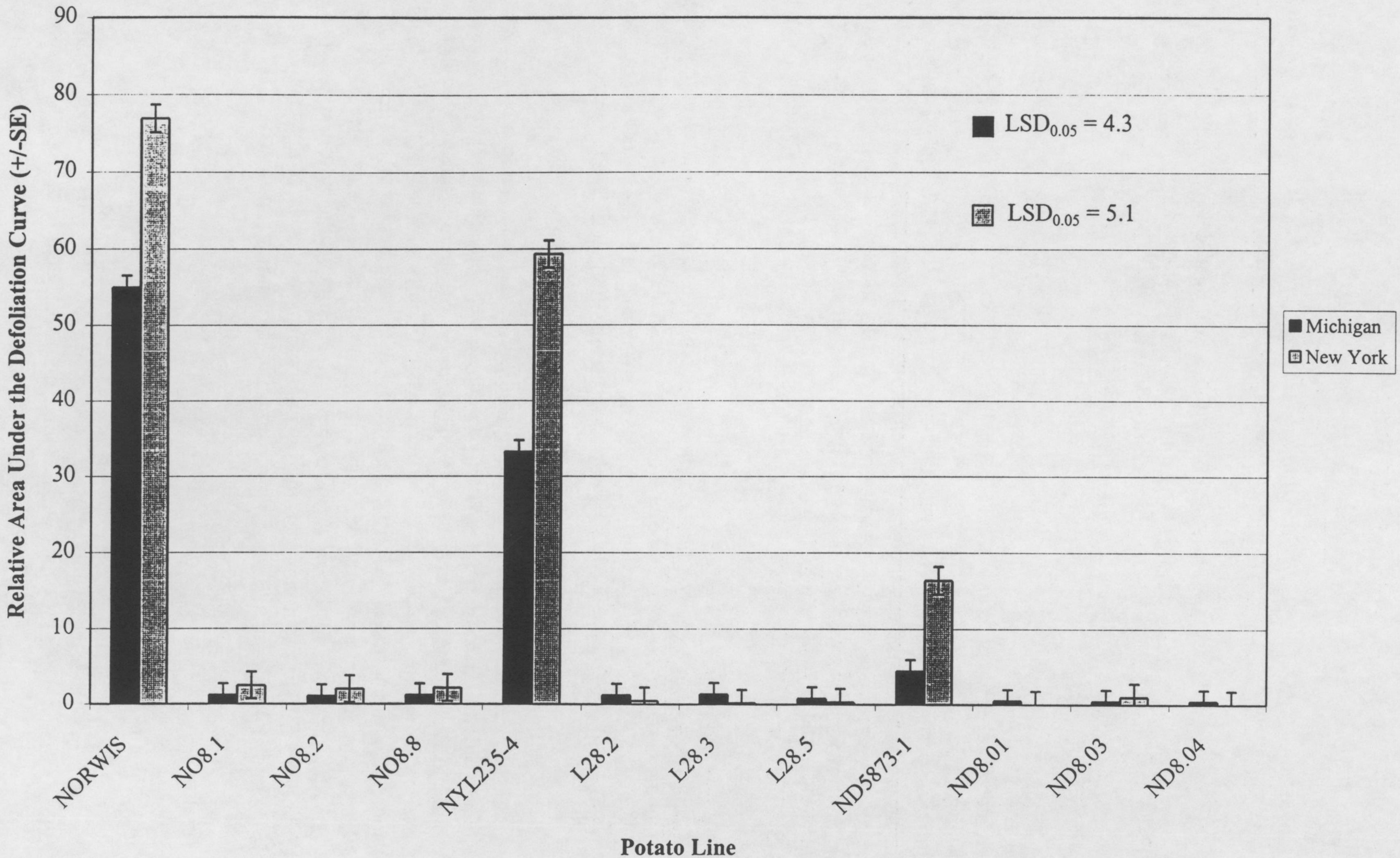
LINE	TISSUE CULTURE[1]	MINI-TUBERS[2]	Y1[3]	Y2[3]	Y3[3]
JACQUELINE LEE (MSG274-3)	Yes	196	8	64	-
LIBERATOR (MSA091-1)	Yes	9804	-	-	60
MICHIGAN PURPLE	Yes	567	11	-	-
MSE192-8RUS	Yes	1140	3	-	-
MSE202-3RUS	Yes	566	8	-	-
MSF099-3	Yes	1688	-	128	-
MSG227-2	Yes	5790	8	32	-
MSJ461-1	Yes	250	-	-	-

1 = Is the line presently in tissue culture (Yes or No)
2 = Number of units available
3 = Number of CWT available

Information listed above is a cumulative count from Golden Seed Farms, Iott Seed Farms Inc., Krueger Seed Farm, and Sklarczyk Seed Farm.

Table courtesy of Chris Long

Figure 1. 2001 CPB Field Trial of Natural and Engineered HPR in Potato



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2001 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, Fusarium dry rot, Erwinia soft rot and blackspot bruising are determined.

PROCEDURE

Ten field experiments were conducted at the Montcalm Research Farm in Entrican, MI. They were planted as randomized complete block designs with 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 fields were fumigated in the fall prior to the field season.

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 Long White and Russet, North Central Regional, Yellow Flesh and European, Heritage, Adaptation, and Preliminary 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.

RESULTS

A. Round White Varieties: Chip-processors (Tables 1 and 2)

There were 14 entries that were compared at two harvest dates. Atlantic, Snowden and Pike were used as checks. The plot yields were average in the early harvest (98 days), and most lines increased approximately 100 cwt/a in yield for the second harvest date (144 days). Tuber specific gravity readings were significantly below average for 2001; for example, Atlantic and Snowden had specific gravity readings of 1.081 and 1.076, respectively, in the late harvest. The results are presented in **Tables 1 and 2**. In the early harvest trial, Atlantic, MSH095-4, NY120, MSH067-3, and MSH098-2 had the highest yields of the 14 entries. At the later harvest, the same lines were again among the top yielding lines along with MSG227-2 and Liberator (MSA091-1). However, MSF099-3, W1386, and NY120 were the top yielding lines in the on-farm processing trials. MSA091-1 and MSG227-2 continue to be very promising selections that have scab resistance along with chip-processing ability. Liberator (MSA091-1) was released in 2001 and MSG227-2 is being considered for release after the 2002 season. Chip-processing quality was high among all the entries in the out-of-the-field samples. In 2001 incidence of internal defects were similar; Atlantic had a higher frequency of hollow heart at the late harvest, and we also saw a high frequency of Pike necrosis (noted as IBS).

Variety Characteristics

LIBERATOR (MSA091-1) - a MSU selection for chip-processing with strong scab resistance. Yield and specific gravity over the past five 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. It is also in the CHIPS2001 program. It was named Liberator and released in 2001.

MSF099-3 – 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. This line is in the CHIPS2001 program.

MSG227-2 – 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. This line is in CHIPS2002. In 2000 it was one of the best chip-processors in the 42°F MPIC demonstration storage. This line will be considered for release in 2002.

MSH067-3 - a new chip-processing selection with cold-chipping potential. It has mid-season maturity and intermediate scab tolerance. The tubers are flattened and round.

MSH094-8 - a new chip-processing selection with cold-chipping potential from 42°F storage. This line also has a low incidence of internal defects and mid-season maturity.

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 in 2001 at the Montcalm Research Farm. It was in the on-farm trials for the first time in 2001.

MSJ461-1 – an exciting, new MSU chip-processing selection with strong foliar resistance to late blight, moderate scab resistance, and marketable maturity. It has excellent chip-processing quality and average yield, but an intermediate specific gravity.

NY120 – a Cornell University chip-processing selection with resistance to common scab. The specific gravity is in the range of 1.080 or lower. The chip-processing quality is high from out-of-the-field and from storage samples.

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

There were 12 entries that were compared at two harvest dates. Onaway and Superior were used as checks. The plot yields were high in the early harvest (98 days), and little yield increase was observed for the second harvest date (141 days). Tuber specific gravity readings were above average. The results are presented in **Tables 3 and 4**. In the early harvest trial, Onaway, Michigan Purple, MSE221-1, MSH031-5, and MSF373-8 were the top yielding lines. There was very little incidence of internal defects in the early harvest. In the later harvest, MSF373-8, Onaway, MSE018-1, MSB107-1, and Michigan Purple were the top yielding lines. Overall, incidence of internal defects was typical in comparison to previous years, with slightly higher frequency of vascular discoloration, hollow heart, and some internal brown spots. MSF373-8 continues to be a high yielding line with a significantly higher percentage of large tubers, and it chip-processes well out of the field. Another strong performing line was Michigan Purple, which was released in 2001, that has a bright purple skin and excellent internal quality. Jacqueline Lee (MSG274-3), a smooth, bright-skinned, yellow-flesh variety with strong resistance to foliar late blight and marketable maturity, was also released in 2001.

Variety Characteristics

JACQUELINE LEE (MSG274-3) – an oval/oblong table stock 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.

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

MSE018-1 - a very high yield potential, high specific gravity, and moderate tolerance to scab. It has a late maturity, large vine and some reduced susceptibility to late blight. Tuber appearance is bright and smooth with a round-oval shape. We regard this as a potential Katahdin replacement (baker).

MSE149-5Y – a MSU tablestock selection. It has high yield potential and produces attractive round tubers with a bright skin and light yellow flesh. It has been a top yielder in the on-farm trials. It chips out of 45°F cold storage, but has a low specific gravity. In the lab we have used this line for transformation with the starch gene to raise the specific gravity. These AGPase-transgenic lines were field-tested in 2000-1.

MSE221-1 - a MSU tablestock selection. It has high yield potential as seen in the MSU and on-farm trials. General appearance is good, but it has a netted appearance similar to Superior. It has strong resistance to scab. It is being considered for release in 2002.

MSF060-6 - a high yielding selection with scab resistance that produces large tubers that have excellent internal characteristics, and a smooth round shape.

MSF373-8 - a very 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. Scab tolerance is intermediate.

MSG004-3 - a MSU tablestock selection. It has average yield potential and produces bright attractive tubers with good internal quality.

C. Long Whites and Russet Varieties (Table 5)

Five varieties and nineteen breeding lines were tested in 2001. Five of the lines evaluated were line selections of Russet Norkotah (Russet Norkotah 3, Russet Norkotah 8, TXNS112, TXNS223, and TXNS278). Russet Burbank and Russet Norkotah were grown as check varieties. The trial was dug at 133 days from planting and results are shown in **Table 5**. The yield of the lines ranged widely with A8893-1, Bannock Russet, AC87079-3, and MSE202-3RUS having high yields; and Russet Norkotah and MSE192-8RUS with slightly below average yields. Internal defects were low, with the exception of A8893-1, AC97079-3, AC87138-4, and Russet Norkotah 3 (line selection), which had greater amounts of hollow heart in the oversize tubers. Of the Russet Norkotah line selections, only Russet Norkotah 3 performed significantly different from Russet Norkotah; however, the higher yield was also accompanied by an increase in internal defects (especially hollow heart). Russet Burbank was the only line to generate an undesirable amount of cull potatoes.

Variety Characteristics

MSB106-7 - a MSU tablestock selection. It has high yield potential as seen in the on-farm trials, but performed poorly at MSU. Tubers are oblong-long with a light netting. Internal quality is excellent and it has a very white flesh.

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 white flesh that does not darken after cooking. It has performed well in taste tests.

MSE202-3RUS – a MSU dual-purpose russet selection. It has a medium-late maturity and high yield potential. Its specific gravity is equivalent to Russet Burbank and the tubers are long with an attractive russet skin. Scab resistance is also high.

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 seven varieties were tested in Michigan. The results are presented in **Table 6**. The yield was high and specific gravities of the lines were significantly low in 2001. The range of yields was wide. Michigan Purple, MSF099-3, and MSE192-8RUS were all included in the North Central Trial for the first time in 2001. Similar to previous years, the MSU selection MSF373-8 performed well. Michigan Purple compared quite favorably to the other red-skinned entries in the trial. Other promising lines include the red-skinned selection ND3574-5R and the chip-processors NY112 , W1386, and B0766-3. In general, the russet varieties and lines performed below average.

E. Yellow Flesh and European Trial (Table7)

Thirteen varieties and advanced selections were tested in 2001. Yukon Gold and Saginaw Gold were used as checks. The results are summarized in **Table 7**. The trial was harvested after 137 days, and yields were above average and varied considerably. The best yielding lines in 2001 were MSJ033-10Y, MSI005-20Y, MSG147-3P, MSJ453-4Y, and Torridon. However, internal defects and late vine maturity make most of these lines undesirable at the commercial level. MSI005-20Y was a strong overall performing line with high yield, excellent internal quality, and medium-early maturity. Although all entries were evaluated for chip-processing quality out-of-the-field, few had acceptable chip color. An increase in incidence of internal defects was observed in 2001, most notably in Torridon and MSJ033-10Y. MSJ453-4Y, MSJ456-2Y and Torridon have foliar resistance to late blight.

F. Heritage Variety Trial (Table 8)

A new trial was added to the variety trials in 2001 to evaluate novelty and fingerling varieties that are often available as heritage variety material for the specialty market. Fifteen yellow flesh and novelty varieties, and 10 fingerling varieties were tested. The results are summarized in **Table 8**. Yields were remarkably low due to poor seed quality and high incidence of virus in this material. A wide range of values was observed for maturity and scab resistance, and none demonstrates foliar resistance to late blight in inoculated disease trials. Some of the varieties in the trial did have unique attributes for marketing and we hope to revisit this trial in 2002 with better quality seed.

G. Adaptation Trial (Table 9)

Four varieties and 37 advanced breeding lines were evaluated in the Adaptation trial (**Table 9**). The trial was harvested after 144 days. The highest yielding lines were CACP10, Onaway, MSI037-4, A91790-13, MSI537-3, and MSH333-3. The best performing scab resistant lines are MSH228-6, MSI111-A, MSG301-9, MSNT-1, and MSH356-A, as well as others. The best lines with chip-processing quality are MSI111-A, MSE080-4, MSJ126-9, MSH015-2, AC91790-13, AC87340-3, BC0894-2, MSH370-3, MSI083-5, MSJ042-3, and MSI083-10. The following lines also had early maturity: MSE080-4, MSH370-3, MSI004-3, MSJ042-3, MSJ126-9, and MSG301-

9. The lines with the best overall tablestock performance were MSI037-4, MSI537-3, and AF1763-2. The best overall chip-processing lines are CACP10, A91790-13, MSH333-3, A90490-1, MSH228-1, and MSH041-1.

H. Preliminary Trial (Tables 10A and B)

The Preliminary trial is the first replicated trial for evaluating new advanced selections from the MSU potato breeding program. Forty-two advanced selections and three check varieties were tested in two separate Preliminary trials. Due to the increase in the number of breeding lines with resistance to late blight, the overall Preliminary Trial was separated into the standard preliminary trial (**Table 10A**), and a preliminary trial of late blight pedigree material (**Table 10B**). The highest yielding lines were MSK068-2, MSJ167-1, MSJ080-1, and MSK217-3P. Lines with the best chip-processing quality are MSJ167-1, MSJ080-1, MSJ080-8, MSK476-1, MSJ147-1, MSJ197-1, MSJ047-5, MSJ170-4, and MSK236-5. Lines with the best potential for the round white tablestock market are MSK068-2, MSI152-A, MSK409-1, and MSJ204-3. MSJ472-4P is a blue-skinned line with white and blue flesh the chip-processes. Two yellow-flesh lines with average yield also had scab resistance (MSK247-9Y and MSK004-2Y). MSI152-A had above average yield, excellent internal quality, marketable maturity, and has demonstrated resistance to foliar late blight. **Table 10B** lists the results for the lines with late blight pedigrees. Of these lines, six have strong foliar resistance to late blight, and five of those lines have good to excellent processing qualities (MSJ317-1, MSK034-1, MSK128-1, MSJ319-1, and MSK101-2Y). Most of these lines also have marketable maturity. MSJ319-1 has strong resistance to both foliar and tuber late blight, scab resistance, high solids, marketable maturity, and excellent chip-processing quality.

I. Potato Scab Evaluation (Table 11)

Each year a replicated field trial at the MSU Soils Farm is conducted to assess resistance to common and pitted scab. For the second year, we are using a modified scale of a 0-5 ranking based upon a combined score for scab coverage and lesion severity. Usually examining one year's data does not indicate which varieties are resistant but it should begin to identify ones that can be classified as susceptible to scab. Our goal is to evaluate important advanced selections and varieties in the study at least three years to obtain a valid estimate of the level of resistance in each line. **Table 11** categorizes many of the varieties and advanced selections tested in 2001 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. These three categories are good levels of scab tolerance. Susceptible lines have greater than 25% infection with pitted lesions. Scores of 4.0 or greater are found on lines with >50% infection and severe pitted lesions. The check varieties Russet Burbank, Superior, Onaway, Red Pontiac, Yukon Gold, Atlantic and Snowden can be used as references (bolded in Table 11). Table 11 indicates that we have been able to breed numerous lines for the chip-processing and tablestock markets with resistance to scab. Although scab disease pressure in 2001 was notably lower compared to other years, the data were separated into three categories (Resistant = 0.0-0.9; Moderately Resistant = 1.0; and Susceptible > 1.0 for this year). Most notable scab resistant lines are Liberator (MSA091-1), MSG227-2, MSE192-8RUS, MSE202-3RUS, MSE221-1, MSG301-9, MSH228-6, MSI111-A, and MSJ036-A. Scab results from the disease nursery are also found in the Trial Summaries (Tables 2, 4-10).

J. Late Blight Trial (Table 12)

In 2001, a late blight trial was conducted at the Muck Soils Research Farm. Over 200 entries were evaluated in replicated plots. The field was planted on 14 June and inoculated 28 July with isolates 94-3, 95-7, 98-2, and 00-1, and ratings were taken during 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 and lines from the National Late Bight Variety Trial. The results are summarized in **Table 12**. Lines with the least infection from multi-year testing were LBR8, LBR9, A90586-1, Jacqueline Lee (MSG274-3), B0767-2, B0692-4, B0718-3, and Torridon (a Scottish variety). Jacqueline Lee (MSG274-3) has demonstrated strong late blight resistance over the past five years. Due to its excellent agronomic performance and foliar late blight resistance, Jacqueline Lee was released in 2001. In addition, many new MSU selections were in this top tier. Included in this group are MSJ461-1, MSJ459-4, MSJ457-2 and MSJ456-2Y, MSJ459-3 and MSJ453-4 which all are progeny of Tollocan; MSJ307-2, MSJ319-1, MSI152-A and MSJ319-7 which are progeny of B0718-3; and MSJ343-1 and MSI058-4 which are progeny of Brodick. 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 including scab resistance and chip-processing quality (see Table 10B). Tuber late blight resistance is being evaluated on all the selections with foliar late blight resistance.

K. Blackspot Susceptibility (Table 13A and B)

Increased evaluations of advanced seedlings and new varieties for their susceptibility to blackspot bruising have been implemented in the variety evaluation program. Check samples of 25 tubers were collected (a composite of 4 reps) from each cultivar at the time of grading. A second 25 tuber sample was similarly collected, placed in 50°F storage overnight and then was placed in a hexagon plywood drum and tumbled 10 times to provide a simulated bruise. Both 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 Tables 13A and 12B. Table 13A summarizes the data for the samples receiving the simulated bruise and Table 13B, the check samples. 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. However, these results become more meaningful when evaluated over 3 years that reflects different growing seasons and harvest conditions. The data indicates that bruise levels were average compared to other years. The most bruise resistant lines this year were MSH098-2, MSH067-3, MSI032-6, MSH031-5, Eva, W1876-1, MSE202-3RUS, MSH026-3RUS, Dark Red Norland, W1431, MSF099-3, MSJ042-3, AF1758-7, BC0894-2, and MSJ126-9.

L. Post-harvest Disease Evaluation: Fusarium Dry Rot

As part of the post harvest evaluation, resistance to *Fusarium sambucinum* (fusarium dry rot) was assessed by inoculating 3 whole tubers post-harvest from selected lines and varieties in the 2001 MRF variety trials. The tubers were held at 20°C (room temperature) for approximately three weeks post inoculation with *Fusarium* mycelial plugs and then scored for dry rot infection depth and width. A total of 105 breeding lines and varieties were tested. Overall the mean infection depth of the lesion ranged from 4-29 mm. We classified 35 of the lines to have a lesser degree of infection from fusarium dry rot. In this group the infection ranged from 4-9 mm. Superior, GoldRush, NorValley, Eva and Michigan Purple were in this group. Liberator, MSE192-8Rus, MSH356-A and MSJ168-2Y were in this group with less infection group for 2001 as well as for the 2000 evaluation. Other lines that had low infection levels include MSJ163-7R, MSJ147-1, MSJ047-5, MSE080-4, NY112, MSJ080-8, MSE018-1 and MSH067-3. The varieties classified as susceptible in this 2001 evaluation were Atlantic, Russet Burbank and Dakota Pearl.

Table 1

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ROUND WHITE CHIP POTATOES: EARLY HARVEST
MONTCALM RESEARCH FARM
AUGUST 6, 2001 (98 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	MAT[4]	CWT/A
ATLANTIC	**348**	**390**	**89**	**9**	**84**	**5**	**2**	**1.085**	**1.0**	**0**	**0**	**0**	**0**	**40**	**3.0**	**342**
MSH095-4	342	389	88	11	79	9	1	1.083	1.0	0	0	0	0	40	3.0	-
NY120	324	364	89	9	86	3	2	1.078	1.0	0	1	0	0	40	2.9	-
MSH067-3	308	347	89	9	80	8	2	1.082	1.0	2	0	0	0	40	2.8	-
MSH098-2	306	333	92	6	70	22	2	1.077	1.0	3	0	2	0	40	2.6	-
P83-11-5	289	379	76	11	71	6	13	1.079	1.0	1	0	3	0	40	2.6	279
W1386	286	366	78	17	74	4	5	1.074	1.0	1	0	0	0	40	2.5	-
MSH094-8	277	337	82	16	81	2	2	1.076	1.0	0	0	0	0	40	2.5	340*
DAKOTA PEARL	266	367	73	26	72	1	1	1.073	1.5	0	0	0	1	40	2.1	-
MSA091-1	261	331	79	12	72	7	9	1.078	1.0	0	1	2	0	40	2.5	260
PIKE	**249**	**280**	**89**	**10**	**84**	**5**	**1**	**1.078**	**1.0**	**0**	**0**	**0**	**0**	**40**	**3.4**	**264***
MSG227-2	247	313	79	19	75	4	2	1.076	1.0	2	0	0	0	40	3.4	287
SNOWDEN	**247**	**310**	**80**	**20**	**78**	**1**	**1**	**1.079**	**1.0**	**0**	**0**	**0**	**0**	**40**	**3.0**	**247**
MSI032-6	238	287	83	17	79	4	0	1.074	1.5	1	0	0	1	40	2.6	-
MSG015-C	238	315	76	23	67	8	2	1.070	1.5	0	0	0	0	40	2.4	294*
MSF099-3	205	282	73	25	70	3	3	1.080	1.0	2	1	0	0	40	2.8	245
MSJ461-1	204	320	64	36	63	0	1	1.067	1.0	0	0	0	0	40	3.1	-
MEAN	273	336						1.077								
$LSD_{0.05}$	50	52						0.004								

* Two-Year Average

[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]MATURITY RATING: Taken August 6, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)
Planted May 1, 2001

Table 2

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ROUND WHITE CHIP POTATOES: LATE HARVEST
MONTCALM RESEARCH FARM
SEPTEMBER 21, 2001 (144 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL	NURSERY	TRIAL		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]	SCAB[4]	MAT[5]	CWT/A
NY120	451	488	92	4	86	6	3	1.074	1.0	0	15	0	0	40	0.3	0.0	2.9	-
ATLANTIC	**448**	**491**	**91**	**7**	**81**	**10**	**2**	**1.081**	**1.0**	**4**	**0**	**14**	**3**	**40**	**1.8**	**2.0**	**3.0**	**397**
MSH095-4	444	496	89	8	74	15	3	1.080	1.5	1	2	1	0	40	0.7	0.8	3.0	-
MSG227-2	403	449	90	8	76	14	2	1.073	1.5	1	1	6	2	40	0.3	0.3	3.4	359
SNOWDEN	**396**	**458**	**86**	**13**	**83**	**4**	**1**	**1.076**	**1.5**	**0**	**2**	**0**	**0**	**40**	**-**	**1.8**	**3.0**	**338**
MSA091-1	395	460	86	8	75	10	6	1.075	1.5	1	3	8	6	40	0.3	0.0	2.5	332
MSH067-3	370	420	88	9	77	12	3	1.078	1.0	1	0	0	0	40	2.0	2.5	2.8	-
MSH094-8	370	420	88	10	76	12	2	1.073	1.0	0	0	10	2	40	1.3	0.8	2.5	399*
PIKE	**355**	**388**	**92**	**8**	**86**	**6**	**1**	**1.080**	**1.0**	**0**	**0**	**22**	**0**	**40**	**-**	**0.0**	**3.4**	**345***
W1386	345	436	79	11	69	11	10	1.073	1.5	1	7	2	0	40	1.5	2.3	2.5	-
MSH098-2	344	381	90	6	62	29	3	1.074	1.5	3	1	0	4	40	1.0	3.0	2.6	-
P83-11-5	332	455	73	9	68	5	18	1.075	1.0	4	2	3	7	40	1.0	1.0	2.6	320
DAKOTA PEARL	320	407	79	19	74	4	2	1.069	1.5	1	4	0	2	40	0.7	0.3	2.1	-
MSG015-C	304	384	79	18	71	8	3	1.067	2.0	0	5	0	0	40	1.0	0.3	2.4	352*
MSI032-6	301	352	86	12	79	7	2	1.070	1.0	0	2	2	1	40	3.0	2.3	2.6	-
MSJ461-1	300	451	66	33	66	0	1	1.067	1.0	0	0	0	0	40	1.0	1.0	3.1	-
MSF099-3	280	363	77	20	70	7	3	1.075	1.5	2	1	0	0	40	3.0	3.0	2.8	298
MEAN	362	429						1.074										
$LSD_{0.05}$	63	57						0.003										

* Two-Year Average

[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 6, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)
Planted May 1, 2001

Table 4

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ROUND WHITE TABLESTOCK POTATOES: LATE HARVEST
MONTCALM RESEARCH FARM
SEPTEMBER 18, 2001 (141 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL	NURSERY	TRIAL		3-YR AVG US#1
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	SCAB[3]	SCAB[3]	MAT[4]	CWT/A
MSF373-8	462	492	94	3	59	34	4	1.072	5	0	0	1	40	1.3	2.0	3.0	490*
ONAWAY	**383**	**423**	**91**	**7**	**86**	**5**	**3**	**1.063**	**0**	**8**	**0**	**0**	**40**	**0.8**	**0.5**	**1.9**	**396**
MSE018-1	359	421	85	13	76	10	2	1.075	0	16	4	0	40	2.3	3.0	4.0	426
MSB107-1	321	416	77	5	62	15	18	1.067	0	0	3	0	40	1.0	2.5	2.8	-
MICHIGAN PURPLE	320	358	89	7	78	12	3	1.065	0	0	0	2	40	2.0	3.3	2.0	-
EVA	318	351	90	7	77	14	2	1.061	3	2	0	2	40	1.7	2.5	2.0	-
MSE221-1	312	363	86	5	67	19	9	1.066	1	4	1	0	40	0.7	1.5	2.0	360
MSH031-5	310	366	85	11	80	4	5	1.071	0	2	0	0	40	2.7	2.8	2.5	378*
MSE149-5Y	303	358	85	9	73	11	6	1.059	10	1	1	0	40	1.3	1.5	2.0	329
MSF313-3	287	354	81	17	79	2	2	1.069	0	2	0	0	40	1.7	2.8	3.0	305
MSF060-6	267	297	90	8	82	8	2	1.073	1	5	3	1	40	0.3	0.3	3.0	-
SUPERIOR	**248**	**314**	**79**	**17**	**79**	**0**	**4**	**1.067**	**0**	**4**	**1**	**0**	**40**	**0.5**	**0.5**	**1.4**	**304**
MSG004-3	229	254	90	10	80	10	0	1.058	0	1	3	0	40	1.0	1.0	2.0	300*
JACQUELINE LEE	189	415	46	47	46	0	7	1.072	0	1	0	0	40	2.3	3.8	3.0	262
MEAN	308	370						1.067									
$LSD_{0.05}$	54	53						0.003									

* Two-Year Average

[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 6, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)
Planted May 1, 2001

Table 3

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ROUND WHITE TABLESTOCK POTATOES: EARLY HARVEST
MONTCALM RESEARCH FARM
AUGUST 6, 2001 (98 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	MAT[3]	CWT/A
ONAWAY	**448**	**483**	**93**	**6**	**89**	**4**	**1**	**1.071**	**0**	**0**	**0**	**0**	**40**	**1.9**	**377**
MICHIGAN PURPLE	399	428	93	7	87	6	0	1.073	2	0	0	0	40	2.0	-
MSE221-1	359	412	87	6	68	20	7	1.068	6	0	0	0	40	2.0	353
MSH031-5	348	398	88	12	85	2	1	1.070	2	0	0	0	40	2.5	375*
MSF373-8	324	351	92	5	73	19	3	1.074	8	0	0	0	40	3.0	395*
MSE149-5Y	316	378	83	13	77	6	3	1.065	3	0	1	0	40	2.0	300
MSB107-1	313	357	88	6	78	9	7	1.071	0	0	0	0	40	2.8	-
SUPERIOR	**307**	**367**	**84**	**15**	**81**	**3**	**2**	**1.071**	**0**	**1**	**0**	**0**	**40**	**1.4**	**312**
EVA	307	354	87	10	84	3	3	1.066	0	0	0	0	40	2.0	-
MSE018-1	268	349	77	22	74	3	1	1.079	0	0	0	0	40	4.0	343
MSF313-3	227	298	76	23	74	3	1	1.077	0	0	0	0	40	3.0	253
MSG004-3	221	254	87	11	81	6	2	1.062	0	0	0	0	40	2.0	266*
MSF060-6	216	249	87	13	84	2	0	1.075	1	0	0	1	40	3.0	-
JACQUELINE LEE	131	402	33	65	33	0	2	1.079	0	0	0	0	40	3.0	157
MEAN	299	363						1.072							
$LSD_{0.05}$	62	59						0.007							

* Two-Year Average

[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]MATURITY RATING: Taken August 6, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)
Planted May 1, 2001

Table 5

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

LONG WHITE and RUSSET TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 10, 2001 (133 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
A8893-1	390	508	77	19	62	14	4	1.068	11	0	2	1	40	0.0	2.6	379*
BANNOCK RUSSET	**370**	**443**	**84**	**15**	**65**	**18**	**1**	**1.074**	**0**	**1**	**0**	**0**	**40**	**0.0**	**4.8**	463*
AC87079-3	361	437	83	15	59	24	3	1.071	20	0	0	0	40	-	3.1	-
MSE202-3RUS	348	425	82	13	58	24	5	1.067	5	0	0	0	40	0.3	3.4	351
A90586-11	348	472	74	24	66	7	2	1.076	2	0	1	0	40	2.5	3.6	-
SILVERTON RUSSET	**342**	**423**	**81**	**17**	**70**	**11**	**2**	**1.065**	**1**	**1**	**1**	**0**	**40**	**0.0**	**3.3**	-
MSH026-3RUS	335	432	78	17	70	8	5	1.069	9	0	6	0	40	1.3	2.9	-
AC87138-4	323	426	76	18	57	19	6	1.071	12	1	0	0	40	0.7	4.0	-
MSB106-7	320	428	75	14	55	19	11	1.063	4	1	1	0	40	1.3	1.6	288
RUSSET NORKOTAH 3	310	383	81	17	60	21	2	1.066	14	1	1	3	40	0.0	2.6	-
W1876-1	301	381	79	20	75	4	1	1.070	0	0	0	0	40	0.3	2.0	-
AC89536-5	274	415	66	26	54	12	8	1.075	5	0	0	0	40	0.0	3.6	-
MSE192-8RUS	268	393	68	29	60	9	3	1.065	0	0	0	0	40	0.0	1.5	215
GOLDRUSH	**255**	**335**	**76**	**22**	**61**	**15**	**2**	**1.063**	**0**	**1**	**0**	**0**	**40**	**0.0**	**2.3**	-
TXNS278	253	384	66	32	57	9	2	1.064	2	1	1	0	40	-	1.6	-
TXNS223	245	350	70	28	56	14	2	1.063	0	0	0	0	40	0.3	1.8	-
RUSSET NORKOTAH	**242**	**368**	**66**	**34**	**61**	**5**	**0**	**1.065**	**1**	**0**	**0**	**0**	**40**	**0.0**	**1.5**	211
C085026-4	234	311	75	24	71	4	1	1.074	0	0	0	0	40	3.0	3.8	-
RUSSET NORKOTAH 8	231	331	70	26	57	13	4	1.064	4	2	0	0	40	0.0	1.9	-
W1879-1	185	321	57	42	56	1	1	1.070	1	0	0	0	40	1.0	1.8	-
RUSSET BURBANK	**177**	**335**	**53**	**26**	**49**	**4**	**21**	**1.067**	**0**	**2**	**0**	**0**	**40**	**0.7**	**2.8**	210
TXNS112	176	327	54	45	50	3	2	1.064	1	0	1	0	40	0.0	1.3	-

continued on following page:

LONG WHITE and RUSSET TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 10, 2001 (133 DAYS)

LINE	CWT/A		PERCENT OF TOTAL[1]					SP GR	TUBER QUALITY[2]				TOTAL			3-YR AVG
	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT	SCAB[3]	MAT[4]	US#1 CWT/A
continued:																
ATX85404-8W	471	528	89	10	71	18	0	1.067	9	0	2	0	40	0.7	3.5	-
NDTX4930-5W	409	475	86	13	83	3	1	1.070	3	4	1	0	40	2.7	2.4	-
MEAN	299	401						1.068								
$LSD_{0.05}$	69	76						0.003								* 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.

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

[4]MATURITY RATING: Taken August 17, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)

Planted May 1, 2001

Table 6

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

NORTH CENTRAL REGIONAL TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 5, 2001 (128 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]
ND5084-3R	516	570	91	8	74	16	1	1.053	0.7	0	1	9	0	40	0.7	3.8	
RED PONTIAC*	**468**	**553**	**84**	**9**	**76**	**9**	**7**	**1.056**	**3.0**	**2**	**2**	**1**	**1**	**30**	**2.0**	**2.8**	
NY112	459	503	91	8	81	10	0	1.072	1.5	0	3	4	0	40	0.7	3.3	3
D.R. NORLAND	**454**	**491**	**93**	**7**	**92**	**1**	**1**	**1.058**	**1.5**	**0**	**1**	**1**	**1**	**40**	**-**	**1.1**	3
W1386	446	496	90	8	78	12	2	1.075	1.5	0	11	1	0	40	1.0	3.3	
W1201	429	483	89	10	83	5	1	1.083	1.5	0	7	3	0	40	1.0	3.0	2
B0766-3	419	457	92	8	84	8	0	1.075	1.5	0	1	0	1	40	1.0	3.0	1
NORVALLEY	**396**	**499**	**79**	**20**	**76**	**4**	**1**	**1.069**	**1.0**	**1**	**4**	**2**	**0**	**40**	**-**	**2.4**	
MSF373-8	394	424	93	4	54	39	3	1.072	1.0	3	0	0	1	40	1.3	3.3	
A90586-11	376	472	80	16	70	10	5	1.074	2.0	3	2	0	0	40	2.5	3.3	
V0299-4	374	520	72	27	72	0	1	1.063	1.5	0	0	4	0	40	2.0	1.3	
MICHIGAN PURPLE	366	415	88	8	70	18	3	1.066	2.5	0	1	0	0	40	2.0	1.8	2
W1836-1RUS	361	447	81	19	77	4	1	1.073	2.0	2	1	0	0	40	0.0	3.1	1
DAKOTA ROSE	352	415	85	11	81	4	4	1.053	3.0	1	3	1	1	40	-	1.3	1
MN19525R	350	434	81	19	78	3	1	1.062	1.0	0	2	6	1	40	0.0	1.9	
CV89023-2	335	436	77	23	74	3	0	1.065	2.5	1	4	3	2	40	1.0	1.4	
ATLANTIC*	**335**	**384**	**87**	**11**	**73**	**14**	**2**	**1.080**	**1.5**	**7**	**1**	**8**	**6**	**30**	**1.8**	**2.7**	
W1431	327	384	85	14	84	1	1	1.074	1.5	1	1	1	0	40	0.7	2.8	
ND3196-1R	327	369	88	11	85	3	0	1.063	3.5	4	2	0	14	40	-	1.1	
MN18747	307	405	76	22	74	2	2	1.062	1.5	0	3	0	0	40	1.0	1.4	
MN19157	298	454	66	33	65	0	1	1.075	2.0	0	1	2	0	40	-	1.6	

continued on following page:

NORTH CENTRAL REGIONAL TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 5, 2001 (128 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:																	
V0168-3	278	361	77	20	71	6	3	1.062	2.5	1	0	0	1	40	2.3	1.0	
SNOWDEN	**277**	**370**	**75**	**24**	**71**	**4**	**1**	**1.073**	**1.0**	**3**	**4**	**0**	**1**	**40**	**-**	**2.3**	
RUSSET BURBANK*	**256**	**432**	**59**	**36**	**58**	**2**	**5**	**1.070**	**2.5**	**4**	**0**	**2**	**0**	**30**	**0.7**	**2.2**	
MSF099-3	237	294	81	12	68	12	8	1.078	1.5	0	2	1	2	40	2.7	2.4	
V0123-25	223	405	55	42	54	1	3	1.071	1.0	1	3	0	0	40	3.7	1.1	
RUSSET NORKOTAH*	**217**	**344**	**62**	**39**	**61**	**1**	**0**	**1.064**	**2.0**	**0**	**1**	**0**	**0**	**30**	**0.0**	**1.2**	**2**
MSE192-8RUS	189	307	61	37	57	4	2	1.065	2.5	0	0	0	0	40	0.0	1.3	3
MN19315	146	338	43	56	43	0	0	1.070	1.5	2	3	1	1	40	2.5	1.3	
MEAN	342	430						1.068									
$LSD_{0.05}$	81	75						0.002									

*These entries had 3 replications, as compared to the 4 replications for all other entries.

[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 17, 2001; 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 in each market class (rank order, 1 = best).
Planted May 1, 2001

Table 7

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

YELLOW FLESH and EUROPEAN TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 14, 2001 (137 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]
MSJ033-10Y	472	552	86	11	72	14	3	1.063	4.0	1	10	19	0	40	1.0	3.5
MSI005-20Y	455	560	81	16	76	6	3	1.068	2.5	0	1	0	2	40	2.0	2.5
MSG147-3P	431	503	86	8	70	15	6	1.058	1.5	0	0	0	0	40	2.0	3.8
MSJ453-4Y	416	541	77	19	74	3	4	1.084	2.0	5	6	5	1	40	2.3	5.0
TORRIDON	414	597	69	22	67	2	9	1.078	2.5	5	0	14	0	40	2.7	4.4
SAGINAW GOLD	**409**	**500**	**82**	**15**	**80**	**2**	**3**	**1.072**	**2.0**	**0**	**2**	**2**	**0**	**40**	**1.7**	**1.8**
MSH380-3Y	403	496	81	15	78	3	4	1.082	2.0	0	4	4	1	40	2.0	3.0
MSJ033-6Y	344	429	80	13	59	22	6	1.066	3.5	5	1	1	3	40	1.0	3.4
MSJ456-2Y	342	470	73	17	70	3	10	1.076	2.5	1	1	0	0	40	2.7	3.1
MSJ049-1Y	328	400	82	11	71	11	7	1.068	3.5	1	0	1	0	40	2.0	2.3
YUKON GOLD	**297**	**335**	**89**	**5**	**68**	**21**	**6**	**1.072**	**2.5**	**7**	**1**	**2**	**3**	**40**	**2.3**	**1.4**
MSJ472-4P	232	351	66	33	65	1	1	1.082	1.5	0	0	0	0	40	2.0	4.1
MSI092-3RY	225	359	63	34	50	12	4	1.066	3.0	1	1	3	0	40	2.7	2.1
MEAN	367	469						1.072								
$LSD_{0.05}$	69	68						0.004								

[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 17, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Planted May 1, 2001

Table 8

HERITAGE POTATO VARIETY TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 11, 2001 (134 DAYS)

YELLOW FLESH and NOVELTY LINES	CWT/A US#1	CWT/A TOTAL	PERCENT OF TOTAL[1] US#1	Bs	As	OV	PO	SP GR	CHIP SCORE[3]	TUBER QUALITY[2] HH	VD	IBS	BC	TOTAL CUT	SCAB[4]	MAT[5]	RAUDPC[6] x100	INCIDENCE OF VIRUS
Gold Nugget	267	353	76	17	75	1	8	1.066	1.5	0	3	6	0	20	1.0	3.8	18.0	PLRV
Viking Purple	243	277	88	10	79	9	2	1.063	2.5	0	1	0	0	20	0.5	1.3	34.4	PVY
Augsburg Gold	239	301	80	17	76	3	3	1.067	1.0	0	0	1	0	20	2.0	3.0	17.7	PLRV
Kerrs Pink	234	308	76	24	72	4	0	1.061	2.0	0	0	2	2	20	2.0	2.3	23.8	
Arran's Pilot*	229	295	78	9	71	7	14	1.063	1.5	0	6	1	1	20	0.3	2.3	30.0	
Purple Chief	221	264	84	10	80	4	6	1.062	2.0	0	3	6	0	20	1.5	1.0	28.7	
Carola	188	303	62	29	58	4	9	1.064	2.0	1	0	0	3	20	3.0	1.0	26.8	PLRV
All Blue	174	292	60	39	60	0	1	1.067	1.5	0	0	0	0	20	3.3	2.0	25.0	
German Butterball*	153	260	59	39	59	0	2	1.064	3.0	0	0	5	0	10	1.7	3.3	25.8	
Anoka	152	208	73	12	69	4	15	1.058	2.0	1	6	2	0	20	1.7	2.0	28.0	PLRV
Catriona	148	233	63	26	63	0	11	1.062	3.0	5	2	1	1	20	3.0	2.0	30.2	
Caribe*	132	149	89	11	80	8	0	1.069	1.0	0	0	0	0	20	0.5	1.0	-	
Rhine Gold	115	191	60	38	60	0	2	1.069	2.0	0	1	0	0	20	2.0	1.3	-	
Caribe Sport	78	103	76	24	73	3	0	1.063	2.0	0	0	1	0	20	0.3	1.0	32.5	VIRUS?
Blue Mac	43	96	44	35	44	0	20	1.059	1.0	0	0	7	0	20	2.5	3.0	33.3	PVY
MEAN	175	242						1.064										

continued on following page:

HERITAGE POTATO VARIETY TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 11, 2001 (134 DAYS)

YELLOW FLESH	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL			RAUDPC[6]	INCIDENCE
and NOVELTY LINES	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	x100	OF VIRUS
continued:																		
FINGERLINGS																		
Ozette	173	-	100	0	100	0	0	1.075	1.5	0	3	0	0	20	1.0	4.5	27.8	
French Fingerling	110	-	100	0	100	0	0	1.061	1.5	0	1	3	0	20	1.7	1.5	31.3	PVY
Rose Fin Apple	98	-	100	0	100	0	0	1.072	1.0	0	2	0	0	20	0.7	2.3	29.1	PVY
Red Thumb	87	-	100	0	100	0	0	1.066	1.5	0	0	2	0	20	1.0	1.0	33.0	PLRV
Russian Banana	86	-	100	0	100	0	0	1.062	2.5	0	1	0	0	20	0.7	1.5	33.0	PVY
Butterfinger*	80	-	100	0	100	0	0	1.069	1.5	0	2	1	0	20	2.0	2.3	30.6	PVY
Indian Pit	76	-	100	0	100	0	0	1.060	2.0	1	0	3	0	20	-	1.3	29.2	PVY
Cowhorn*	60	-	100	0	100	0	0	1.069	1.5	0	3	12	0	20	0.5	2.3	26.3	PVY
Purple Peruvian	52	-	100	0	100	0	0	1.083	1.5	0	0	0	0	20	1.5	5.0	25.8	
Huckleberry	32	-	100	0	100	0	0	1.059	1.5	0	0	0	0	20	0.0	1.0	38.2	PLRV
MEAN	85							1.068										

*Poor stand

[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 17, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering)
[6]RAUDPC: Relative Area Under the Disease Progress Curve (from MSU Late Blight Trial). A RAUDPC (x100) value > 15 is classified as susceptible to Late Blight.

Planted May 1, 2001

Table 9

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

ADAPTATION TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 21, 2001 (144 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL	NURSERY	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]
CACP10	501	547	92	7	82	9	1	1.075	1.5	0	5	0	0	40	1.3	3.0
ONAWAY	**477**	**507**	**94**	**5**	**90**	**5**	**1**	**1.066**	**-**	**0**	**12**	**0**	**0**	**40**	**0.8**	**1.5**
MSI037-4	458	528	87	12	79	8	2	1.076	2.0	0	4	0	1	40	3.0	4.5
A91790-13	450	519	87	13	82	5	1	1.078	1.0	0	1	0	1	40	2.0	4.0
MSI537-3	433	481	90	9	81	9	1	1.063	-	4	1	2	0	40	1.7	2.3
MSH333-3	432	475	91	8	85	6	1	1.068	1.5	0	0	1	0	40	3.7	2.4
CACP15	427	458	93	7	84	9	0	1.068	2.0	0	2	0	0	40	2.0	2.1
ATLANTIC	**426**	**453**	**94**	**5**	**76**	**18**	**1**	**1.084**	**1.5**	**5**	**0**	**6**	**1**	**40**	**1.8**	**3.0**
A90490-1	424	457	93	6	65	28	1	1.069	2.0	1	0	0	4	40	1.7	4.8
AF1763-2	419	509	82	15	79	4	2	1.058	2.5	0	0	0	1	40	2.0	1.5
MSH228-6	403	445	91	7	77	13	2	1.071	1.5	0	4	1	0	40	0.0	3.4
MSH041-1	398	429	93	7	68	25	1	1.068	1.5	3	3	0	2	40	2.0	2.3
CACP20	397	438	91	8	76	14	1	1.072	2.5	0	4	0	0	40	2.3	3.1
MSI077-5	381	423	90	9	73	17	1	1.068	-	0	1	0	0	40	3.0	3.0
MSI085-10	379	435	87	12	75	12	1	1.077	1.0	0	3	1	0	40	3.3	3.9
AC87340-2	379	469	81	19	77	4	1	1.070	1.0	0	2	0	0	40	2.0	2.8
MSI582-A	371	421	88	8	77	12	4	1.066	-	0	1	0	2	40	2.3	3.1
SNOWDEN	**371**	**425**	**87**	**12**	**84**	**4**	**0**	**1.075**	**1.5**	**0**	**1**	**0**	**1**	**40**	**-**	**2.8**
AF1615-1	358	412	87	12	78	10	1	1.067	2.0	1	2	2	1	40	1.3	2.9
SUPERIOR	**356**	**404**	**88**	**11**	**86**	**2**	**1**	**1.067**	**-**	**0**	**3**	**0**	**1**	**40**	**0.7**	**1.1**
CACP25	350	417	84	16	83	1	0	1.071	1.5	1	0	0	0	40	1.3	2.0
MSJ438-2	348	451	77	21	76	2	2	1.098	2.0	1	4	0	0	40	0.7	4.6
MSJ307-2	329	390	84	10	65	20	5	1.056	-	0	0	0	0	40	1.7	3.5
MSE080-4	328	360	91	8	62	29	1	1.070	1.0	4	1	0	0	40	0.7	1.9
BC0894-2	317	391	81	17	79	2	1	1.062	1.0	0	1	0	0	40	2.0	1.4

continued on following page:

ADAPTATION TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 21, 2001 (144 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL	NURSERY	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]
continued:																
MSI083-5	312	361	86	12	76	11	2	1.072	1.0	2	1	2	0	40	2.3	3.6
MSH017-C	306	335	91	6	67	24	3	1.081	1.5	4	1	0	0	40	1.7	2.6
MSH360-1	303	363	83	13	72	12	4	1.077	2.0	2	1	0	0	40	2.0	2.4
AF1758-7	298	395	75	12	60	16	13	1.052	-	1	4	3	2	40	0.7	3.3
MSH120-1	294	398	74	25	71	3	1	1.071	2.5	5	0	2	11	40	0.7	2.8
MSJ319-7	286	330	87	12	74	13	2	1.068	-	0	1	0	0	40	1.7	3.6
MSH015-2	284	342	83	13	80	3	4	1.081	1.0	1	0	2	1	40	1.3	2.3
MSH356-A	280	332	84	13	77	7	2	1.077	1.5	2	2	0	0	40	0.3	2.6
MSH370-3	270	385	70	29	69	1	1	1.075	1.0	0	1	0	0	40	2.0	1.4
MSI004-3	262	353	74	20	68	7	5	1.072	-	1	3	0	0	40	0.7	1.4
MSI111-A	254	291	87	11	73	14	1	1.082	1.0	21	0	0	0	40	0.0	3.9
A92584-3BB	246	471	52	46	52	0	2	1.063	-	0	1	1	0	40	3.3	2.1
MSJ042-3	241	379	64	36	63	0	1	1.076	1.0	0	1	4	0	40	2.5	1.8
MSJ126-9	241	306	79	21	75	4	1	1.072	1.0	0	1	0	0	40	1.0	1.6
MSG301-9	231	282	82	16	75	7	2	1.069	2.0	0	2	1	0	40	0.0	1.5
MSNT-1	217	297	73	26	71	2	1	1.074	-	1	2	0	0	40	0.0	2.1
MEAN	347	411						1.071								
$LSD_{0.05}$	53	51						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 17, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

Planted May 1, 2001

PRELIMINARY TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 27, 2001 (149 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL			PEDIGREE	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	FEMALE	MALE
MSK068-2	480	580	83	16	77	6	2	1.070	-	1	2	1	1	20	2.3	3.8	E041-1	H142-2
MSJ167-1	470	551	85	12	78	7	3	1.083	1.5	0	0	0	0	20	1.0	4.5	P84-13-12	E250-2
MSJ080-1	436	488	89	10	74	15	1	1.062	1.0	0	0	0	0	20	1.0	1.8	C148-A	S440
MSK217-3P	427	476	90	6	59	31	4	1.066	-	0	0	0	1	20	1.0	2.0	RUSSIAN BLUE	PICASSO
MSI152-A *	416	482	86	11	67	19	3	1.062	-	1	0	0	0	20	1.7	2.5	MAINESTAY	B0718
MSJ080-8	412	461	89	9	80	10	1	1.071	1.0	1	0	0	0	20	1.0	1.8	C148-A	S440
MSK409-1	412	464	89	10	74	15	1	1.073	-	1	0	0	0	20	1.5	2.8	C148-A	A091-1
MSJ204-3	406	458	89	6	75	14	5	1.058	-	0	1	0	0	20	1.0	2.8	SUPERIOR	OP
ONAWAY	**402**	**430**	**94**	**5**	**82**	**12**	**2**	**1.063**	**-**	**0**	**1**	**0**	**0**	**20**	**0.8**	**1.0**		
MSK476-1	402	452	89	9	81	7	3	1.087	1.0	3	0	0	2	20	1.0	2.3	H361-1	H228-6
MSK125-3	402	483	83	15	75	8	2	1.068	-	6	0	0	0	20	-	1.3	G214-1	G274-3
MSJ147-1	386	473	82	14	78	3	4	1.072	1.0	0	0	3	0	20	2.0	1.8	ND2417-6	S440
MSK061-4	373	441	85	15	85	0	0	1.080	1.5	0	0	0	0	20	0.3	1.5	C148-A	ND2676-10
MSJ197-1	369	393	94	5	56	37	1	1.066	1.0	0	1	0	1	20	2.7	2.8	SNOWDEN	A7961-1
MSK247-9Y	350	401	87	10	77	11	3	1.069	-	7	0	0	0	20	0.7	1.5	YUKON GOLD	PICASSO
MSJ163-7R	335	387	86	14	74	12	0	1.090	1.5	1	0	0	1	20	2.3	1.3	PIKE	ZAREVO
MSJ143-4	326	420	78	21	75	3	1	1.079	1.5	0	0	0	0	20	2.0	1.8	ND01496-1	S440
MSK469-1	292	379	77	22	71	6	1	1.081	-	0	0	1	2	20	2.0	2.0	H216-1	H228-6
MSK004-2Y	287	375	76	17	65	11	7	1.062	-	0	0	1	0	20	0.7	1.0	A097-1	PICASSO
MSI061-B	287	331	87	12	73	13	1	1.069	-	2	0	0	1	20	1.0	1.0	BRODICK	ND01496-1
MSJ047-5	282	379	74	24	74	0	1	1.076	1.0	0	0	0	0	20	1.3	1.3	B076-2	S438
MSJ168-2Y	266	296	90	8	79	11	2	1.065	-	0	2	0	0	20	1.7	1.3	P84-13-12	ND860-2
MSJ157-B	265	342	78	13	54	24	9	1.078	-	1	0	6	0	20	2.0	2.0	PIKE	C127-3

continued on following page:

PRELIMINARY TRIAL
MONTCALM RESEARCH FARM
SEPTEMBER 27, 2001 (149 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL			PEDIGREE	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	FEMALE	MALE
continued:																		
MSJ494-1	249	349	71	27	70	2	2	1.087	1.5	2	1	0	0	20	1.0	2.0	PIKE	ZAREVO
MSJ170-4	245	358	68	30	68	1	1	1.078	1.0	0	1	0	0	20	1.7	1.8	P84-13-12	S440
MSJ482-2	216	327	66	31	66	0	3	1.092	1.5	0	0	0	0	20	1.5	1.5	ZAREVO	C127-3
MSK236-5	189	266	71	24	69	2	5	1.077	1.0	1	0	0	1	20	1.7	1.5	SNOWDEN	H094-3
MEAN	348	416						1.073										
$LSD_{0.05}$	96	107						0.005										

[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 September 4, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).
Planted May 2, 2001 * MSI152-A has demonstrated resistance to Late Blight (*Phytopthora infestans*) in inoculated field trials.

PRELIMINARY TRIAL (LATE BLIGHT PEGRIGREE MATERIAL)
MONTCALM RESEARCH FARM
SEPTEMBER 27, 2001 (142 DAYS)

	CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL				PEDIGREE	
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT	SCAB[4]	MAT[5]	LB[6]	FEMALE	MALE
MSJ316-AY	555	603	92	7	74	18	1	1.074	-	0	0	6	0	20	1.0	4.3	S	PIKE	B0718-3
ATLANTIC	**534**	**551**	**97**	**3**	**63**	**34**	**0**	**1.083**	**1.0**	**5**	**0**	**3**	**2**	**20**	**1.8**	**1.8**	**S**		
MSJ031-6	520	577	90	8	82	8	2	1.068	1.0	2	0	0	0	20	1.0	1.3	RS	ATLANTIC	TOLLOCAN
MSK498-1Y	489	540	91	8	84	6	1	1.072	-	0	0	0	0	20	1.0	3.0	S	SAGINAW GOLD	BRODICK
MSJ317-1 *	486	521	93	5	87	6	2	1.074	1.5	0	0	0	0	20	2.0	4.0	LBR	PRESTILE	B0718-3
MSK214-1R	484	534	91	8	77	14	1	1.062	-	0	0	1	0	20	0.5	2.0	S	PRESTILE	PICASSO
MSJ036-A	467	523	89	11	84	5	0	1.074	-	0	0	1	5	20	0.0	2.0	S	A7961-1	ZAREVO
MSI049-A	459	524	88	10	65	23	3	1.060	-	2	0	2	0	20	1.5	1.5	S	BRODICK	C121-7
MSK034-1 *	446	505	88	8	79	9	4	1.072	1.0	1	0	0	0	20	2.0	3.5	LBR	B0718-3	H133-2
MSK410-2Y	424	500	85	13	81	4	2	1.082	1.5	0	1	0	1	20	2.0	3.0	S	C148-A	G274-3
MSJ456-4Y	397	490	81	18	79	2	1	1.077	-	1	1	2	2	20	1.0	3.3	LBR	CONESTOGA	TOLLOCAN
MSK128-1	367	396	93	6	71	21	2	1.075	1.5	1	0	0	7	20	3.0	1.5	LBR	G274-3	H094-3
SNOWDEN	**364**	**411**	**89**	**11**	**83**	**5**	**0**	**1.076**	**1.0**	**0**	**0**	**0**	**0**	**20**	**-**	**2.3**	**S**		
MSJ319-1 *	356	458	78	22	73	4	1	1.084	1.0	0	0	0	0	20	0.5	2.8	LBR	B0718-3	W870
MSJ482-1	315	355	89	8	80	9	3	1.100	1.0	12	0	0	0	20	1.0	3.3	RS	ZAREVO	C127-3
MSK136-2 *	299	376	79	20	78	2	1	1.078	-	0	0	0	0	20	1.0	3.0	LBR	GRETA	B0718-3
MSJ334-1Y *	293	370	79	15	64	15	6	1.075	-	0	1	1	0	20	1.5	3.5	MR	D040-4	BRADOR
MSK101-2Y	247	304	81	14	80	2	5	1.072	1.5	0	0	0	0	20	1.5	1.5	LBR	F059-1	G274-3
MEAN	417	474						1.075											
$LSD_{0.05}$	99	106						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 September 4, 2001; Ratings 1-5; 1: Early (vines completely dead); 5: Late (vigorous vine, some flowering).

[6]LATE BLIGHT RATING: Reaction to foliar *Phytopthora infestans* ; LBR: Resistant; MR: Moderately Resistant; RS: Reduced Susceptibility; S: Susceptible.

Planted May 9, 2001

* These lines have also demonstrated tuber resistance to Late Blight in the laboratory.

Table 11

2001 SCAB DISEASE TRIAL
SCAB NURSERY, EAST LANSING, MI

Potato Line	Mean Rating * (0-5)	Worst Rating (0-5)	Reps
RESISTANT CATEGORY:			
A8893-1	0.0	0	3
AC87079-3RUS	0.0	0	3
AC89536-5RD	0.0	0	3
BANNOCK RUSSET	0.0	0	2
GOLDRUSH	0.0	0	3
HUCKLEBERRY	0.0	0	2
MN19525	0.0	0	2
MSE192-8RUS	0.0	0	3
MSG301-9	0.0	0	3
MSH228-6	0.0	0	3
MSI111-A	0.0	0	3
MSJ036-A	0.0	0	2
MSNT-1	0.0	0	3
RN-3	0.0	0	3
RN-8	0.0	0	3
RUSSET NORKOTAH	**0.0**	**0**	**3**
SILVERTON RUSSET	0.0	0	3
TXNS 112	0.0	0	2
W1836-1	0.0	0	3
ARRON'S PILOT	0.3	1	3
CARIBE SPORT	0.3	1	3
LIBERATOR (MSA091-1	0.3	1	3
MSE202-3RUS	0.3	1	3
MSF060-6	0.3	1	3
MSG227-2	0.3	1	3
MSH356-A	0.3	1	3
MSJ465-6Y	0.3	1	3
MSK061-4	0.3	1	3
NY120	0.3	1	6
OZETTE	0.3	1	3
TXNS 223	0.3	1	3
W1876-1RUS	0.3	1	3

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Reps
RESISTANT CATEGORY:			
CARIBE	0.5	1	2
COWHORN	0.5	1	2
MSJ319-1	0.5	1	2
MSK214-1R	0.5	1	2
VIKING PURPLE	0.5	1	2
SUPERIOR	**0.6**	**1**	**9**
AC87138-4RUS	0.7	1	3
AF1758-7	0.7	1	3
ATX85404-8W	0.7	2	3
DAKOTA PEARL	0.7	1	3
MSE080-4	0.7	1	3
MSE221-1	0.7	1	3
MSH095-4	0.7	1	3
MSH120-1	0.7	2	3
MSI004-3	0.7	1	3
MSJ438-2	0.7	2	3
MSJ458-2	0.7	2	3
MSK004-2Y	0.7	1	3
MSK247-9Y	0.7	1	3
ND5084-3R	0.7	1	3
NY112	0.7	2	3
ROSE FINN APPLE	0.7	1	3
RUSSET BURBANK	**0.7**	**1**	**3**
RUSSIAN BANANA	0.7	1	3
ONAWAY	**0.9**	**1**	**6**

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Reps
MODERATELY RESISTANT CATEGORY:			
B0766-3	1.0	1	6
MSB107-1	1.0	1	3
CHERRY RED	1.0	1	2
CV89023-2	1.0	3	3
MSG004-3	1.0	1	3
MSG015-C	1.0	1	3
MSG153-2Y	1.0	1	1
GOLD NUGGET	1.0	1	3
MN18747	1.0	1	2
MSH098-2	1.0	2	3
MSI061-B	1.0	1	2
MSJ031-6	1.0	1	2
MSJ033-10Y	1.0	2	3
MSJ080-1	1.0	2	2
MSJ080-8	1.0	1	3
MSJ126-9	1.0	1	3
MSJ167-1	1.0	2	3
MSJ204-3	1.0	1	3
MSJ316-AY	1.0	1	2
MSJ456-4Y	1.0	1	1
MSJ461-1	1.0	2	3
MSJ462-A	1.0	1	2
MSJ482-1	1.0	1	2
MSJ494-1	1.0	1	3
MSK070-2Y	1.0	1	2
MSK136-2	1.0	1	2
MSK217-3P	1.0	1	2
MSK476-1	1.0	2	3
MSK498-1Y	1.0	1	2
P83-11-5	1.0	1	3
MSR4-2	1.0	1	1
RED THUMB	1.0	1	3
W1201	1.0	2	3
W1431	1.0	2	5
W1879-1	1.0	2	3

*SCAB DISEASE RATING: MSU Scab Nursery; 0: No Infection; 1: Low Infection <5%; 3: Intermediate; 5: Highly Susceptible.
Planted: May 3, 2001 Harvested: Aug. 31, 2001

Table 11 continued

2001 SCAB DISEASE TRIAL
SCAB NURSERY, EAST LANSING, MI

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Reps
SUSCEPTIBLE CATEGORY:			
W1386	1.3	3	9
AF1615-1	1.3	2	3
CAPC10	1.3	2	3
CAPC25	1.3	2	3
MSB106-7	1.3	2	3
MSE149-5Y	1.3	2	3
MSF373-8	1.3	2	3
MSH015-2	1.3	2	3
MSH026-3RUS	1.3	2	3
MSH094-8	1.3	2	3
MSJ047-5	1.3	2	3
W1355-1	1.3	2	3
MSI049-A	1.5	2	2
MSJ153-2Y	1.5	2	2
MSJ334-1Y	1.5	2	2
MSJ464-5	1.5	2	2
MSJ482-2	1.5	2	2
MSK101-2	1.5	2	2
MSK193-1	1.5	2	2
MSK223-5	1.5	2	2
MSK409-1	1.5	2	2
PURPLE CHIEF	1.5	2	2
PURPLE PERUVIAN	1.5	3	2
A90490-1	1.7	3	3
ANOKA	1.7	2	3
EVA	1.7	2	3
FRENCH FINGERLING	1.7	2	3
GERMAN BUTTERBALL	**1.7**	**3**	**3**
MSF313-3	1.7	3	3
MSH017-C	1.7	2	3
MSH063-1	1.7	3	3
MSI026-A	1.7	3	3
MSI152-A	1.7	3	3
MSI537-3	1.7	2	3
MSJ168-2Y	1.7	2	3
MSJ170-4	1.7	3	3
MSJ307-2	1.7	3	3
MSJ319-7	1.7	2	3
MSJ457-2	1.7	3	3
MSK219-8RY	1.7	2	3
MSK236-5	1.7	2	3
MSK418-1	1.7	4	3
SAGINAW GOLD	**1.7**	**2**	**3**
ATLANTIC	**1.8**	**3**	**8**

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Reps
SUSCEPTIBLE CATEGORY:			
A91790-13	2.0	3	3
AC87340-2W	2.0	3	3
AF1763-2	2.0	4	3
AUSBURG GOLD	2.0	3	3
BC0894-2W	2.0	4	3
BUTTERFINGER	2.0	3	3
CAPC15	2.0	3	3
KERR'S PINK	2.0	2	2
MICHIGAN PURPLE	2.0	3	3
MSG147-3P	2.0	3	3
MSH041-1	2.0	3	3
MSH067-3	2.0	3	3
MSH360-1	2.0	3	3
MSH370-3	2.0	2	3
MSH380-3Y	2.0	3	3
MSI005-20Y	2.0	3	3
MSJ049-1Y	2.0	3	3
MSJ143-4	2.0	3	3
MSJ147-1	2.0	3	3
MSJ157-B	2.0	3	3
MSJ317-1	2.0	3	2
MSJ472-4P	2.0	3	3
MSK034-1	2.0	2	2
MSK244-6	2.0	3	3
MSK410-2Y	2.0	3	2
MSK438-4	2.0	3	3
MSK469-1	2.0	3	3
RED PONTIAC	**2.0**	**3**	**2**
RHINE GOLD	2.0	2	2
V0299-4	2.0	3	3
CAPC20	2.3	3	3
JACQUELINE LEE (MSG274-3)	2.3	3	3
MSE018-1	2.3	3	3
MSI083-5	2.3	3	3
MSI582-A	2.3	3	3
MSJ163-7R	2.3	3	3
MSJ430-6Y	2.3	3	3
MSJ453-4Y	2.3	3	3
MSK039-3	2.3	3	3
MSK068-2	2.3	3	3
MSR6-2	2.3	3	3
V0168-3	2.3	3	3
YUKON GOLD	**2.3**	**3**	**3**

Potato Line	Mean Rating (0-5)	Worst Rating (0-5)	Reps
SUSCEPTIBLE CATEGORY:			
A90586-11	2.5	4	6
AF1424-7	2.5	4	2
AF1775-2	2.5	4	2
BLUE MAC	2.5	3	2
MN19315	2.5	3	2
MSJ042-3	2.5	3	2
MSJ308-BY	2.5	3	2
MSK003-1Y	2.5	3	2
NDTX4930-5W	2.6	4	3
MSE228-1	2.7	3	3
MSF099-3	2.7	3	3
MSH018-5	2.7	3	3
MSH031-5	2.7	3	3
MSI092-3RY	2.7	3	3
MSI201-2PY	2.7	4	3
MSJ132-1Y	2.7	4	3
MSJ197-1	2.7	3	3
MSJ343-1	2.7	3	3
MSJ456-2Y	2.7	3	3
MSR3-110	2.7	4	3
TORRIDON	2.7	3	3
C085026-4RD	3.0	4	3
CAROLA	3.0	5	2
CATRIONA	3.0	4	3
MSF099-3	3.0	4	3
MSH217-1	3.0	4	3
MSI032-6	3.0	3	3
MSI037-4	3.0	4	3
MSI077-5	3.0	4	3
MSJ142-3	3.0	3	1
MSJ459-4	3.0	3	2
MSK128-1	3.0	3	2
PURPLE #5	3.0	3	2
A92584-3BB	3.3	5	3
ALL BLUE	3.3	5	3
MSI085-10	3.3	4	3
MSR3-105	3.3	5	3
MSH308-2Y	3.5	4	2
MSH333-3	3.7	4	3
V0123-25	3.7	5	3

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

2001 LATE BLIGHT VARIETY TRIAL
MUCK SOILS RESEARCH FARM

Foliar Resistance Category:

LINE	N	RAUDPC[1] MEAN
LBR9	3	0.0
LBR8	2	0.0
WTS1212-1	3	0.1
B0767-2	3	0.1
WTS1212-6	3	0.2
MSJ461-1	3	0.2
MSJ457-2	2	0.2
MSJ459-4	3	0.3
WTS1217-7	3	0.3
MSJ453-4Y	3	0.4
AWN86514-2	3	0.4
MSJ456-4Y	3	0.4
TORRIDON	3	0.4
MSJ464-5	3	0.5
WTS1217-4	3	0.6
JACQUELINE LEE	**3**	**0.7**
A90586-11	6	0.7
B0718-3	3	0.8
WTS1216-4	3	0.8
B0692-4	3	1.0
MSK136-2	3	1.2
MSJ317-1	2	1.5
MSJ319-1	3	1.5
MSJ343-1	3	1.6
MSK128-1	2	1.6
WTS1217-3	3	1.7
MSJ307-2	2	1.7
MSJ319-7	3	1.9
MSI152-A	3	2.0
MSJ458-2	2	2.1
MSK101-2	2	2.3
MSJ456-2Y	3	2.7
MSJ031-6	3	5.1
MSK034-1	3	6.2
MSJ334-1Y	2	6.2

Foliar Susceptibility Category (select lines):

LINE	N	RAUDPC[1] MEAN
WTS1221-1	3	13.3
YUKON GOLD	**2**	**13.6**
SNOWDEN	**3**	**16.0**
BANNOCK RUSSET	3	16.3
EVA (NY103)	2	16.8
WTS1212-7	1	17.6
KEUKA GOLD (NY101)	3	18.0
KEYSTONE RUSSET	3	18.9
SILVERTON RUSSET	3	19.8
WTS1212-2	3	23.7
RUSSET BURBANK	**5**	**24.4**
RUSSET GEM	2	24.4
RUSSET NORKOTAH	**6**	**24.6**
WWW297	3	24.9
ATLANTIC	**6**	**24.9**
SUPERIOR	**6**	**25.2**
SHEPODY	**1**	**25.3**
CACP10	3	26.4
CACP20	3	27.6
RANGER RUSSET	2	27.7
CACP15	3	27.9
CACP25	3	28.3
RED LASODA	**2**	**30.0**
DARK RED NORLAND	**2**	**30.1**
ONAWAY	**3**	**31.0**
MICHIGAN PURPLE	3	36.0

[1] Ratings indicate the RAUDPC (Relative Area Under the Disease Progress Curve) over the entire plot.
[2] Over 200 varieties and 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 7.0 and less are considered resistant in 2001.

Phytopthora infestans isolates 94-3, 95-7, 98-2, 00-1 inoculated 28 July 2001.
Planted as a randomized complete block design consisting of 3 replications of 4 hill plots on 14 June 2001.

Table 13A

2001 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
SIMULATED BRUISE SAMPLES*

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
ROUND WHITES: CHIP									
MSH098-2	25						25	100	0.00
MSH067-3	23	2					25	92	0.08
MSI032-6	20	5					25	80	0.20
P83-11-5	20	4	1				25	80	0.24
DAKOTA PEARL	18	6	1				25	72	0.32
MSG227-2	16	7	1	1			25	64	0.48
MSH094-8	15	9			1		25	60	0.52
PIKE	17	5	1	2			25	68	0.52
MSA091-1	13	9	3				25	52	0.60
MSF099-3	15	6	3	1			25	60	0.60
MSJ461-1	13	9	3				25	52	0.60
NY120	13	8	3	1			25	52	0.68
SNOWDEN	9	10	3	2	1		25	36	1.04
W1386	9	10	4	1		1	25	36	1.04
ATLANTIC	5	14	4	2			25	20	1.12
MSG015-C	7	3	3	7	4	1	25	28	2.04
MSH095-4	4	6	4	4	4	3	25	16	2.28
ROUND WHITES: TABLE									
MSH031-5	23	2					25	92	0.08
EVA	21	4					25	84	0.16
SUPERIOR	19	5	1				25	76	0.28
MSE149-5Y	18	6	1				25	72	0.32
MICHIGAN PURPLE	16	8	1				25	64	0.40
ONAWAY	18	5	1	1			25	72	0.40
MSF373-8	16	4	5				25	64	0.56
MSF313-3	16	5	2	2			25	64	0.60
MSE221-1	13	9	2	1			25	52	0.64
MSG004-3	15	4	6				25	60	0.64

* 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 29, 2001. The table is presented in ascending order of average number of spots per tuber.

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSB107-1	11	8	4	1	1		25	44	0.92
MSE018-1	6	10	5	4			25	24	1.28
JACQUELINE LEE	5	4	10	4	1	1	25	20	1.80
MSF060-6	3	8	8	1	5		25	12	1.88
LONG WHITES and RUSSETS									
W1876-1	23	2					25	92	0.08
MSE202-3RUS	22	3					25	88	0.12
MSH026-3RUS	22	3					25	88	0.12
ATX85404-8W	22	2	1				25	88	0.16
BANNOCK RUSSET	21	3	1				25	84	0.20
AC87079-3	19	6					25	76	0.24
AC89536-5	21	2	2				25	84	0.24
GOLDRUSH	20	4	1				25	80	0.24
TXNS112	20	4	1				25	80	0.24
MSE192-8RUS	18	7					25	72	0.28
C085026-4	17	8					25	68	0.32
RUSSET NORKOTAH 3	18	6	1				25	72	0.32
TXNS278	19	5		1			25	76	0.32
RUSSET NORKOTAH	19	3	2	1			25	76	0.40
W1879-1	17	6	2				25	68	0.40
AC87138-4	17	5	3				25	68	0.44
TXNS223	18	4	2	1			25	72	0.44
RUSSET NORKOTAH 8	14	10	1				25	56	0.48
SILVERTON RUSSET	16	6	2	1			25	64	0.52
A8893-1	15	7	2	1			25	60	0.56
A90586-11	16	5	3	1			25	64	0.56
NDTX4930-5W	13	9	3				25	52	0.60
RUSSET BURBANK	12	6	5	2			25	48	0.88
MSB106-7	10	7	3	4	1		25	40	1.16
NORTH CENTRAL REGIONAL TRIAL									
D.R. NORLAND	25						25	100	0.00
W1431	23	2					25	92	0.08
MSF099-3	21	4					25	84	0.16
ND5084-3R	22	2	1				25	88	0.16
DAKOTA ROSE	21	3	1				25	84	0.20
MN19315	19	6					25	76	0.24
MSE192-8RUS	20	4	1				25	80	0.24
CV89023-2	18	7					25	72	0.28
MN19525R	17	7	1				25	68	0.36
MSF373-8	17	7	1				25	68	0.36

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
V0168-3	19	3	3				25	76	0.36
RED PONTIAC	17	6	2				25	68	0.40
A90586-11	15	9	1				25	60	0.44
ATLANTIC	17	6	1	1			25	68	0.44
RUSSET NORKOTAH	15	9	1				25	60	0.44
V0123-25	16	7	1	1			25	64	0.48
MN18747	13	10	2				25	52	0.56
MN19157	14	8	3				25	56	0.56
V0299-4	14	9		2			25	56	0.60
MICHIGAN PURPLE	12	11	1	1			25	48	0.64
W1201	17	3	2	3			25	68	0.64
SNOWDEN	10	8	6	1			25	40	0.92
W1386	9	11	3	2			25	36	0.92
B0766-3	9	8	8				25	36	0.96
NY112	10	8	5	2			25	40	0.96
W1836-1RUS	6	14	3	1	1		25	24	1.08
NORVALLEY	9	6	8	2			25	36	1.12
RUSSET BURBANK	4	7	9	4	1		25	16	1.64
YELLOW FLESH and EUROPEAN TRIAL									
MSG147-3P	22	3					25	88	0.12
MSJ472-4P	20	5					25	80	0.20
YUKON GOLD	19	5	1				25	76	0.28
MSJ033-6Y	19	5		1			25	76	0.32
MSJ033-10Y	16	6	3				25	64	0.48
TORRIDON	12	9	4				25	48	0.68
MSH380-3Y	13	6	5	1			25	52	0.76
MSI092-3RY	10	10	3	2			25	40	0.88
SAGINAW GOLD	11	8	4	2			25	44	0.88
MSJ456-2Y	8	6	10	1			25	32	1.16
MSJ453-4Y	4	12	6	3			25	16	1.32
ADAPTATION TRIAL									
MSJ042-3	25						25	100	0.00
AF1758-7	23	2					25	92	0.08
BC0894-2	24		1				25	96	0.08
MSJ126-9	23	2					25	92	0.08
A91790-13	22	3					25	88	0.12
AC87340-2	22	3					25	88	0.12
AF1763-2	22	3					25	88	0.12
MSH120-1	22	3					25	88	0.12
MSH370-3	21	4					25	84	0.16

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
A92584-3BB	21	3	1				25	84	0.20
MSG301-9	21	3	1				25	84	0.20
MSI077-5	20	5					25	80	0.20
MSJ319-7	21	3	1				25	84	0.20
MSE080-4	20	4	1				25	80	0.24
SUPERIOR	20	4	1				25	80	0.24
MSH228-6	20	3	2				25	80	0.28
CACP15	18	6	1				25	72	0.32
MSH041-1	17	7	1				25	68	0.36
MSH360-1	18	5	2				25	72	0.36
ONAWAY	18	5	2				25	72	0.36
A90490-1	17	7		1			25	68	0.40
MSH015-2	15	10					25	60	0.40
MSI083-5	17	7		1			25	68	0.40
CACP25	17	6	1	1			25	68	0.44
MSH333-3	18	4	2	1			25	72	0.44
MSI582-A	18	4	2	1			25	72	0.44
CACP10	15	7	3				25	60	0.52
AF1615-1	15	7	2	1			25	60	0.56
MSH356-A	16	4	5				25	64	0.56
MSI004-3	16	5	3	1			25	64	0.56
MSJ438-2	14	7	4				25	56	0.60
MSI037-4	14	8	1	1	1		25	56	0.68
MSI111-A	14	6	3	2			25	56	0.72
MSI085-10	13	6	5	1			25	52	0.76
CACP20	9	12	2	1	1		25	36	0.92
MSH017-C	10	10	2	2		1	25	40	1.00
SNOWDEN	9	7	8	1			25	36	1.04
ATLANTIC	9	3	9	3	1		25	36	1.36
PRELIMINARY TRIAL									
MSJ080-1	19	5	1				25	76	0.28
MSI049-A	17	7	1				25	68	0.36
MSJ204-3	16	6	3				25	64	0.48
MSJ319-1	15	8	2				25	60	0.48
MSI061-B	17	4	3	1			25	68	0.52
MSJ031-6	15	7	3				25	60	0.52
MSK061-4	15	7	2	1			25	60	0.56
MSK125-3	13	9	3				25	52	0.60
MSJ047-5	14	7	3	1			25	56	0.64
MSJ080-8	11	12	2				25	44	0.64
MSJ163-7R	11	12	2				25	44	0.64

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSJ482-2	14	7	3	1			25	56	0.64
MSJ170-4	13	8	3	1			25	52	0.68
MSJ334-1Y *	12	10	1	2			25	48	0.72
MSK217-3P	13	7	4	1			25	52	0.72
MSJ197-1	10	12	2	1			25	40	0.76
MSJ147-1	11	11	2			1	25	44	0.80
ONAWAY	10	10	5				25	40	0.80
MSK034-1 *	11	7	6	1			25	44	0.88
MSK498-1Y	11	7	6	1			25	44	0.88
MSJ494-1	8	11	6				25	32	0.92
MSK136-2	8	9	7	1			25	32	1.04
MSJ157-B	7	13	3	1		1	25	28	1.08
MSK236-5	8	9	6	2			25	32	1.08
MSK476-1	8	10	4	3			25	32	1.08
MSK068-2	9	7	5	3	1		25	36	1.20
MSK214-1R	7	10	5	2	1		25	28	1.20
MSK409-1	5	11	7	2			25	20	1.24
MSI152-A *	7	9	4	4	1		25	28	1.32
MSJ482-1	6	9	7	2	1		25	24	1.32
MSK247-9Y	10	5	4	3	3		25	40	1.36
MSJ316-AY	5	9	7	3		1	25	20	1.48
MSI026-A	6	9	4	3	2	1	25	24	1.56
MSK469-1	3	9	9	3	1		25	12	1.60
MSJ317-1	6	7	6	2	4		25	24	1.64
MSK128-1	4	8	8	3	1	1	25	16	1.68
MSK410-2Y	5	8	6	4		2	25	20	1.68
MSJ456-4	5	5	8	4	1	2	25	20	1.88
SNOWDEN	2	8	7	6	1	1	25	8	1.96
ATLANTIC	3	4	6	7	4	1	25	12	2.32
MSJ167-1		6	10	5	2	2	25	0	2.36
MSK101-2Y	1	3	7	5	5	4	25	4	2.88
MSK004-2Y	1	5	2	6	4	7	25	4	3.12
SNACK FOOD ASSOCIATION TRIAL									
B0766-3	19	6					25	76	0.24
NDTX4930-SW	14	8	2	1			25	56	0.60
NY120	14	8	2	1			25	56	0.60
AF1775-2	13	7	4	1			25	52	0.72
Liberator	11	6	6	1	1		25	44	1.00
ATLANTIC	10	5	4	5	1		25	40	1.28
SNOWDEN	7	7	6	4		1	25	28	1.44

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
AGPase TRIAL									
EAGP15	16	8	1				25	64	0.40
EAGP8	15	9	1				25	60	0.44
E149-5Y	**16**	**6**	**2**		**1**		**25**	**64**	**0.56**
EAGP20	11	8	4	2			25	44	0.88
EAGP3	6	4	3	4	1	7	25	24	2.44
EAGP9	4	4	6	3	1	7	25	16	2.56
EAGP4	2	2	6	3	2	10	25	8	3.24
EAGP24	4	1	3	3	4	10	25	16	3.28
ONAWAY	**17**	**7**	**1**				**25**	**68**	**0.36**
ONAGP2	5	8	5	3	3	1	25	20	1.76
ONAGP1	5	2	9	5	2	2	25	20	2.12
ONAGP3	2	1	4	2	1	15	25	8	3.76

Table 13B

MICHIGAN STATE UNIVERSITY
POTATO BREEDING and GENETICS

2001 BLACKSPOT BRUISE SUSCEPTIBILITY TEST
CHECK BRUISE SAMPLES**

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
ROUND WHITES: CHIP									
MSF099-3	25						25	100	0.00
MSG227-2	25						25	100	0.00
MSH067-3	25						25	100	0.00
MSH094-8	25						25	100	0.00
MSH095-4	25						25	100	0.00
MSH098-2	25						25	100	0.00
MSI032-6	25						25	100	0.00
MSJ461-1	25						25	100	0.00
NY120	25						25	100	0.00
DAKOTA PEARL	24	1					25	96	0.04
SNOWDEN	23	2					25	92	0.08
W1386	23	2					25	92	0.08
PIKE	22	3					25	88	0.12
ATLANTIC	20	5					25	80	0.20
MSG015-C	17	5	3				25	68	0.44
ROUND WHITES: TABLE									
EVA	25						25	100	0.00
MSE018-1	25						25	100	0.00
MSF313-3	25						25	100	0.00
MSH031-5	25						25	100	0.00
ONAWAY	25						25	100	0.00
MICHIGAN PURPLE	24	1					25	96	0.04
MSE149-5Y	24	1					25	96	0.04
MSB107-1	23	2					25	92	0.08
MSE221-1	23	2					25	92	0.08
MSF373-8	23	2					25	92	0.08
MSG004-3	22	3					25	88	0.12
SUPERIOR	22	3					25	88	0.12

** Tuber samples were collected at harvest, graded, and held until evaluation.
Samples were abrasive-peeled and scored on October 30, 2001.
The table is presented in ascending order of average number of spots per tuber.

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
JACQUELINE LEE	21	4					25	84	0.16
MSF060-6	13	12					25	52	0.48
LONG WHITES and RUSSETS									
AC87138-4	25						25	100	0.00
ATX85404-8W	25						25	100	0.00
MSE192-8RUS	25						25	100	0.00
MSE202-3RUS	25						25	100	0.00
RUSSET NORKOTAH	25						25	100	0.00
RUSSET NORKOTAH 3	25						25	100	0.00
TXNS223	25						25	100	0.00
TXNS278	25						25	100	0.00
W1876-1	25						25	100	0.00
W1879-1	25						25	100	0.00
A90586-11	24	1					25	96	0.04
AC87079-3	24	1					25	96	0.04
BANNOCK RUSSET	24	1					25	96	0.04
C085026-4	24	1					25	96	0.04
GOLDRUSH	24	1					25	96	0.04
RUSSET NORKOTAH 8	24	1					25	96	0.04
TXNS112	24	1					25	96	0.04
SILVERTON RUSSET	23	2					25	92	0.08
A8893-1	23	1	1				25	92	0.12
AC89536-5	23	1	1				25	92	0.12
NDTX4930-5W	22	3					25	88	0.12
RUSSET BURBANK	21	4					25	84	0.16
MSB106-7	15	4	3	3			25	60	0.76
NORTH CENTRAL REGIONAL TRIAL									
D.R. NORLAND	25						25	100	0.00
DAKOTA ROSE	25						25	100	0.00
MSE192-8RUS	25						25	100	0.00
MSF099-3	25						25	100	0.00
ND3196-1R	25						25	100	0.00
RED PONTIAC	25						25	100	0.00
RUSSET NORKOTAH	25						25	100	0.00
W1386	25						25	100	0.00
W1431	25						25	100	0.00
A90586-11	24	1					25	96	0.04
CV89023-2	24	1					25	96	0.04
MICHIGAN PURPLE	24	1					25	96	0.04
ND5084-3R	24	1					25	96	0.04
RUSSET BURBANK	24	1					25	96	0.04

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MN19315	23	2					25	92	0.08
MN19525R	23	2					25	92	0.08
NORVALLEY	23	2					25	92	0.08
V0168-3	23	2					25	92	0.08
W1201	24		1				25	96	0.08
ATLANTIC	22	3					25	88	0.12
SNOWDEN	22	3					25	88	0.12
W1836-1RUS	22	3					25	88	0.12
V0299-4	21	4					25	84	0.16
B0766-3	20	5					25	80	0.20
NY112	22	2		1			25	88	0.20
MN19157	19	6					25	76	0.24
MSF373-8	21	2	2				25	84	0.24
V0123-25	17	7	1				25	68	0.36
MN18747	18	5	1	1			25	72	0.40
YELLOW FLESH and EUROPEAN TRIAL									
MSG147-3P	25						25	100	0.00
MSI005-20Y	25						25	100	0.00
MSI092-3RY	25						25	100	0.00
MSJ033-6Y	25						25	100	0.00
YUKON GOLD	25						25	100	0.00
MSJ033-10Y	24	1					25	96	0.04
MSJ453-4Y	24	1					25	96	0.04
MSJ472-4P	24	1					25	96	0.04
MSH380-3Y	23	2					25	92	0.08
TORRIDON	22	3					25	88	0.12
MSJ456-2Y	21	3	1				25	84	0.20
SAGINAW GOLD	19	5	1				25	76	0.28
ADAPTATION TRIAL									
A90490-1	25						25	100	0.00
A91790-13	25						25	100	0.00
A92584-3BB	25						25	100	0.00
AC87340-2	25						25	100	0.00
AF1763-2	25						25	100	0.00
BC0894-2	25						25	100	0.00
CACP15	25						25	100	0.00
CACP20	25						25	100	0.00
CACP25	25						25	100	0.00
MSG301-9	25						25	100	0.00
MSH015-2	25						25	100	0.00
MSH120-1	25						25	100	0.00

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSH228-6	25						25	100	0.00
MSH370-3	25						25	100	0.00
MSI004-3	25						25	100	0.00
MSI077-5	25						25	100	0.00
MSI111-A	25						25	100	0.00
MSJ307-2	25						25	100	0.00
MSJ319-7	25						25	100	0.00
ATLANTIC	24	1					25	96	0.04
CACP10	24	1					25	96	0.04
MSE080-4	24	1					25	96	0.04
MSH041-1	24	1					25	96	0.04
MSH360-1	24	1					25	96	0.04
MSI537-3	24	1					25	96	0.04
SNOWDEN	24	1					25	96	0.04
SUPERIOR	24	1					25	96	0.04
AF1615-1	23	2					25	92	0.08
AF1758-7	23	2					25	92	0.08
MSH333-3	23	2					25	92	0.08
MSI083-5	24		1				25	96	0.08
MSJ126-9	23	2					25	92	0.08
MSH017-C	22	3					25	88	0.12
MSI037-4	22	3					25	88	0.12
MSI085-10	22	3					25	88	0.12
MSI582-A	22	3					25	88	0.12
MSJ438-2	22	3					25	88	0.12
ONAWAY	22	1	2				25	88	0.20
PRELIMINARY TRIAL									
MSJ080-1	25						25	100	0.00
MSJ080-8	25						25	100	0.00
MSJ170-4	25						25	100	0.00
MSJ204-3	25						25	100	0.00
MSJ316-AY	25						25	100	0.00
MSJ319-1	25						25	100	0.00
MSK125-3	25						25	100	0.00
MSI152-A	24	1					25	96	0.04
MSJ163-7R	24	1					25	96	0.04
MSJ168-2Y	24	1					25	96	0.04
MSJ482-1	24	1					25	96	0.04
MSJ494-1	24	1					25	96	0.04

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
MSK247-9Y	24	1					25	96	0.04
MSK409-1	24	1					25	96	0.04
MSK476-1	24	1					25	96	0.04
MSI026-A	23	2					25	92	0.08
MSJ047-5	23	2					25	92	0.08
MSJ317-1	23	2					25	92	0.08
MSK034-1	23	2					25	92	0.08
MSK068-2	23	2					25	92	0.08
MSK214-1R	23	2					25	92	0.08
MSK236-5	23	2					25	92	0.08
MSK469-1	23	2					25	92	0.08
MSI049-A	22	3					25	88	0.12
MSI061-B	22	3					25	88	0.12
MSJ157-B	22	3					25	88	0.12
MSJ197-1	22	3					25	88	0.12
MSJ334-1Y	22	3					25	88	0.12
MSJ456-4Y	22	3					25	88	0.12
MSJ482-2	22	3					25	88	0.12
MSK061-4	22	3					25	88	0.12
MSK128-1	23	1	1				25	92	0.12
MSK136-2	22	3					25	88	0.12
MSJ167-1	21	4					25	84	0.16
MSK217-3P	21	4					25	84	0.16
ONAWAY	21	4					25	84	0.16
SNOWDEN	21	4					25	84	0.16
MSK101-2Y	20	5					25	80	0.20
MSJ143-4	21	2	2				25	84	0.24
MSJ147-1	21	2	2				25	84	0.24
MSK498-1Y	19	6					25	76	0.24
MSK410-2Y	19	5	1				25	76	0.28
MSJ036-A	18	5	2				25	72	0.36
MSK004-2Y	18	5		1	1		25	72	0.48
ATLANTIC	13	9	2	1			25	52	0.64
SNACK FOOD ASSOCIATION TRIAL									
AF1775-2	25						25	100	0.00
B0766-3	22	3					25	88	0.12
SNOWDEN	22	3					25	88	0.12
ATLANTIC	22	2	1				25	88	0.16
NDTX4930-SW	21	4					25	84	0.16
NY120	19	3	3				25	76	0.36
Liberator	15	7	3				25	60	0.52

VARIETY	NUMBER OF SPOTS PER TUBER 0	1	2	3	4	5+	TOTAL TUBERS	PERCENT (%) BRUISE FREE	AVERAGE SPOTS/TUBER
AGPase TRIAL									
E149-5Y	**24**	**1**					**25**	**96**	**0.04**
EAGP15	21	4					25	84	0.16
EAGP20	20	4	1				25	80	0.24
EAGP8	20	4	1				25	80	0.24
EAGP3	14	8	1	2			25	56	0.64
EAGP24	12	8	5				25	48	0.72
EAGP4	8	10	7				25	32	0.96
EAGP9	11	5	6	2	1		25	44	1.08
ONAWAY	**18**	**4**	**3**				**25**	**72**	**0.40**
ONAGP1	12	7	6				25	48	0.76
ONAGP3	9	5	6	2	1	2	25	36	1.48
ONAGP2	5	6	5	9			25	20	1.72

Funding: Federal Grant, MPIC and SFA

2001 On-Farm Potato Variety Trials

Chris Long, Dr. Dave Douches, Dr. Dick Chase, Don Smucker (Montcalm), Paul Marks (Monroe), Dave Glenn (Presque Isle) and Dr. Doo-Hong Min

Introduction

On-farm potato variety trials were conducted with 12 farms in 2001 at a total of 17 locations. Thirteen of the locations evaluated processing entries and four evaluating fresh market entries. The processing cooperators were Crooks Farms Inc.(St. Joseph / Montcalm), Hansen Farms Inc. (Montcalm), L. Walther & Sons, Inc. (St. Joseph), W.J. Lennard & Sons Inc. (Monroe), Fertile Valley Farms (Allegan), Sackett Potatoes (Mecosta) and Townview Farms (Montcalm). The SFA chip trial was at V & G Farms (Gratiot). Fresh market trial cooperators were Horkey Bros. (Monroe), Tom Fedak (Bay), R & E Farms (Presque Isle) and T.J.J. Van Damme Farms (Delta).

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 Hansen Farms, W. J. Lennard & Sons, Fertile Valley Farms, and L. Walthers & Sons. The Walther trial was planted in three replicated plots and harvested at two harvest days of 98 and 119 days after planting. Varieties in these trials were planted in 100' strip plots.

The second type of processing trial, referred to as a "Select" trial, contained from three to ten lines which were not compared to any check variety. In these trials each variety was planted in a 15' row plot.

Within the fresh market trials, there were 24 entries evaluated. There were 12 lines planted at each of the following location Monroe, Bay and Delta. The varieties ranged from mostly round white varieties to mostly russet varieties. The Presque Isle location contained 16 lines ranging from round white to predominately russet types. These varieties were planted in 100' strip plots.

Results

A. Processing Trial and "Select" Processing 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, Monroe and Montcalm Counties are shown in table 2. The data from L. Walther & Sons in St. Joseph County is shown separately in table 3 (first harvest, 98 days) and table 4 (second harvest, 119 days). The overall averages of the "Select" processing trial, which is averaged across three growers and three counties, are in table 5.

B. SFA Chip Trial

The Michigan location of the SFA chip trial was at the V & G Farm in Riverdale, MI. Table 6 shows the yields, size distribution and specific gravity of the entries when compared with Atlantic and Snowden. Table 7 shows the chip quality evaluations from samples processed and scored by Jays Foods, LLC, Chicago.

C. Fresh Pack Variety Trials

A description of the fresh pack varieties, their pedigree and scab rating are listed in table 8. Table 9 shows the overall average of three locations Delta, Monroe and Presque Isle Counties. The Fedak location was not included in the overall average because irrigation was not available and the yields were greatly effected because of this. Fedak Farm results are printed separately in table 10.

Table 1. 2001 MSU Processing Potato Variety Trials

Entry	Pedigree	Scab Rating*	Characteristics
Atlantic	-	3.0	Early check variety.
B0766-3	B0243-18 X B9792-157 (Coastal Chip)	-	Early maturing, high yield, cold chip potential, resistant to golden nematode, some heat sprouts have been noted.
Dakota Pearl	ND1118-1 X ND944-6	1.5	Early maturing, low internal defects, average yield, cold chipping potential at 42 F.
Pike	-	1.5	Early/storage check variety.
Snowden	-	3.0	Late/storage check variety
Liberator (MSA091-1)	MS702-80 X Norchip	0.5	Mid season maturity, average yield, tubers round with some tendency to Norchip type off-types, chips best from 50 °F.
MSF099-3	Snowden X Chaleur	3.0	Oval to oblong and slightly flattened, above average yield: low internal defects and excellent chip color from 42-46 °F.
MSG227-2	Prestile X MSC127-3	0.8	Average yield potential: flattened round shape, shallow eyes, low internal defects and excellent chip color from 48 °F.
MSH094-8	MSE251-1 X W877	2.0	Mid season maturity, cold chipping potential 42 °F, low internal defects,
MSH095-4	MSE266-2 OP	2.5	Mid season maturity, bruise susceptibility equal to Snowden
NY120	Kanona X AF186-2	1.5	Late Maturity, round, high yield potential, resistant to race Ro1 of golden nematode, dormancy like Atlantic.
P83-11-5	MSU selection from Purdue Seedlings	2.0	Mid to early season maturity, 50 °F chipper
W1386	-	2.5	Late maturing, high yield, cold chipper 45 °F, like Snowden

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

Table 2.

2001 Potato Processing Variety Trial
Overall Average - Three Locations
(Allegan, Monroe, Montcalm)

	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
B0766-3	367	406	90	7	74	16	3	1.071	1.0	4	4	0	0	30
MSF099-3	361	398	90	9	82	8	1	1.077	1.2	3	4	0	0	30
W1386	355	400	89	9	79	10	3	1.070	1.2	9	5	0	0	30
Snowden	**315**	**362**	**87**	**12**	**87**	**0**	**1**	**1.072**	**1.0**	**1**	**3**	**1**	**0**	**30**
NY120	312	335	93	6	82	11	1	1.072	1.2	2	6	2	0	30
Atlantic	**308**	**353**	**87**	**8**	**74**	**13**	**5**	**1.075**	**1.2**	**8**	**4**	**0**	**0**	**30**
MSH095-4	283	325	87	10	80	6	3	1.074	1.0	2	3	0	0	30
MSH094-8	270	311	87	13	81	5	1	1.073	1.0	1	4	0	0	30
P83-11-5	270	338	80	13	77	2	8	1.076	1.2	1	5	1	0	30
MSG227-2	250	316	77	8	75	2	15	1.070	1.2	3	2	2	3	30
Dakota Pearl	231	289	78	21	78	0	1	1.070	1.0	0	1	2	5	30
Pike	**224**	**266**	**84**	**15**	**84**	**0**	**1**	**1.076**	**1.0**	**2**	**3**	**0**	**0**	**30**
MEAN	295	342						1.073						

[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

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

Table 3.

2001 Potato Processing Variety Trial
L. Walther & Sons, Inc. (Three Rivers, MI)
First Harvest August 20, 2001 (98 Days)

	CWT/A		PERCENT OF TOTAL[1]					
			US#1		Small	Large		
LINE	US#1	TOTAL	As	Bs	As	As	SP GR	SCAB
Atlantic	**394**	**418**	**94**	**6**	**41**	**53**	**1.095**	**1**
W1386	369	399	92	7	39	53	1.083	1
NY120	357	366	97	2	33	64	1.092	1
MSH095-4	344	373	92	8	35	57	1.090	0
P83-11-5	340	373	91	9	48	43	1.090	0
Dakota Pearl	336	372	90	10	52	38	1.080	0
Snowden	**335**	**364**	**92**	**8**	**48**	**44**	**1.092**	**0**
MSF099-3	301	345	87	13	64	23	1.090	2
MSG227-2	292	326	89	11	42	47	1.083	1
MSH094-8	287	304	94	6	42	52	1.089	0
B0766-3	259	273	95	5	27	68	1.080	0
Pike	**243**	**278**	**88**	**12**	**50**	**38**	**-**	**0**
MEAN	321	349					1.088	

[1]Percent of Total (Size)
US#1: 1.8 - 4 in.
Large As: 2.5 - 4 in.
Small As: 1.8 - 2.5 in.
Bs: < 1.8 in.

Planted May 19, 2001

[2]Scab Rating
1 = occasional surf scab
2 = numerous surface lesions
3 = a few pits
4 = frequent or large pits
5 = severe pitted scab

<u>**Table 4.**</u>

2001 Potato Processing Variety Trial
L. Walther & Sons, Inc. (Three Rivers, MI)
Second Harvest September 10, 2001 (119 Days)

	CWT/A		PERCENT OF TOTAL[1]					
LINE	US#1	TOTAL	US#1 As	Bs	Small As	Large As	SP GR	SCAB
P83-11-5	461	500	92	8	47	45	1.090	0
W1386	455	486	93	6	38	55	1.083	1
MSH095-4	453	474	95	4	26	69	1.090	0
Atlantic	**423**	**447**	**94**	**6**	**31**	**63**	**1.095**	**1**
Snowden	**411**	**438**	**94**	**6**	**52**	**42**	**1.092**	**0**
Dakota Pearl	408	446	91	9	48	43	1.080	0
MSG227-2	403	447	90	10	35	55	1.083	1
NY120	397	407	98	3	27	71	1.092	1
MSH094-8	395	427	92	8	37	55	1.089	0
Pike	**352**	**396**	**89**	**11**	**39**	**50**	**-**	**0**
MSF099-3	296	341	88	13	72	16	1.090	2
B0766-3	216	248	81	18	34	47	1.080	0
MEAN	389	421					1.088	

[1]<u>Percent of Total (Size)</u>
US#1: 1.8 - 4 in.
Large As: 2.5 - 4 in.
Small As: 1.8 - 2.5 in.
Bs: < 1.8 in.

[2]<u>Scab Rating</u>
1 = occasional surf scab
2 = numerous surface lesions
3 = a few pits
4 = frequent or large pits
5 = severe pitted scab

Planted May 19, 2001

Table 5.

2001 "Select" Potato Processing Variety Trial
Overall Average - Three Growers, Three Counties
Mecosta, Montcalm & St. Joseph Counties

NUMBER OF		CWT/A		PERCENT OF TOTAL[1]						CHIP	TUBER QUALITY[2]				TOTAL
LOCATIONS	LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	SCORE[3]	HH	VD	IBS	BC	CUT
5	W1201	545	619	88	6	76	11	6	1.083	1.0	0	2	1	0	40
3	B0766-3	500	546	91	4	64	27	5	1.077	1.0	1	0	0	0	10
3	NY120	494	523	94	5	85	10	1	1.076	1.0	0	2	0	0	10
8	MSG227-2	474	540	88	10	82	6	3	1.077	1.0	0	4	3	2	60
8	MSF099-3	468	515	91	7	85	6	2	1.083	1.0	1	2	1	0	60
6	W1386	466	551	83	10	78	6	7	1.076	1.0	2	2	1	0	50
4	W1431	420	462	90	10	88	3	0	1.081	1.0	2	0	0	0	40
8	MSA091-1	403	452	90	6	77	12	4	1.079	1.0	2	4	4	1	60
4	W1355-1	245	379	62	38	61	0	0	1.078	1.0	0	0	4	0	40
	MEAN	446	510						1.079						

[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

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

Table 6.

SNACK FOOD ASSOCIATION TRIAL
GRATIOT COUNTY, MICHIGAN
V & G FARMS
OCTOBER 22, 2001 (146 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]
LIBERATOR (MSA091-1)	331	375	88	7	75	14	4	1.086	1.0	3	1	3	0	30	0.3
SNOWDEN	**315**	**362**	**87**	**12**	**79**	**8**	**1**	**1.085**	**1.0**	**15**	**1**	**0**	**0**	**30**	**-**
ATLANTIC	**291**	**337**	**86**	**14**	**80**	**7**	**0**	**1.084**	**1.0**	**4**	**0**	**1**	**0**	**30**	**1.8**
NY120	290	312	93	7	84	9	0	1.081	1.5	2	4	0	0	30	0.3
NDTX4930-5W	267	310	86	10	79	7	4	1.078	1.5	0	0	0	0	30	2.5
B0766-3	266	291	92	7	80	12	2	1.077	1.5	6	1	0	0	30	1.0
AF1424-7	-	-	-	-	-	-	-	1.064	1.0	-	-	-	-	-	2.5
AF1775-2	-	-	-	-	-	-	-	1.071	1.0	-	-	-	-	-	2.5
MEAN	293	331						1.078							
$LSD_{0.05}$															

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

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

Planted May 30, 2001
Vine killed: September 25, 2001

Table 7.

Chip Quality Evaluation*
2001 SNACK FOOD ASSOCIATION TRIAL - V & G FARMS

October 22, 2001 (153 DAYS AFTER PLANTING)

LINE	SPECIFIC GRAVITY	CHIP COLOR	PERCENT CHIP DEFECTS INTERNAL	EXTERNAL	TOTAL	% CHIP MOIST.
LIBERATOR (MSA091-1)	1.095	63.0	10.4	41.2	51.6	1.18
SNOWDEN	**1.092**	**60.9**	**4.3**	**11.5**	**15.8**	**1.07**
ATLANTIC	**1.088**	**59.9**	**6.2**	**24.1**	**30.2**	**0.98**
NY120	1.085	64.9	3.4	20.4	23.8	1.00
NDTX4930-5W	1.082	60.0	2.8	15.0	17.8	1.00
B0766-3	1.085	60.9	1.5	24.3	25.8	1.04
AF1424-7	1.072	64.9	1.0	6.2	7.2	1.09
AF1775-2	1.082	61.9	13.1	31.0	44.1	1.09

*Samples processed and scored by Jays Foods, LLC. Chicago October 29, 2001

Table 8. 2001 MSU Freshpack Potato Variety Trials

Entry	Pedigree	Scab Rating*	Characteristics
Bannock Russet (A81473-2)	A75175-1 X A75788-3	0.3	Long tubers, medium russeting, high yield, low incidence of internal defects
Eva	NY103-Steuben X Neotbr - tbr.	2.5	High yield, bright appearance, shallow eyes, low incidence of internal defects.
Goldrush	-	-	Long to oval tubers, heavy russet, check variety
Michigan Purple	MSU OP Selection	3.0	Mid season, attractive purple skin, white flesh, high yield potential, low incidence of internal defects
Onaway	-	1.2	Early maturing check variety.
Reba	Monona X Allegany	2.5	High yield, bright tubers, low incidence of internal defects, mid to late season.
Russet Burbank	-	1.0	Long tubers, russet check variety
Russet Norkotah	-	2.5	Long to oval tubers, heavy russet, check variety
Russet Norkotah S8	Colorado selection of R. Norkotah	-	Reduced need for nitrogen, resistant to early dye complex, strong vine.
Silverton Russet (A083064-6)	CalWhite X A7875-5	-	Oblong to long, medium russet skin, medium to high yield.
Superior	-	1.5	Average yielding check variety
Yukon Gold	-	2.0	Low yield, yellow flesh, check variety
A8893-1	A7816-14 X NorKing Russet	0.5	Early maturing, dual purpose, medium yield, short dormancy, Good sizing.
MSB106-7	LaBelle X Lemhi Russet	1.6	Long white skin tubers, high yield and low internal defects.
MSE018-1	Gemchip X W877	2.9	High yield, high gravity, smooth oval shape and flattened, tall upright vine, sparse eye distribution.
MSE 149-5Y	Saginaw Gold X ND860-2	1.9	High yield, bright skin, light yellow flesh, low internal

			defects.
Entry	Pedigree	Scab Rating*	Characteristics
MSE192-8 Rus	A81163 X Russet Norkotah	1.2	Long russet tubers, low internal defects, bright white flesh, good cooking quality, SG similar to R. Norkotah.
MSE202-3 Rus	Frontier Russet X A8469-5	0.5	Long russet, lighter russet like R. Burbank.
MSE 221-1	Superior X Spartan Pearl	1.2	Average yield, moderately early, low internal defects.
MSF060-6	Stueben X MS702-80	1.5	Mid season maturity, average yield,
MSF373-8	MS702-80 X NY88	2.8	High yield, large tubers, low internal defects, medium deep eyes.
MSG004-3	Mainestay X MS702-80	3.0	Average yield, bright skin, low internal defects.
Jaqueline Lee (MSG274-3)	Tollocan X Chaleur	3.5	Oval shape, light yellow flesh, low internal defects, heavy tuber set (15-18/hill), strong foliar resistance to US8 late blight.
MSH026-3 Rus	MSB076-2 OP	1.0	Low yield, oval medium russet, mid season maturity.

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

Table 9.

2001 Potato Variety Freshpack Trial
Overall Averages - Three Locations
(Delta, Monroe, Presque Isle)

NUMBER OF		CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL
LOCATIONS	LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT
2	MSF373-8	528	552	96	2	49	46	3	1.075	3	0	1	2	20
2	**Onaway**	**473**	**521**	**91**	**7**	**75**	**16**	**2**	**1.068**	**0**	**5**	**0**	**0**	**20**
3	MI Purple	445	480	92	7	59	33	1	1.074	0	2	0	0	30
2	MSB106-7	331	435	76	18	52	24	6	1.071	0	0	1	0	20
2	MSG004-3	288	320	90	10	72	18	0	1.063	0	0	0	0	20
3	MSG274-3	277	510	54	43	54	0	4	1.078	0	5	0	0	30
2	Russet Norkotah S8	276	347	80	17	49	31	3	1.068	8	0	0	0	20
2	Silverton Russet	276	361	75	21	47	28	4	1.065	9	2	0	0	20
2	Bannock Russet	247	356	68	31	53	14	2	1.069	4	0	0	0	20
2	A8893-1	240	360	68	28	60	7	6	1.072	5	0	0	0	20
2	**Goldrush**	**217**	**319**	**68**	**25**	**58**	**10**	**7**	**1.068**	**0**	**0**	**0**	**0**	**20**
2	**Russet Burbank**	**212**	**348**	**60**	**22**	**42**	**19**	**17**	**1.076**	**2**	**1**	**1**	**0**	**20**
2	MSE192-8	212	305	70	24	46	24	7	1.072	5	0	1	0	20
2	**Russet Norkotah**	**196**	**324**	**61**	**32**	**53**	**8**	**8**	**1.064**	**6**	**1**	**1**	**0**	**20**
2	MSE202-3	134	239	49	44	43	5	7	1.076	4	1	0	0	20
	MEAN	290	385						1.070					

[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

Table 10.

2001 Potato Variety Freshpack Trial
Fedak Farms - Bay County
September 7, 2001 (125 Days)

	CWT/A		PERCENT OF TOTAL[1]						TUBER QUALITY[2]				TOTAL
LINE	US#1	TOTAL	US#1	Bs	As	OV	PO	SP GR	HH	VD	IBS	BC	CUT
MSH031-5	185	243	100	24	76	0	0	1.083	0	0	0	0	10
MSF060-6	165	175	94	6	87	8	0	1.076	0	0	0	0	10
MSF313-3	156	184	87	15	83	2	0	1.061	0	2	1	0	10
Eva	125	167	91	25	75	0	0	1.075	0	0	0	0	10
MI Purple	121	165	51	16	73	0	11	1.070	0	3	0	0	10
Reba	111	131	75	16	84	0	0	1.070	0	1	0	0	10
MSG004-3	96	155	76	28	62	0	10	1.056	0	0	0	0	10
Onaway	**90**	**128**	**67**	**30**	**70**	**0**	**0**	**1.072**	**0**	**6**	**0**	**0**	**10**
MSG274-3	67	152	70	45	44	0	11	1.073	0	0	0	0	10
Superior	**52**	**114**	**71**	**54**	**46**	**0**	**0**	**1.079**	**0**	**8**	**0**	**0**	**10**
MSE149-5Y	48	89	28	46	54	0	0	1.074	0	2	0	0	10
MEAN	111	155						1.072					

[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

Planted May 5, 2001

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

Black scurf and stem canker; *Rhizoctonia solani*

W. W. Kirk and R. L Schafer

Department of Plant Pathology
Michigan State University
East Lansing, MI 48824

Seed treatments, in-furrow and seed plus foliar treatments for control of potato stem canker and black scurf, 2001.

Potatoes infected with *Rhizoctonia solani* (black scurf), 2- 5% tuber surface area infected, were selected for the trials. Potato seed w prepared for planting by cutting and treating with fungicidal seed treatments seven days prior to planting.. Seed were plan at the Michigan State University Muck Soils Experimental Station, Bath, MI on 29 Jun into two-row by 20-ft plots (ca. 10- between plants to give a target population of 50 plants at 34-in row spacing) replicated four times in a randomized comple block design. The two-row beds were separated by a five-foot unplanted row. Dust formulations were measured and add to cut seed pieces in a Gustafson revolving drum seed treater and mixed for two minutes to ensure even spread of t fungicide. Fungicides applied as pre-planting potato seed liquid treatments were applied at a rate of 0.02pt/cwt onto t exposed seed tuber surfaces, with the entire seed surface being coated in the Gustafson seed treater. In furrow applicatio 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 usi one XR11003VS nozzle per row. Fertilizer was drilled into plots before planting, formulated according to results of s tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP (days after plantin Bravo WS 6SC was applied at 1.5 pt/A on a seven day interval, total of 8 applications, starting after the canopy was abo 50% closed. A permanent irrigation system was established prior to the commencement of fungicide sprays and the fiel were maintained at soil moisture capacity throughout the season by frequent (minimum 5 day) irrigations. Weeds we 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 DA 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 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 t soil surface or fully emerged after planting. The rate of emergence was estimated as the area under the plant emergen curve (max=100) from the day of planting until 29 days after planting. The rate of canopy development was measured as t RAUCPC, relative area under the canopy development curve, calculated from day of planting to a key reference point taken as 49 D (about 100% canopy closure), (max = 100). Severity of stem canker was estimated as the percentage of stems per plant wi greater than 5% girdling caused by *R. solani*, measured 70 days after planting (5 plants per sample were destructive harvested and total stem number and number affected was counted). Vines were killed with Diquat 2EC (1 pt/A on 20 Se Plots (25-ft row) were harvested on 29 Oct and individual treatments were weighed and graded. Samples of 50 tubers p plot were harvested 14 days after dessication (approximately 135 DAP). The tubers were evaluated 14 days after harve Tubers were washed and assessed for black scurf (*R. solani*) incidence (number of tubers with infection, percent incidenc and disease severity (average percent surface area infected of individual tubers from entire sample).

The final number of emerged plants was low for all treatments and considerable tuber rot had occurred. *Fusariu sambucinum* (dry rot) and *Erwinia spp.* (soft rot) were recovered from non-emerged plants. Moncut 50 WP 0.07 pt/1000 [at planting in-furrow application (IF)] treatment emerged at a significantly faster rate [relative rate of emergen (RAUEPC)] than the untreated control. The seed treatment (ST) 6% Mancozeb 1lb+ Auxigro WP 0.31 lb A [foli application (F)] emerged at a significantly slower rate than treatments with RAUDPC values < 11.5 including the Maxim M 0.5 lb (ST) commercial standard treatment. However, no other 6% Mancozeb 1lb (ST) base treatments significantly low the rate of emergence in comparison with other treatments. No other treatments emerged at a rate significantly different fro the untreated control or from the Maxim MZ 0.5 lb (ST) commercial standard treatment No seed treatment, fungici applied in-furrow (IF) or any other treatment (ST + F) was significantly different from the untreated control or from t Maxim MZ 0.5 lb (ST) commercial standard treatment in terms of the final plant stand. The rate of canopy formati (RAUCDC) was not affected by any seed treatment or in-furrow application of any fungicide. Seed treatments and in-furr applications of fungicides were not phytotoxic. All treatments, including the foliar treatments of Auxigro WP 0.31 lb/A both application timings, except Planthelper 0.03 pt [*Trichoderma atroviride* (IF)] and Messenger 0.1 lb (ST), significan reduced the percentage of stolons with greater than 5% girdling due to *R. solani* in comparison with the untreated contr All treatments with less than about 30% stolon girdling were not significantly different from the commercial standard [Maxim M 0.5 lb (ST) % stolon girdling = 16.4%]. No treatments significantly reduced the percent incidence of black scurf on tubers comparison with the untreated control or the commercial seed treatment standard. Severity of black scurf on tubers w significantly reduced in comparison with the untreated control by PCC 553 0.75 lb (ST) and PCC 553 1 0.75 lb (ST) and t foliar treatments of Auxigro WP 0.31 lb/A at both application timings. No treatments, including the untreated control, we significantly different from the commercial standard seed treatment in terms of severity of black scurf on the tubers. Yie was moderate to high despite late planting and no treatments were significantly different from the untreated control or t commercial seed treatment standard in terms of marketable or total yield.

Treatment and rate/cwt (seed treatment) rate/A (in furrow) rate/1000 row ft (in furrow)	Application timing[1]	Emergence (RAUEPC)[2]	Plant number (%) emerged 29 days after planting	Canopy development (RAUCPC)[3]	Percent stolons with greater than 5% girdling due to *R. solani*[4]	Incidence of black scurf on tubers (%)[5]	Severity of black scurf on tubers (%)[6]	Yield cwt/A Marketable (US1)[7]	Yield cwt/A Total[8]
Maxim MZ 0.5 lb	ST............	11.88 abc	80 a	22.9 a	16.4 abc	47.5 ab	20.6 abc	313 ab	342 ab
Moncut 50 WP 0.07 pt/1000 ft	IF............	12.09 ab	80 a	22.9 a	15.1 ab	55.0 ab	28.4 ab	332 ab	359 ab
Moncut 50WP 0.1 pt/1000 ft	IF............	11.17 abcd	77.2 a	22.8 a	11.4 a	35.0 ab	15.3 abc	313 ab	345 ab
PCC 553 0.75lb	ST............	9.85 abcd	80 a	23.8 a	12.8 ab	27.5 ab	9.1 bc	351 ab	374 ab
PCC 553 1 0.75 lb	ST............	11.69 abc	82 a	23.4 a	16.6 abc	11.3 b	3.1 c	337 ab	366 ab
PCC 553 2 0.375 lb	ST............	11.63 abc	82 a	24.5 a	16.5 abc	26.3 b	12.5 abc	410 ab	440 ab
PCC 553 3 0.75 lb	ST............	11.34 abcd	78 a	27.9 a	24.6 abcd	38.8 ab	16.3 abc	433 a	461 a
6% Mancozeb 1lb	ST............	10.98 abcd	82 a	24.1 a	36.4 cde	38.8 ab	16.9 abc	297 ab	324 ab
TADS 14749 0.75 lb	ST............	9.16 abcd	80 a	21.6 a	29.5 abcd	43.8 ab	17.2 abc	306 ab	333 ab
TADS 14750 0.75 lb	ST............	8.94 abcd	78 a	17.9 a	33.5 bcde	33.8 ab	14.4 abc	311 ab	332 ab
TADS 14751 0.375 lb	ST............	9.67 abcd	76 a	19.7 a	28.2 abcd	27.5 ab	10.3 abc	280 ab	302 ab
6% Mancozeb 1lb +	ST............	8.05 d	71.2 a	21.3 a	33.9 bcde	38.8 ab	13.8 abc	302 ab	325 ab
Auxigro WP 0.31 lb A[10]	F...............								
6% Mancozeb 1lb +	ST............	10.15 bcd	78 a	19.2 a	32.9 bcde	33.8 ab	10.0 abc	331 ab	357 ab
Auxigro WP 0.31 lb B	F...............								
6% Mancozeb 1lb +	ST............	9.17 bcd	73.2 a	19.6 a	36.6 cde	27.5 b	10.3 abc	295 ab	318 ab
Auxigro WP 0.31 lb A,B	F...............								
Auxigro WP 0.31 lb A	F...............	8.73 bcd	58 a	19.3 a	39.1 de	22.5 b	5.9 bc	335 ab	363 ab
Auxigro WP 0.31 lb B	F...............	9.68 abcd	70 a	19.7 a	36.7 cde	20.0 b	7.2 bc	257 b	284 b
Planthelper 0.03 pt/A	IF............	8.69 bcd	75.2 a	21.6 a	53.9 ef	41.3 ab	20.9 abc	289 ab	312 ab
Messenger 0.1 lb	ST............	9.64 abcd	85.2 a	20.5 a	75.2 g	46.3 ab	25.0 abc	331 ab	355 ab
Untreated	NA............	8.69 cd	74 a	19.1 a	74.4 fg	58.8 ab	32.5 a	291 ab	311 ab

[1] Application type, seed treatment (ST), in-furrow at planting (IF), foliar (F), untreated (NA).
[2] 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).
[3] 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)
[4] Percentage of stems with greater than 5% girdling caused by *R. solani*, average of 5 plants taken 70 days after planting (10 days after all foliar treatments applied).
[5] Percent incidence of tubers with sclerotia of *R. solani* from sample of 20 tubers per replicate.
[6] Average percent surface area covered by sclerotia of *R. solani* on tubers from sample of 20 tubers per replicate as a measure of disease severity.
[7] Marketable yield, tubers greater than 2.5" in any plane (US1 grade).
[8] Total yield, combined total of US1 grade and tubers less than 2.5" in any plane.
[9] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).
[10] Foliar application dates: A= 7 Jul; B= 28 Jul.

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

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

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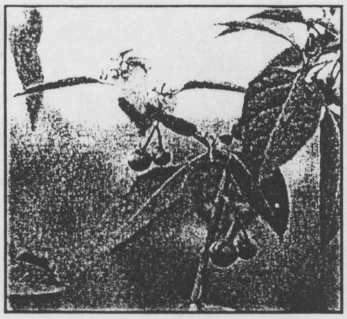
EVALUATION OF AT-PLANTING IN-FURROW SOIL APPLICATIONS OF RIDOMIL 4EC, ULTRA FLOURIS 2EC AND PHOSPHONIC ACID AND FOLIAR APPLICATIONS OF RIDOMIL GOLD BRAVO AND FLUORINIL FO POTATO PINK ROT AND PYTHIUM LEAK CONTROL, 2001: Soil was inoculated with mefenoxam-sensitive *Pythiu ultimum* and *Phytophthora erythrospetica* at the Michigan State University Botany Farm, East Lansing, MI on 9 May, s days prior to planting. Inoculum was prepared for this experiment by soaking 1 lb of sweet corn in 2 pint water in 2 l flasl and adding mefenoxam-sensitive isolates of *P. ultimum* and *P. erythrospetica* to the sterile growing medium. Three coloni of each pathogen were prepared. The colonies were grown for 28 days and formed lush mycelia and were rich in oospore The corn/mycelial/sporangium was homogenized and mixed in 12.25 lb sand and broadcast over the trial plot (0.5 A) at rate of 25 lb/A. Potatoes (cut seed) were planted at the Michigan State University Botany Farm, East Lansing, MI on 15 Ma into four-row by 50-ft plots (34-in. row spacing) replicated four times in a randomized complete block design. The two-ro beds were separated by a five-foot unplanted row. Plots were irrigated at planting and soil moisture was monitored wi tensiometers. Water was applied as needed with seep-hose to maintain soil moisture at a minimum of 80% field capacit After desiccation, plots were continuously watered to encourage tuber disease development caused by the inoculat pathogens. Plots were hilled immediately before foliar sprays began. Fungicides were applied in-furrow at planting at a ra of 5 gal/A (40 p.s.i.) applied at a rate using the conversion factor: Band rate per acre = [Band width (inches)/Row spaci (inches)] * Broadcast Rate per Acre. Thereafter fungicides treatments (as scheduled) and late blight prevention maintenan treatments of Previcur 6SC 1.2 pt/A were applied weekly from 5 Jun to 15 Aug (10 applications) with an ATV rear-mount R&D spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Weeds were controlled 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 oz/A at planting on 15 May) and Sevin 80S (1.25 lb on 1 and 17 Jul). Plots were rated visually for percent emergence a percent canopy closure from planting to full emergence and full canopy closure respectively and a relative rate development was calculated for both emergence and canopy formation. Prior to application of foliar treatments for tub disease control, one 25 foot row from each replicate was harvested and the number of tubers greater than 0.25" (any plan per plant was counted. Four plants were selected at random from each treatment plot on 17 Jul and15 Aug and tuber numb and percent of tubers with symptoms of pink rot and/or Pythium leak were assessed. Tuber number per plant and percenta of tubers per four plant sample were compared using two-way repeated measures ANOVA. At harvest, tuber samples about 20 lb/plot (ca. 80 tubers) were weighed and tubers cut into 2 pieces and exposed to air at 60 - 70°F. The cut surfac of the pieces were then assessed for symptoms indicative of Pink rot or Pythium leak (tuber discoloration). At each harve symptomatic tubers were tested with Phytophthora and Pythium specific ELISA assays. Tubers with symptoms th correlated with symptoms that tested positive by immuno-diagnosis were rated as positive and infected with either Pink rot Pythium or both. The weight of infected cut tubers was expressed as a percentage of the total sample weight and as percentage of the untreated control. The pathogens causing the tuber infections were re-isolated from the infected tubers a sensitivity to mefenoxam established using the amended plate assay of Deahl et al., (1995).Vines were killed with Diq 2EC (1 pt/A on 15 Aug). Plots (50-ft row) were harvested on 29 Aug and individual treatments were weighed and grad (tubers less than 2.5 in width in any plane were discarded and only total marketable yield was reported). A further subsam of 20 tubers per plot were challenge inoculated with *Pythium ultimum*, *Phytophthora erythroseptica*, *Phytophtho infestans*(all mefenoxam-sensitive isolates) or a sterile rye agar core by placing an 1/8" diameter core, taken from an axe 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/ diameter Eppindorf tube, the lid of which was cut off and dipped in petroleum jelly to adhere the tube to the tuber surface, ensure a humid micro environment. Tubers were cut open 28 days after inoculation and the percentage of tubers w symptoms of the diseases were calculated. Mefenoxam content of a sample of 20 tubers per mefenoxam-treated treatm was determined by standard analytical techniques at the Center for Integrated Plant Systems at MSU.

Taking 35 days after planting (dap) as a key reference point, no fungicide applied in-furrow delayed emergence comparison with treatments that were not applied in-furrow in terms of the RAUEPC or plant stand. However, the fi number of emerged plants for all treatments was low and considerable mother tuber rot had occurred . *Fusari sambucinum* (dry rot pathogen) and *Erwinia caratovora* var *caratovora* (soft rot pathogen) were recovered from n emerged plants. Canopy formation (RAUCDC) was not affected by any in-furrow application of any fungicide. The furrow applications of fungicides were not phytotoxic. The number of tubers greater than 0.25" (any plane) prior application of foliar treatments was not significantly different between replicate blocks and was 10.3 ± 1.87 tubers per pl and the average percentage of tubers with symptoms of rot was 7.6 ± 6.37 % per plant [average of all treatments ± stand deviation (n = 240 plants)] at 42 days after planting (DAP). After the first harvest the number of tubers per plant was redu in comparison with the tuber count during early tuber development 5.5± 1.44 [average of all treatments ± standard deviation (n = 240 plants)] at 70 DAP) and after the second harvest 4.0± 1.56 [average of all treatments ± standard deviation (n = 240 plants)] at desiccation 99 DAP. Isolation of pathogens from samples of the infected tubers at all three harvests confirmed the presence of both *Pythium ultimum* and *Phytophthora erythroseptica* as well as the soft rot bacterium *(Erwinia caratovora* var *caratovora*). None of the programs had significantly different tuber number per plant 70 DAP or 99 DAP either in comparison with the untreated control or other programs. However, the Ridomil Gold Bravo mid-season application program had significantly less infected tubers in comparison with the untreated control 70 DAP but not from other programs. In terms of tuber loss, the Quadris 2SC 0.2 pt/A (IF), Acrobat 50WP 0.08 lb/A (IF) and the Ultra Flourish 2EC 0.2 pt/A + Phostrol 4SC 1.44 pt (IF)/Phostrol 4SC 4 pt/A (foliar application) programs had significantly fewer tubers per plant 99 DAP than at 70 DAP. About 60% tuber loss was experienced by all treatments up to 99 DAP. Yields were low due to a combination of tuber loss and early vine senescence. There was no significant difference between treatments or the untreated control in terms of marketable yield however Ultra Flourish 2EC 0.2 pt/A (IF) had a significantly greater total yield in comparison with the untreated control but was not significantly different from other treatments. At harvest, there was no significant difference in the percentage of tubers with tuber rots between any treatments. Extremely high soil moisture levels throughout the season encouraged the development of both Pythium leak and Pink rot in tubers. Under conditions conducive to development of pink rot and Pythium leak about 30 - 50% of the tubers survived to the end of the season however 20 - 30% of those were under 2" diameter (any plane). Re-isolation from infected tubers confirmed the presence of mefenoxam-sensitive *P. erythroseptica* and *P. ultimum* as the disease-causing agent.

No mefenoxam was detected in tubers treated with any of the mefenoxam-based treatments. A low proportion of tubers that were challenge-inoculated with *P. erythroseptica*, *P. ultimum* or *P. infestans* became infected and there was no significant difference among treatments. The majority of tubers survived the inoculations and suggesting that surviving tubers are less predisposed to infection than others. This may be a result of position in hill, maturity of tuber in relation to those that appear to be predisposed. The apparent lack of efficacy may be due to several reasons including high disease pressure as a result of soil inoculum load and environment, canopy structure and initial tuber number. Potato canopies of currently grown varieties may be more indeterminate than in varieties used when initial studies were done. In addition it is possible that initial studies were done in canopies that may have been N–deficient in comparison with current practices where N is applied prescriptively. In conclusion, there may not be sufficient mefenoxam for even and effective distribution throughout the plant as mefenoxam is still distributed to the vines as well as the tubers.

Treatment and rate/acre	Emergence and Canopy development			Tuber number per plant and percent tubers with Pythium and/or Pink Rot[4]				Yield cwt/A[5]		Percent tubers with Pythium and/or pink rot	Percent of tubers with symptoms of disease after challenge noculation[6]			
				harvest 1		harvest 2								
	% final[1]	RAUEPC[2]	RAUCDC[3]	Tuber number	% diseased	Tuber number	% diseased	Marketable	Total		Pythium	Pink Rot	Late Blight	Control
Ridomil Gold 4EC 0.1 pt (A)	77.3 a	0.38 a	0.20 a	5.5 a	30.8 ab	4.6 a	36.3 a	93 a	124 ab	14.0 a	0 a	10 a	0 a	0 a
Ridomil Gold 4EC 0.1 pt (A) Ridomil Gold Bravo 6WP 2.0 lb (E)	82.9 a	0.36 a	0.20 a	5.3 a	12.5 ab	4.6 a	47.0 a	103 a	133 ab	14.8 a	10 a	20 a	10 a	0 a
Ridomil Gold Bravo 6WP 2.0 lb (E,G)	77.1 a	0.36 a	0.19 a	5.5 a	3.6 b	4.1 a	17.4 a	100 a	125 ab	14.8 a	0 a	5 a	0 a	0 a
Ridomil Gold Bravo 6WP 2.0 lb (G,I)	78.5 a	0.36 a	0.20 a	5.1 a	29.3 ab	3.5 a	38.4 a	116 a	152 ab	14.0 a	0 a	0 a	5 a	0 a
Bravo WS 6SC 0.36 pt (A)	71.3 a	0.34 a	0.21 a	5.6 a	5.8 ab	4.8 a	28.8 a	101 a	132 ab	18.2 a	0 a	5 a	0 a	0 a
Acrobat 50WP 0.08 lb (A)	78.8 a	0.35 a	0.20 a	6.0 a*	35.5 ab	3.8 a	34.6 a	103 a	129 ab	16.7 a	0 a	0 a	5 a	0 a
Quadris 2SC 0.2 pt (A)	77.7 a	0.34 a	0.21 a	6.6 a*	35.3 ab	4.5 a	18.8 a	88 a	114 ab	10.5 a	0 a	0 a	0 a	0 a
Ultra Flourish 2EC 0.2 pt (A)	76.0 a	0.32 a	0.20 a	4.9 a	11.7 ab	3.4 a	12.5 a	128 a	159 a	12.9 a	0 a	0 a	0 a	0 a
Ultra Flourish 2EC 0.2 pt + (A) Phostrol 4SC 1.44 pt	76.0 a	0.35 a	0.19 a	6.6 a	7.5 ab	4.0 a	28.8 a	88 a	113 ab	16.1 a	0 a	10 a	0 a	0 a
Ultra Flourish 2EC 0.2 pt + (A) Phostrol 4SC 1.44 pt Fluorinil 76.4WP 2.0 lb (E)	75.1 a	0.37 a	0.20 a	5.6 a	19.6 ab	5.3 a	43.6 a	103 a	124 ab	14.1 a	0 a	5 a	0 a	0 a
Ultra Flourish 2EC 0.2 pt + (A) Phostrol 4SC 1.44 pt Fluorinil 76.4WP 2.0 lb (E,G)	64.6 a	0.34 a	0.19 a	6.3 a	30.9 ab	4.2 a	19.0 a	115 a	141 ab	11.0 a	0 a	0 a	0 a	0 a
Ultra Flourish 2EC 0.2 pt + (A) Phostrol 4SC 1.44 pt Phostrol 4SC 4 pt (B,D,F,H,J) Phostrol 4SC 6.0 pt (C,E,G,I,K)	78.5 a	0.36 a	0.19 a	6.3 a*	23.5 ab	3.3 a	31.3 a	98 a	130 ab	10.1 a	5 a	15 a	15 a	0 a
Planthelper 4SC 0.8 pt (A)	74.8 a	0.36 a	0.20 a	5.5 a	24.2 ab	4.1 a	36.8 a	111 a	149 ab	16.5 a	0 a	0 a	0 a	0 a
Messenger 3WDG 0.1 lb (A) Messenger 3WDG 0.28 lb (E,G,I)	79.4 a	0.35 a	0.20 a	5.5 a	8.0 ab	4.9 a	57.9 a	112 a	146 ab	9.3 a	5 a	0 a	0 a	0 a
Untreated	75.4 a	0.34 a	0.20 a	5.5 a	41.3 a	3.8 a	45.3 a	78 a	100 b	14.9 a	0 a	10 a	5 a	0 a

[1] Percent emergence calculated as percent of maximum possible emergence in 2 x 50' rows.
[2] Relative Area Under the Emergence Progress Curve from planting until 95% emergence [35 days after planting (dap)] in untreated control (max = 1).
[3] Relative Area Under the Canopy development Curve from planting until 100% canopy cover (53 dap) in untreated control (max = 1).
[4] Intermediate tuber harvests: four plants were selected at random from each treatment plot on 17 Jul (Harvest 1)and15 Aug (Harvest 2), tuber number and percent of tubers with symptoms of pink rot and/or Pythium leak were assessed. Tuber number per plant and percentage of tubers per four plant sample were compared using two-way repeated measures ANOVA.
[5] Total marketable yield (cwt/A) estimated from 2 x 50ft row, tubers >2.5" width in any plane.
[6] A sample of about 20 lb/plot (ca. 80 tubers) was weighed and cut into 2 pieces and exposed to air at 60 - 70°F, the cut surfaces of the pieces were then assessed for symptoms indicative of Pink rot or Pythium leak (tuber discoloration). Symptomatic tubers were tested with Phytophthora and Pythium specific ELISA assays. Tubers with symptoms that correlated with symptoms that tested positive by immuno-diagnosis were rated as positive and infected with either Pink rot or Pythium or both. The weight of infected cut tubers was expressed as a percentage of the total sample weight and as a percentage of the untreated control.
[7] Application dates: A= 9 May (in-furrow at planting); (foliar applications B - K), B= 5 Jun; C= 12 Jun; D= 19 Jun; E= 26 Jun; F= 3 Jul; G= 10 Jul; H= 17 Jul; I= 24 Jul; J= 4 Aug; I= 15



Eastern black nightshade (*Solanum ptycanthum*) and hairy nightshade (*Solanum sarrachoides*) biology and management in potatoes.

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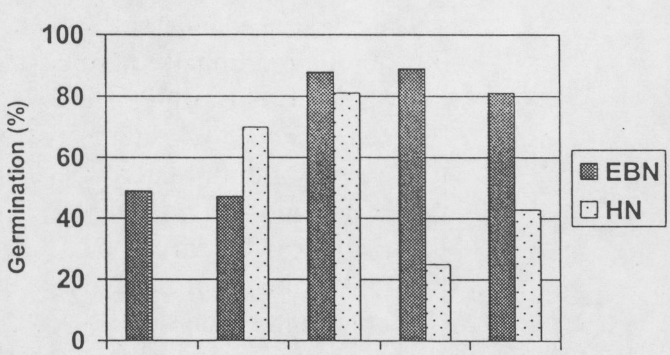
Eastern black nightshade has been a predominant weed problem in the Corn Belt of the United States for many years (Stoller and Myers 1989). In recent years hairy nightshade has increased in prevalence in potato production areas of Michigan. Dual + Lorox preemergence would be recommended for eastern black and hairy nightshade control in Michigan. However, these herbicides provide only fair control. If nightshades emerge in the potato crop, Matrix may provide fair control. In research by Eberlein et al. (1994), Matrix postemergence controlled hairy nightshade (> 90%) but did not control cutleaf nightshade (*Solanum triflorum*). Preemergence control of hairy nightshade with Matrix + Sencor was highly variable (Guttieri and Eberlein 1997). Nightshade species have not been present in our field research with Matrix (Renner and Powell 1998).

Two objectives were addressed in this research. Thos objectives were:
1) Determine the optimum temperature for eastern black nightshade and hairy nightshade germination.
2) Determine the effect of three levels of shading on the germination and early season growth of eastern black nightshade and hairy nightshade.

Eastern black nightshade and hairy nightshade seeds were investigated at four temperature regimes. Those temperature regimes were day:night temperatures of 95:77, 86:68, 77:77, 86:68 and 68:50^{O} F. Eastern black nightshade seeds germinated at slightly warmer temperature regimes than hairy nightshade seeds (Figure 1). Maximum emergence of eastern black nightshade occurred at the three warmest temperature regimes investigated (77:77, 86:68, 95:77). The highest percentage of hairy nightshade germination occurred at temperature regimes of 77:68 and 77:77, while germination declined at temperature regimes warmer than 77:77. Eastern black nightshade germinated at each temperature regime, while hairy nightshade did not germinate at the regime of

Figure 1. Temperature Affects Nightshade Germination



68:50 (Figure 1). Samples of hairy nightshade seed at the higher temperature regimes became infected with a fungus, which may have reduced germination. Germination studies of hairy nightshade at the higher temperatures are currently being conducted again. Based on these observations, eastern black nightshade appeared to be less dependent on temperature for germination than hairy nightshade.

Figure 2. Shade Influence on Nightshade Emergence (Growth Chamber).

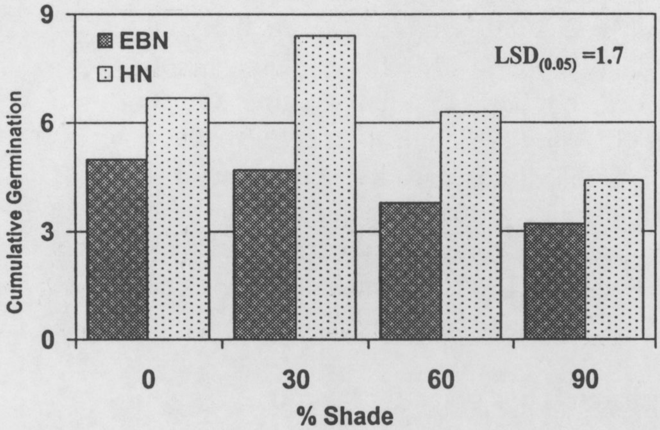


Figure 3. Shade Influence on Nightshade Leaf Area (Greenhouse).

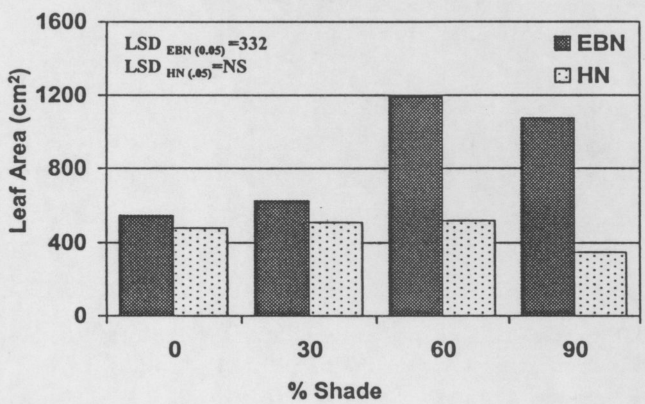
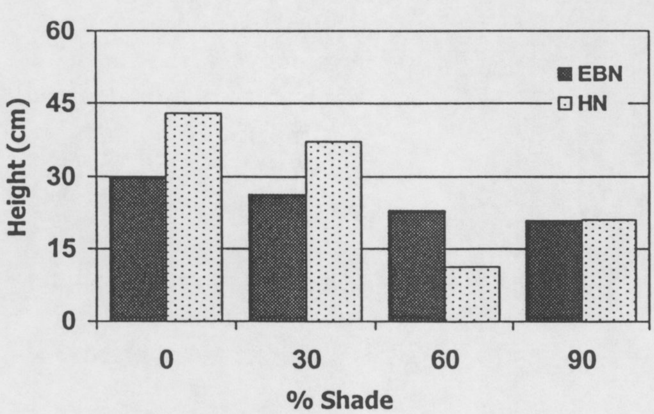


Figure 4. Plant Height (Greenhouse)



To determine the effect of shade on nightshade growth, dark cloths rated for solar radiation interception of approximately 30%, 60%, and 90% were be placed over pots of each nightshade at planting. Emergence of both nightshade species declined at shade levels above 30%, but the reduction was more dramatic with hairy nightshade (Figure 2). These observations indicated that eastern black nightshade emergence was less dependent on shade than emergence of hairy nightshade. Eastern black nightshade compensated for shade by increasing total leaf area as shade increased (Figure 3), while hairy nightshade leaf area did not increase as shade increased (Figure 3). These observations indicated that eastern black nightshade is better at compensating under shaded conditions than hairy nightshade. Higher shade levels reduced hairy nightshade plant height but had little effect on eastern black nightshade plant height (Figure 4.) Higher shade levels caused changes in both species in total reproductive growth and total plant growth. Higher shade levels decreased flower and berry dry weight of both eastern black and hairy nightshade (Figure 5). Total plant growth, based on a measurement of final dry weights, of both nightshade species were decreased as shade levels increased (Figure 6).

Eastern black nightshade appeared to be more tolerant to shade levels than hairy nightshade. These observations indicated that dense crop canopies would cause greater reduction of plant growth for hairy nightshade than for eastern black nightshade.

Studies are being conducted in the greenhouse to better determine chemical control of the nightshade species. Results from those findings will be distributed upon completion of the research.

Figure 5. Shade Influence on Nightshade Berries and Flowers Dry Weight (Greenhouse).

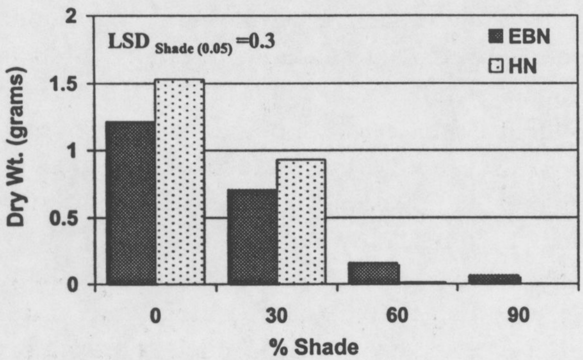
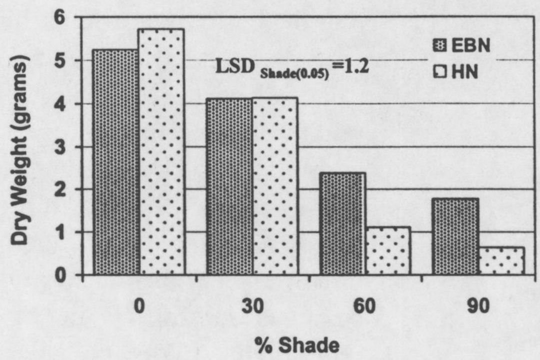


Figure 6. Effect of Shade on Final Dry Weight (Greenhouse).



Integrated Control of Common Scab (*Streptomyces scabies*) in Potato
I. Cultivar Resistance and Soil Moisture Treatments in Greenhouse Experiment
II. Inducing Resistance in Potato to Common Scab in Field Experiment
2001 Report to MPIC

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Introduction

The incidence and severity of common scab in North America is increasing due to the use of susceptible cultivars, and conducive cultural and environmental factors, such as rotation and soil moisture. Common scab (*Streptomyces scabies*) is a soil-borne bacterium which incites a range of symptoms on the surface of potato tubers including superficial russet lesions, pitted lesions, or most commonly corky erumpent lesions raised above the surface of the tuber skin. Potato scab is the fourth most problematical disease in potatoes[3], and although it has a relatively small yield impact, it significantly reduces marketability. The bacterium is introduced into fields on infected seed potatoes, but is persistent and survives indefinitely in soil, and can be distributed by soil water, wind and farm equipment. *S. scabies* can infect root crops such as carrot, beets, turnip etc. and survives best in soils at pH 5.5 - 7.5, which is the optimal pH for growing underground vegetable crops. Short rotations between susceptible crops increase the pathogen population and severity of the disease. Potato tubers are most susceptible to infection during early tuber development. Tubers are infected through stomata and immature lenticels yet to form a protective barrier. Mature tubers with well-developed skin are not susceptible to infection. However, infections established when the tubers are immature, expand as the tubers enlarge and lesions increase in severity over the season. *S. scabies* is favored by warm, dry soil at the time of tuber infection.

The environmental influences on cultivar susceptibility to different strains are unknown. The most important management strategy in controlling potato scab is maintenance of adequate soil moisture. Irrigation impacts control of plant pathogens through effects on the physical environment of the soil and the plant surface[1]. Water applied early in the season to soil was shown to reduce common scab on susceptible cultivars[4]. Maintaining adequate soil moisture at –40 kPA or wetter 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* sp. in the soil is not well understood.

Although there are no current chemicals available for controlling common scab, there are biological agents used on other plant-pathogen systems that have been effective in providing immunity against infection by a broad range of pathogens. This phenomenon is known as systemic acquired resistance (SAR). SAR occurs when a plant is treated with a chemical, an elicitor, or an incompatible pathogen, and the plant is subsequently able to send signals to biochemical pathways that are related to plant defense. These defensive symptoms can be effective in suppressing pathogens, changing the chemistry of the cell wall and cuticle, and producing antimicrobial compounds for additional protection against pathogens. It has been well documented in cucumbers with protection against a wide range of pathogens and 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 biological agents 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 and severity of tubers.
2. Investigate the effect of cultivar resistance on scab incidence and severity of tubers.

II. Objectives

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

Methods

I. Objectives

1. Investigate the effect of varying soil moisture levels on scab incidence and severity of tubers.
2. Investigate the effect of cultivar resistance on scab incidence and severity of tubers

In greenhouse experiments, soil boxes compartmentalized into sections (1'x2'x3') 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 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 will also be subjected to three varieties, two of which have been developed by the MSU Potato Breeding and Genetics Program, differing in susceptibility to common scab were initially screened: susceptible, cv Atlantic; moderately resistant, cv MSF373-8; and most resistant, cv MSA091-1. Tubers were sampled after the skin had been fully developed for assessment of scab incidence and severity.

II. Objectives

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

Potatoes (cut seed) were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 11 July 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 spore suspension of *Streptomyces strains* at 10^6 spores/fl oz on 13 August. 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. Fungicides were applied weekly from 24 July to 19 September with an ATV rear-mounted R&D spray boom delivering 25 gal/A (80 p.s.i.) 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). Applications of Messenger® (Eden® Bioscience) and Elexa®4 (Safe Science, Inc.®) were applied according to specified labeled rate as four different treatment methods: seed pieces, in furrow, pre-emergence, and early emergence. Messenger seed treatments (0.1pt/100wt) were coated in the Gustafson seed treater with the entire tuber surface being exposed. In furrow applications of Messenger (0.42lbs/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. These applications were repeated again before emergence and early after emergence. Elexa (1:40 in 25 gal of water) was coated in the Gustafson seed treater with the entire tuber surface being exposed. In furrow applications of Elexa (1:40 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. These applications were repeated again before emergence and early after emergence. Vines were killed with Reglone 2EC (1 pt/A on 30 September). Plots (25-ft row) were harvested on 19 October and individual treatments were evaluated based on scab incidence and severity.

Results

I. The soil moisture treatments measured by Campbell Scientific, Inc.® were 22.4%, 40.6%, 60.4%, and 77.1% soil moisture, respectively (as shown in Figure 1). The most susceptible cultivar showed an average scab coverage at about 9.8% at the lowest amount of soil moisture percentage treatment. When the soil moisture treatment was increased to 40.6%, the average amount of scab cover was reduced to about 7%. A further increase of soil moisture decreased average scab severity to about 2.5% and at the highest soil moisture treatment the scab infection was not observed. Similar results were demonstrated with the intermediately susceptible cultivar (Figure 2). As soil moisture increased, the scab infections of the intermediately susceptible cultivar decreased.

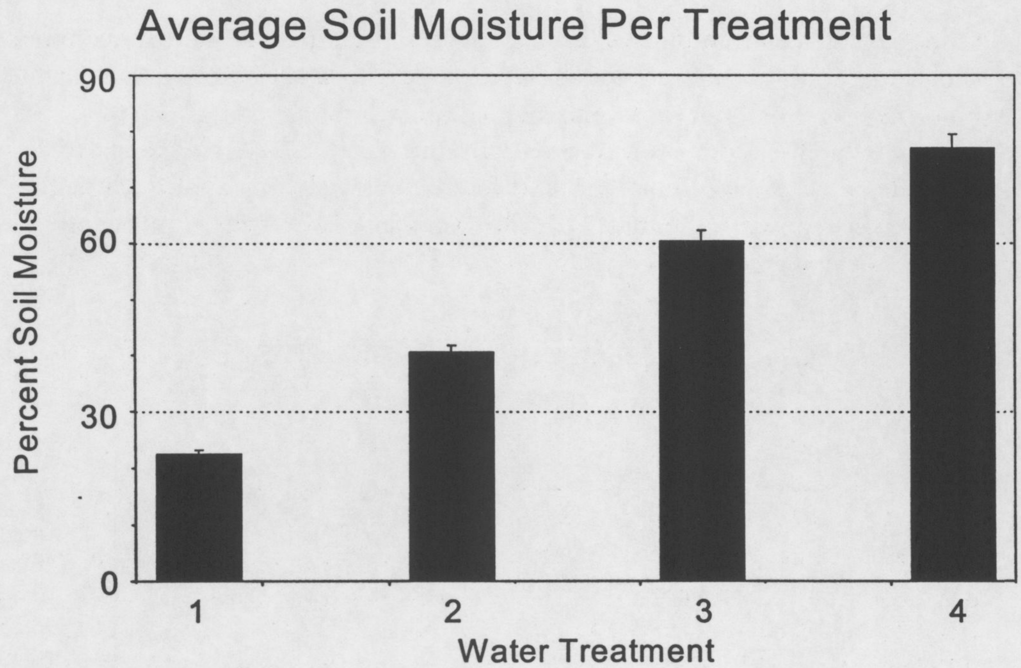
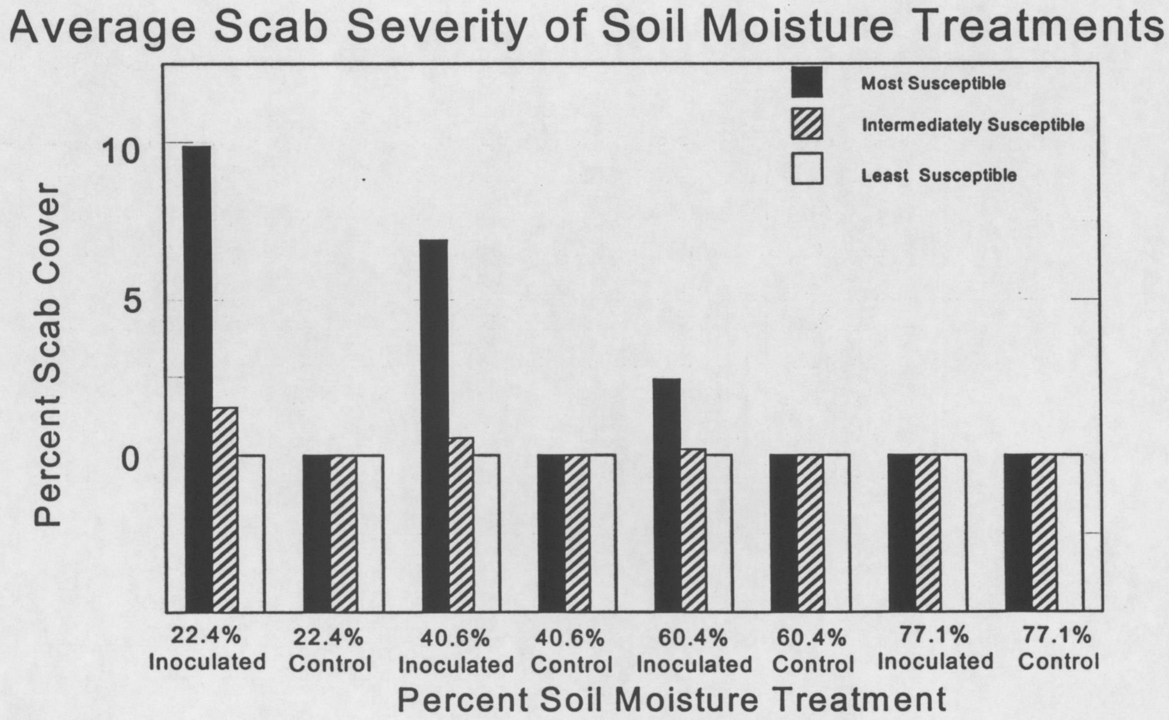


Figure 1. Average soil moisture per treatment measured by CS 615 water content reflectometers.

Figure 2. Percent scab coverage averaged from total potatoes per treatment.



The least susceptible cultivar had no scab infection at all soil moistures. In the most susceptible cultivar, the treatments at the two lowest soil moistures had significantly more common scab than all other treatments at $\alpha = 0.05$.

II. The application of Messenger in the field trial as a seed, furrow, pre-emergence, and early-emergence offered no protection against infection by *S. scabies* (as shown in Figure 3). The treatments were not significantly different among groups at $\alpha = 0.05$.

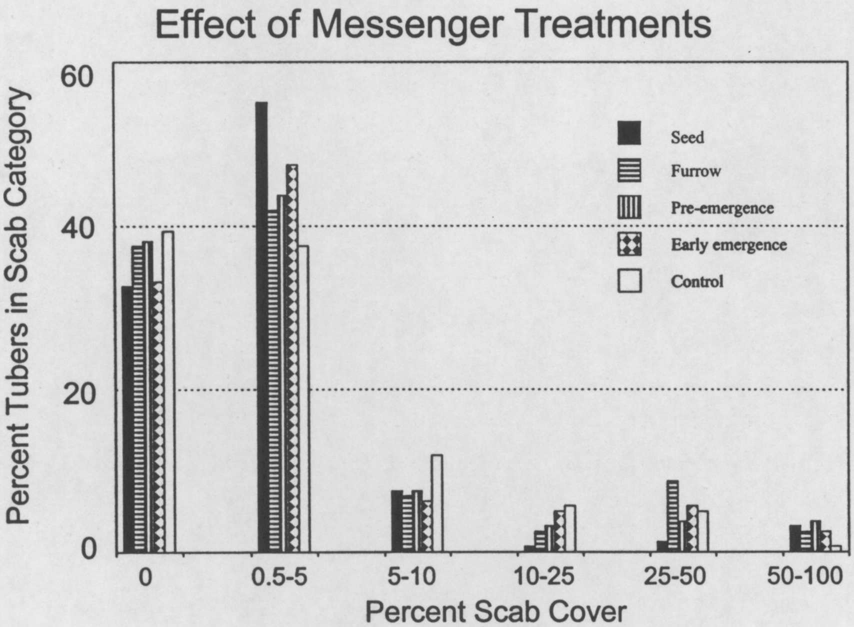


Figure 3. Effectiveness of Messenger in reducing average scab cover by four different treatment methods; seed, furrow, pre-emergence, early emergence.

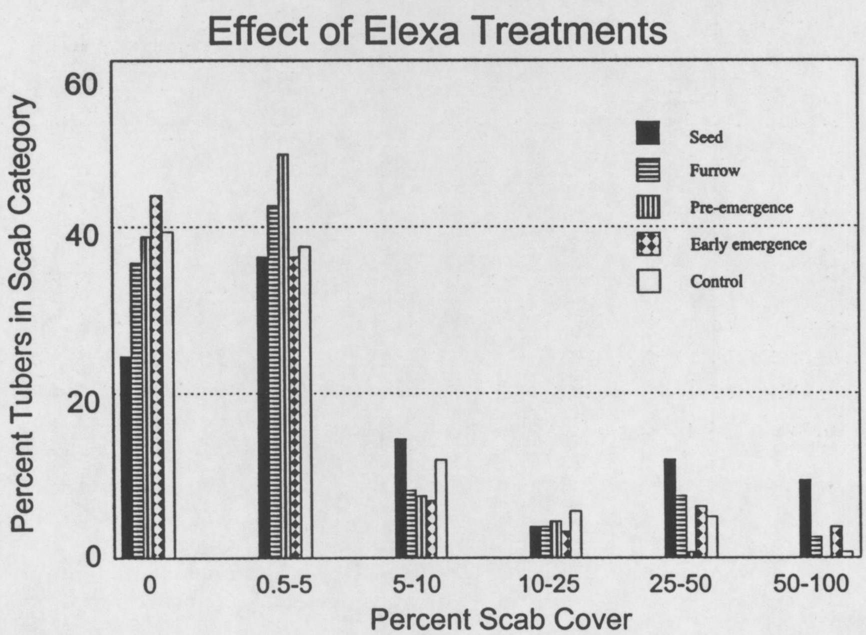


Figure 4. Effectiveness of Elexa in reducin the average scab cover by four different treatme methods: seed, furrow, pre-emergence, and early emergence

Likewise, all of the Elexa treatments (Figure 4) provided no infection coverage against *S. scabies*. In fact more of the tubers from the control plots had no scab then most of the other treatments. The treatments were not significantly different among treatment groups at $\alpha = 0.05$.

Conclusion

The greenhouse experiment validates what other research reports have shown, which is irrigation provides a means to control common scab[4]. It is evident that applying soil moisture will reduce the infection by the pathogen (Figure 2). Although the maximum common scab infection was about 10% in the greenhouse experiment, increasing the percentage of soil moisture reduced the infection. Additionally, the importance of cultivar selection has been demonstrated. The resistant cultivar showed no signs of infection by *S. scabies* at all soil moistures. This may infer that the least susceptible cultivars may need less irrigation than the more susceptible cultivars to avoid infection. At this time the interaction of genotype x environment has not yet been determined at what soil moisture the least susceptible cultivar would become susceptible to scab infection. More experiments must be conducted to further 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 treatments of Messenger and Elexa did not prove to be efficacious and in fact, some control treatments had less scab infection than the biological treatments. Although these were not effective, there should be more tests of other products that may induce resistant to common scab. Additionally, the effects of experiments using more frequent applications and in conjunction with irrigation to suppress the pathogen may provide effective have not been demonstrated.

References

1. Cook, R. J. and Baker, R. J. 1983. ***The Nature and Practice of Biological Control of Plant Pathogens.*** American Phytopathological Society: St. Paul, 416-421.

2. Elesawy, A. A., and Szabo, I. M. 1979. Isolation and Characterization of ***Streptomyces scabies*** Strains From Scab Lesions of Potato Tubers: Designation of the Neotype Strain of ***Streptomyces scabies. Acta Microbiologica Academiae Scientarum Hungaricae.*** 26, 311-320.

3. Hooker, W. J. 1981. ***Compendium of Potato Diseases.*** American Phytopathological Society: St. Paul, 33-34.

4. Lapwood, D. H., Wellings, L. W., and Hawkins, J. H. 1973. Irrigation as a Practical Means to Control Potato Common Scab (*Streptomyces scabies*): Final Experiment and Conclusions. ***Plant Pathology.*** 22: 35-41.

5. Lucas, J. A. 1998. ***Plant Pathology and Plant Pathogens.*** Blackwell Science. United Kingdom, 160-164.

2001 Nematode Research Annual Report
Michigan Potato Industry Commission

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Potato Early-Die Resistance/Tolerance Research.- Twenty-seven potato lines/varieties were evaluated in 2001 for tolerance or resistance to potato early-die. F 349-Y (Rose Gold x WI 877) exhibited resistance characteristics in 1998, 2000 and 2001. E 228-1 exhibited characteristics of tolerance in 1998, 1999, 2000 and 2001. Five additional lines appeared to be tolerant (Table 1). Five lines designated as potentially tolerant in previous years were not evaluated in 20021. Six varieties (Atlantic, Snowden, Onaway and Superior) and E 149-5Y were designated as susceptible. The category of probable susceptibility was given to dleven lines. An additional three lines in this category were not evaluated in 2001. Based on multiple-year performance, data for four f the varieties/lines evaluated were inconclusive. Four lines not evaluated in 2001 have previously been placed in the inconclusive category.

The t-Test statistic was used in 2001 for assessment of the difference in potato tuber yields between the potato-early die and fumigated soil environments. The analysis for the 27 lines/varieties ranged from 1.00 (highly tolerant or resistant) to 0.000 (highly susceptible. General observations about the lines/varieties are presented in Table 2.

Tillage System/Soil Quality Research.- The 10-Year-Term Potato Crop rotation trial funded by MPIC from 1991 through 2000 has resulted in a new classification system for soil quality (Table 3). The system consists of six categories. The research also had a major impact on the development of Michigan Field Crop Ecology and Michigan Field Crop Pest Ecology and Management. As a result of this work it was determined that much of the land at the Montcalm Potato Research Farm would be classified in Category IV (degraded soil that responds to management) and some sites as Category V (degraded soil that does not respond to management. Without potato early-die management, these sites yield 200 cwt or less. Based on these findings, a potato, wheat/clover, corn/clover system was initiated in 2001 to enhance the soil quality over a period of six-years. Alternative tillage systems (mold board plow vs chisel plow) was used as the major variable for the research project. In 2001, total tuber yields were 247 cwt with the chisel plow and 196 under the mold board plow system (Table 4). Mid-season root-lesion nematode population densities were significantly greater with the corn/alfalfa than with potato (Table 5) Although the northern root-knot nematode is present in the site, non were recovered from root tissue at mid-season.

Nematicide Evaluation.- Three nematicides (metham, Messanger and Micro-CN) were evaluated in 2001 for potato early-die control. Tuber yields under the metham system were significantly greater than without the soil fumigant (Table 6). Neither Messenger or

Micro-CN had any impact on tuber yield or quality. Metham provided season-long control of root-lesion nematodes (Table 7). Messenger and Micro-CN had no long-term impact on the population development of this nematode. The northern root-knot nematode was present in the research site; however, its distribution was highly variable. Messenger and Micro-CN did not appear to have an impact on this nematode.

Soil Quality Research.- A long-term soil quality research project was started in 2001 in cooperation with Dr. Snapp. The project uses two ranges at the Montcalm Potato Research Farm and consists of site consists of 72 plots. The 2001 objectives were to establish base-line information about the quality of the soil using a system of nematode community structure analysis. Research conducted by the MSU Nematology Program throughout Michigan, Iowa, Pennsylvania and Canada has shown this procedure to be highly sensitive in detection of soil quality differences among farming practices and locations. Because nematodes are involved in many different aspects of the below-ground food webs, their reproduction amplifies what is going on in the system and can be used for assessment of soil quality. The current hypothesis is that most Michigan soils should have a total nematode population density of between 500 and 3,000 per 1000 cm^3 soil. The population, however, must be composed of a mixture of the different types of feeding groups, including significant number of bacterial and fungal feeding nematodes. After the initial baseline analysis of the research site, the entire area was fumigated with 75 gpa of metham. This was done so the research could be initiated under uniform soil conditions.

Nematode community structure analysis currently costs $50 per sample or $10,800 for early, mid and late-season analyses of the site, or $43,200 if each plot is divided into four sections. A sampling protocol was developed that should provide excellent resolution and reduce the annual cost of to $2,800. The protocol is designed to test variance both between and within the experimental units. It was tested in 2001 in 2001. It appears to work in a statistically acceptable manner. The before fumigation nematode community structure analysis revealed that the two ranges selected for this research are Category IV soils that are degraded potato-early die sites that are degraded, but respond to management. Twenty-eight of the 56 sites evaluated had less than 500 nematodes per 100 cm^3 soil and another 13 were of marginal quality (500-1,000 nematodes per 100 cm^3 soil). only 14 of the 56 areas within the field appeared to have soil of a quality that should produce satisfactory potato tuber yields without specific potato early-die management practices. A new classification of soil quality has been developed and is presented as Table 8.

Precision Agriculture Research.- A precision agriculture research project was initiated on Field 26 (62.1 acres) of the Andersen Brothers Farm in 2000 in cooperation with Agri-Business Consultants Inc. (Figure 2). The results appears to have good potential for producer decision-making and provided an excellent new technique for field research. The plan was to repeat the research in Field 23 (55.3 acres) in 2001 (Figure 3). Unfortunately, the entire site was fumigated, making it impossible to use as a site for repeating the research. Two alternate sites were evaluated as substitutes: Field 12 (141 acres) and Field 21 (151 acres). Neither were entirely satisfactory, so a decision was made to incorporate 40 acres of Field 12 and 64 acres of Field 21 into the 2001 project in addition to Field 21. Field 12 was used by Dr. Snapp for calcium research and Field 21 by Agri-Business Consultants for evaluation of Messenger. The hand digging data from the Messenger research indicated a 15-20 cwt/acre tuber yield increase: however, the results from the yield monitoring showed no differences (314 and 316 cwt/acre respectively for Messenger and the control).

Prior to 2001, the MSU Nematology Program relied on Agri-Business Consultants Inc. and the MSU Department of Agricultural Engineering for precision agriculture technology. The nematology program now has its own precision agriculture hardware and software and two staff have been trained in its use. Analysis of the 2001 project data is currently in progress had will be completed within the next 60 days.

The soil fumigation associated with Field 23 provided season-long control of root-lesion nematodes, with none being detected on September 17 in any of the 18 sampling points.

Table 1. Summary of 2001 Michigan State University Potato Early-Die Nematode Tolerance-Resistance Research.

Probable Resistance

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

F349-1RY (98, 00, 01)
Needs one more year of data. Rose Gold x WI 877
Will be working with Dave Douches in detail on these lines.

Tolerant

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

E228-1 (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

NY 120 (01)
NY 112 (01)
H 094-8 (01)
G 227-2 (01)
H 333-3 (01)
WI 1431 (01)

Not evaluated in 2001
E 028-1 (00)
E 273-8 (00)
F 018-1 (99, 00)
F 060-6 (00)
F 373-3 (98, 00)

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)
E 149-5Y (98, 99, 00,01)
Superior (01)
Snowden (97, 99, 00, 01)
Onaway (01)

Table 1. continued

Probable Susceptibility

G 274-3 (99, 00, 01)
E 202-3 Rus (00, 01)
F 099-3 (99, 00, 01)
E 221-1 (00, 01)
G 015-C (01)
H 095-4 (01)
B 076G-3
WI 1368 (01)
WI 1386 (01)
H 026-3 Rus (01)
A 091-1 (01)

Not tested in 2001

B 106-7 (00)
G 124-85 (00)
P 81-11-5 (00)

Inconclusive

G 004-3 (00 susceptible, 01 tolerant)
G 227-2 (00 susceptible, 01 tolerant)
H 031-5 (00 tolerant, 01 susceptible)
MI Purple (00 tolerant, 01 susceptible)

Not evaluated in 2001

B 107-1 (98 inconclusive, 99 susceptible, 00 tolerant)
F 313-3 (98 susceptible, 00 tolerant)
G 050-2 (99 possible resistance, 00 susceptible)
E 048-2Y (98 possible tolerant., 99 susceptible, 00 susceptible)

Table 2. Potato early-die line/variety observations.

Possible Resistance

- F349-1RY (98, 00) Lowest root-lesion nematode reproduction in trial. Extremely high scab susceptibility.

Tolerant

- E228-1 (98, 99, 00) Second lowest root-lesion nematode reproduction in trial.

Probable Tolerance

- B107-1 (98 inconclusive, 99 susceptible, 00 tolerant)
- E028-1 (00) Scab tolerant.
- E273-8 (00) Root-knot nematode host.
- F018-1 (99, 00)
- F060-6 (00) Scab tolerant.
- F313-3 (98 susceptible, 00 tolerant) Scab susceptible.
- F373-3 (98, 00) Root knot nematode host.
- H031-5 (00) Scab susceptible.
- MI Purple (00) Scab susceptible

Susceptible

- Atlantic (97, 99, 00) Very good root-lesion nematode host
- Snowden (97, 99, 00) Very good root-lesion nematode host

Probable Susceptibility

- B106-7 (00) Root knot nematode host. Scab tolerant.
- E202-E Rus (00) Root knot nematode host. Scab tolerant.
- E221-1 (00) Excellent root knot nematode host.
- F099-3 (99, 00) Scab susceptible.
- G050-2 (99 possible resistance, 00) Excellent root-lesion nema host, RK host.
- G124-85 (00)
- G274-3 (99, 00) Scab susceptible.

Highly Susceptible

- E-149-5Y (98, 99, 00) Scab tolerant.

Probable High Susceptibility

- E048-2Y (98 possible tol., 99, 00)
- G004-3 (00) Excellent root-lesion nematode host. RK host. Scab tolerant.
- G227-2 (00) Scab tolerant.
- P81-11-5 (00) Excellent root knot nematode host. Scab susceptible.

Table 3. Influence of soil tillage on potato tuber yields.

Tillage	Tuber yield (cwt)			
	A	B	J	Total
Mold board plow	106.5	20.4	0.4	196.0
Chisel plow	142.5	17.5	0.4	247.0
T-test statistics	0.307	0.233	1.000	0.333

Table 4. Influence of soil tillage and three agronomic crops on root-lesion and northern root-knot nematode population development.

Tillage/Crop	Nematodes per 1.0 gram of root tissue (7/19/01)	
	Root-lesion nematode	Northern root-knot nematode
Moldboard plow		
Potato	130 a	0 a
Wheat/clover	270 ab	0 a
Corn/clover	316 b	0 a
Chisel plow		
Potato	169 a	0 a
Wheat/clover	278 ab	0 a
Corn/clover	529 b	0 a

Table 5. Influence of metham and two candidate nematicides on potato tuber yield.

Treatment	Tuber yield (cwt)			
	A	B	J	Total
Non-fumigated soil				
Check	236 a	17 a	2 a	255 a
Messenger	192 a	15 a	0 a	207 a
Micro-CN	239 a	17 a	1 a	256 a
Metham-fumigated soil				
Check	324 b	14 a	13 b	352 b
Messenger	349 b	18 a	3 a	370 b
Micro-CN	335 b	17 a	12 b	363 b
AOVA Statistic	0.000	0.193	0.011	0.000
Non-Fumigated	222 x	16 x	1 x	239 x
Metham-fumigated	336 y	15 y	9 y	362 y
t-Test Statistic	0.000	0.795	0.003	0.000

Table 6. Influence of metham and two candidate nematicides on root-lesion nematode population dynamics.

Treatment	Root-lesion nematodes			
	No./100 cm^3 soil			No./1.0g root
	5/30/01	7/19/01	10/3/01	7/19/01
Non-fumigated soil				
Check	101 a	23 a	95 a	105 c
Messenger	77 a	21 a	85 a	40 ab
Micro-CN	73 a	33 a	71 a	65 ac
Metham-fumigated soil				
Check	6 b	1 b	4 b	1 b
Messenger	7 b	1 b	3 b	2 b
Micro-CN	2 b	0 b	3 b	1 b

Table 7. Influence of metham and two candidate nematicides on root-lesion nematode population dynamics.

Treatment	Northern Root-Knot Nematodes			
	No./100 cm^3 soil			No./1.0g root
	5/30/01	7/19/01	10/3/01	7/19/01
Non-fumigated soil	6 a	0 a	44 a	0 a
Check	16 a	2 a	370 a	0 a
Messenger	11 a	1 a	885 a	0 a
Micro-CN				
Metham-fumigated soil				
Check	0 a	1 a	11 a	0 a
Messenger	0 a	1 a	6 a	0 a
Micro-CN	0 a	1 a	0 a	0 a

Table 8. Six categories of soil quality.

CATEGORY I. New Land.- Forest or grassland soil that has not been used for agricultural purposes for many years. With proper preparation this type of soil will produce high yields of superior quality crops with no external inputs. Both yields and crop quality will decrease every year after the first crop. Category I situations have been observed five times in potato production by the author of this classification system: three times following 75 years of maple tree forestation and two times following 10 years of old-field succession.

CATEGORY II. High Quality Soil.- Soil with microbiologically mediated nutrient cycles that produce excellent yields of high quality crops using only limited supplemental organic inputs designed to replace the matter removed with the previous crop. Growing the supplemental organic matter in place through the use of various covercrops is common. The author of this classification systems has observed Category II soil in association with a limited number of highly successful farms where a major objective of the enterprise was focused on the maintenance of humus.

Table 8 (continued) Six categories of soil quality.

CATEGORY III. Non-Degraded Soil.- Good quality soil where conventional soil nutrient and management practices are used to successfully produce excellent yields of high quality crops with no soil nutrient or soil-borne pathogen problems. Category III soil is not uncommon, but often requires a sound system of crop rotation. There is currently a significant increase in Michigan in the use of cover-crops to assist in the maintenance of the quality of Category III soil. Category III soils do not include cyst nematode, potato early-die or other sites with major soil-borne pathogen problems.

CATEGORY IV. Degraded/Responsive Soil .- Soil with significant nutritional or soil-borne pathogen problems that produces good yields of high quality crops through of use of conventional soil nutrient, irrigation and soil-borne pathogen management inputs. There currently appears to be an increasing interest in technologies designed to improve the quality of Category IV soil. Category IV soils are frequently cyst nematode, potato early-die or sites with other nematode and soil-borne pathogen problems.

CATEGORY V. Degraded/Non Responsive Soil.- Soils with significant nutritional or soil-borne pathogen problems that will not produce good yields of high quality crops through the use of conventional soil nutrient, irrigation and soil-borne pathogen management inputs. Category V soil situations often result in "survival characteristics" that threaten the existence of both specific farming enterprises and the local community. The author of this classification system has observed Category V. situations on numerous occasions during the last 25 years, including potato early-die.

CATEGORY VI. Dead Soil.- Soil that will not grow agricultural crop plants regardless of short-term management tactics. Category VI. soils have been observed in a limited number of situations by the author of this classification system.

Insect Management in Potatoes
2001 Research Report

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Introduction:

Colorado potato beetle pressure was light in most of Michigan during the 2001 growing season. Imidacloprid (Admire®, Provado®, Bayer) continued to give good control. In May 2001, thiamethoxam (Platinum®, Actara®, Syngenta) was registered for control of Colorado potato beetles, aphids and leafhoppers on potatoes. Aphid pressure was very light, despite hot, dry periods throughout the summer. Leafhopper pressure was moderate.

During 2001, we continued to survey Colorado potato beetle populations for resistance to the neonicotinoids, imidacloprid and thiamethoxam. We also investigated the length of control obtained by different formulations and rates of imidacloprid and thiamethoxam. The effect of biocontrol agents (nematodes and carabids) on Colorado potato beetle control was also investigated.

Admire (imidacloprid) resistance in the Colorado potato beetle

Colorado potato beetle has demonstrated its ability to evolve resistance to virtually any insecticide used to control it. In the late 1980's and early 1990's, no registered insecticide adequately controlled Colorado potato beetle in most of Michigan. In 1995, the neonicotinyl insecticide imidacloprid (Admire®, Provado®, Bayer) was registered and became the primary means to control insecticide-resistant Colorado potato beetles in Michigan and other areas of the U.S. In early 2001, thiamethoxam, another neonicotinyl insecticide, (Platinum®, Actara®, Syngenta) was registered for control of Colorado potato beetle on potatoes. Because these compounds are so widely used, concerns have arisen over potential resistance development.

<u>Survey of Admire (imidacloprid) and Platinum (thiamethoxam) resistance in field populations of Colorado potato beetle.</u>

Since 1995, we have tested populations of Colorado potato beetle collected from fields throughout the United States to detect changes in susceptibility to imidacloprid. In 1998, we began testing these same populations also for resistance to thiamethoxam (Syngenta). We were especially interested in detecting any cross-resistance between the two neonicitinoids: imidacloprid and thiamethoxam.

Insecticides used included imidacloprid (97.7%, technical grade) provided by Bayer (Kansas City, MO) and thiamethoxam (98.9%, technical grade) provided by Syngenta (Greensboro, NC).

Colorado potato beetle populations were collected by cooperators from Maine, New York (two populations, one from Long Island), Wisconsin, Minnesota (two populations) and Montana. Adults were either stored at room temperature (25±1° C) and fed foliage daily or were, for long term storage, kept in a controlled environment chamber (11±1° C) and fed weekly. Before each bioassay potato beetles were combined and randomly assigned to treatments. Beetles were treated with 1 µl of acetone/insecticide solution of known concentration applied to the abdomen using a 50 µl Hamilton® microsyringe. Following treatment, beetles were placed in 100 mm polystyrene petri dishes lined with Whatman® No.1 filter paper and provided with fresh potato foliage. The petri dishes were stored at 25±1° C and the foliage and filter paper were checked daily and changed as needed.

Each population was first screened to determine relative susceptibility to imidacloprid and thiamethoxam by testing 10 beetles each with three concentrations of insecticide/acetone solution plus an acetone-only control. Based on the results of these screens, a range of five concentrations of each insecticide was selected for each population to be assayed.

The responses of the beetles were assessed 7 days after treatment. A beetle was classified as dead if its abdomen was shrunken, it did not move when the legs or tarsi were pinched, and its elytra were darkened. Dead beetles were removed from dishes. A beetle was classified as walking 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. Data were analyzed by probit analyses using SAS® System v6.12.

LD_{50} values for imidacloprid, 7 days after treatment, ranged from 0.019 µg/beetle (Montana) to 0.701 µg/beetle (Long Island) (Table 1). These values are consistent with the general levels of insecticide resistance typically found in these regions and are similar to the values found previously. The LD_{50} values for thiamethoxam, 7 days after treatment, ranged from 0.039 µg/beetle (Minnesota-1) to 0.146 µg/beetle (Long Island). The general resistance level, as measured by LD_{50} values, was not significantly different than those measured previously.

Table 1. LD_{50} values (µg/beetle) and 95% fiducial limits for Colorado potato beetle populations treated with imidacloprid or thiamethoxam 7 days post treatment.

	Imidacloprid		Thiamethoxam	
strain	**LD_{50}**	**95% fiducial limits**	**LD_{50}**	**95% fiducial limits**
Maine	0.067	0.054-0.091	0.050	*
Minnesota-1	0.063	0.027-0.091	0.039	0.020-0.062
Minnesota-2	0.047	0.034-0.057	0.040	0.012-0.072
New York	0.056	0.028-0.075	0.071	0.002-0.107
Long Island	0.701	0.001-2.364	0.146	0.080-0.240
Montana	0.019	*	0.086	0.001-0.141
Wisconsin	0.144	0.062-0.204	0.070	0.029-0.102

<u>Length of control for different formulations of neonicitinoids</u>

Field-collected populations of Colorado potato beetle vary in their susceptibility to imidacloprid or thiamethoxam (as measured by LD_{50}'s). When either of these insecticides are applied at planting, the concentration of insecticide in the plant is initially high enough to control even resistant beetles. As the plant grows, this concentration drops. Eventually the insecticide concentration drops low enough so that the more resistant potato beetles are able to survive, even though susceptible potato beetles may still be killed. This earlier survival of the more resistant Colorado potato beetles may be important during cooler than normal seasons where emergence from overwintering is attenuated.

There are currently different formulations of imidacloprid and thiamethoxam that can be applied at planting. Imidacloprid can be applied as a liquid in furrow (Admire) or as a dust applied to the seed piece (Gaucho). Thiamethoxam can be applied as a liquid in furrow (Platinum). Another thiamethoxam application—a liquid applied to seed pieces (Adage) is pending registration.

Our objective was to test different commercial formulations of thiamethoxam and imidacloprid applied at planting on Colorado potato beetle control over time.

Potatoes were planted at the MSU Potato Research Farm (Entrican, MI) on 5 May 2001 (three rows, 40 feet each per treatment) and at the MSU Muck Soils Research Farm on 14 June 2001 (two rows, 50 ft each per treatment). All treatments were applied at planting. Treatments included: Admire 2F(16 fl oz/A), Admire 2F (8 fl oz/A), Platinum 2SC (0.1 lb AI/A), Platinum 2SC 0.05lb AI/A), Adage 5FS (0.8 fl oz/cwt) and Gaucho.(12 oz/cwt).

Colorado potato beetles collected from the MSU Potato Research Farm in July 2001 were used for this study. Foliage was collected from the insecticide-treated plots, placed in petri dishes and five adult Colorado potato beetles were added. Each treatment was replicated five times by placing foliage in five separate dishes (25 beetles total per treatment).

Foliage was collected from the MSU Potato Research Farm and feeding tests were set up on 26 June (52 days after planting), 16 July (72 days after planting), and 24 July (80 days after planting). Foliage was collected from the MSU Muck Soils Research Farm on 18 July (35 days after planting) and 25 July (42 days after planting). Dishes were checked daily and appropriate foliage was added if necessary. All foliage was changed and replaced with fresh foliage of the appropriate treatment 3 to 4 days after tests were set up.

Beetle mortality was assessed 7 days after tests were set up. Data were analyzed using two-way ANOVA and significance was found at the 0.05 level with Fisher's Protected LSD.

Colorado potato beetle mortality was significantly higher between treatments for foliage consumed 52 days after planting at the MSU Potato Research Farm (Table 2). Significantly more beetles died after consuming foliage treated with Adage and Platinum at 0.1 lb AI/A than those consuming untreated foliage, foliage treated with Admire or Platinum at half field rate or Gaucho. By 16 July (72 days after planting) the efficacy of the at plant treatments had dropped so that all treatments resulted in minimal mortality and there were no differences between treatments.

Colorado potato beetle mortality after consuming foliage treated at planting at the MSU Muck Soils Research farm was low on 18 July (35 days after planting) and 25 July (42 days after planting) (Table 3). There were no significant differences between treatments.

Table 2. Mean Colorado potato beetle mortality 7 days after consuming foliaged treated at the MSU Potato Research Farm at planting (5 May).				
Treatment	**Rate**	**26 June**		**18 July**
Adage 2FS	0.8 fl oz/cwt	44%	cd	5%
Admire 2F	16 oz/A	28%	bc	0%
Admire 2F	8 oz/A	12%	ab	0%
Platinum 2SC	0.1 lbAI/A	52%	d	9%
Platinum 2SC	0.05 lb AI/A	12%	ab	8%
Gaucho	12 oz/cwt	16%	ab	0%
Untreated		0%	a	0%

Table 3. Mean Colorado potato beetle mortality 7 days after consuming foliaged treated at the MSU Muck Soils Research Farm at planting (14 June).			
Treatment	**Rate**	**18 July**	**25 July**
Adage 2FS	0.8 fl oz/cwt	8%	8%
Admire 2F	16 oz/A	0%	8%
Admire 2F	8 oz/A	4%	16%
Platinum 2SC	0.1 lbAI/A	0%	8%
Platinum 2SC	0.05 lb AI/A	12%	12%
Gaucho	12 oz/cwt	12%	4%
Untreated		4%	8%

Biological Control of Colorado potato beetle

Biological control of Colorado potato beetle by entomopathogenic nematodes

During spring of 2000, laboratory tests were performed on the survival and pathogenicity of the entomopathogenic nematode *Heterorhabditis marelatus* (Liu and Berry), on four soil types (clay loam, muck, sandy loam, and sand) and four moisture levels (4.7, 40.5, 60.2, and 100.9%). Nematode survival was significantly higher in sandy loam compared to clay loam, higher in sand compared to clay loam, and highest in the moisture levels 60%-100%. Host (*Galleria mellonella*) mortality due to *H. marelatus* was significantly higher in sandy soils and 60-100% moisture. Results of the study indicate that moisture levels above 60% and sandy soils are best for nematode survival and pathogenicity. These conditions are compatible with typical potato production in Michigan.

A field study testing the pathogenicity of *H. marelatus* on Colorado potato beetle at different doses was conducted at the MSU Potato Research Farm during the 2000 and 2001 growing seasons. Small potato plots were treated with known numbers of nematodes (0, 333 million, 667 million or 1 billion nematodes/hectare). Results from 2000 show significantly higher Colorado potato beetle numbers and greater potato defoliation in untreated plots compared with nematode treated plots (Figures 1 and 2, respectively). However, in 2001 there was no correlation between nematode dose and Colorado potato beetle numbers (Figure 2). This difference may be due to higher

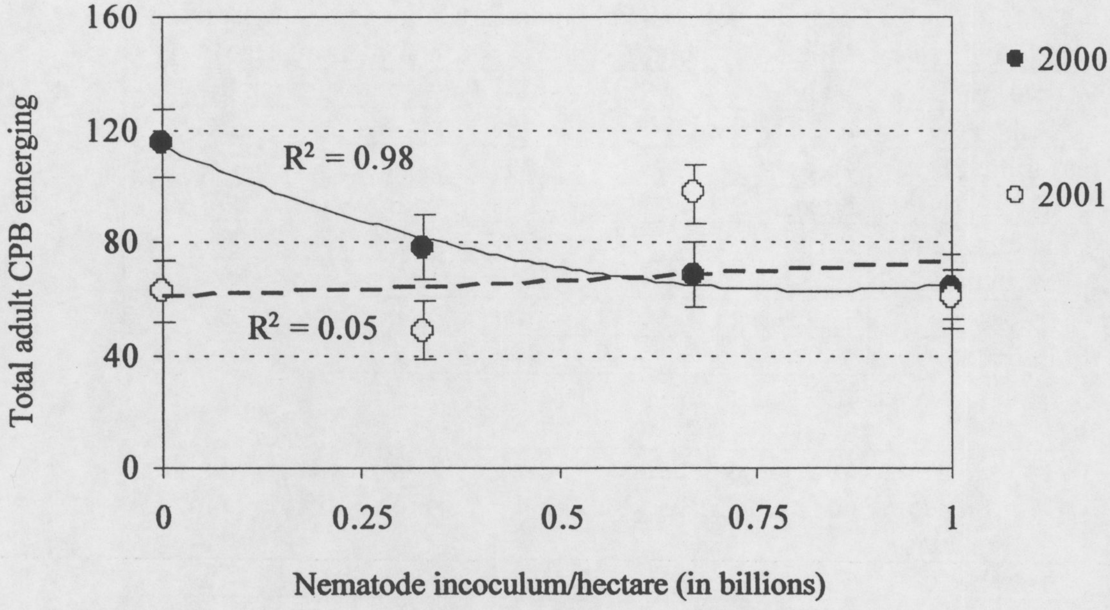

Fig. 1. Average CPB numbers vs. nematode Dose. CPB was counted beginning 1 week after nematode application and continued for 5 weeks. Results shown in the graph are average CPB numbers for each treatment.

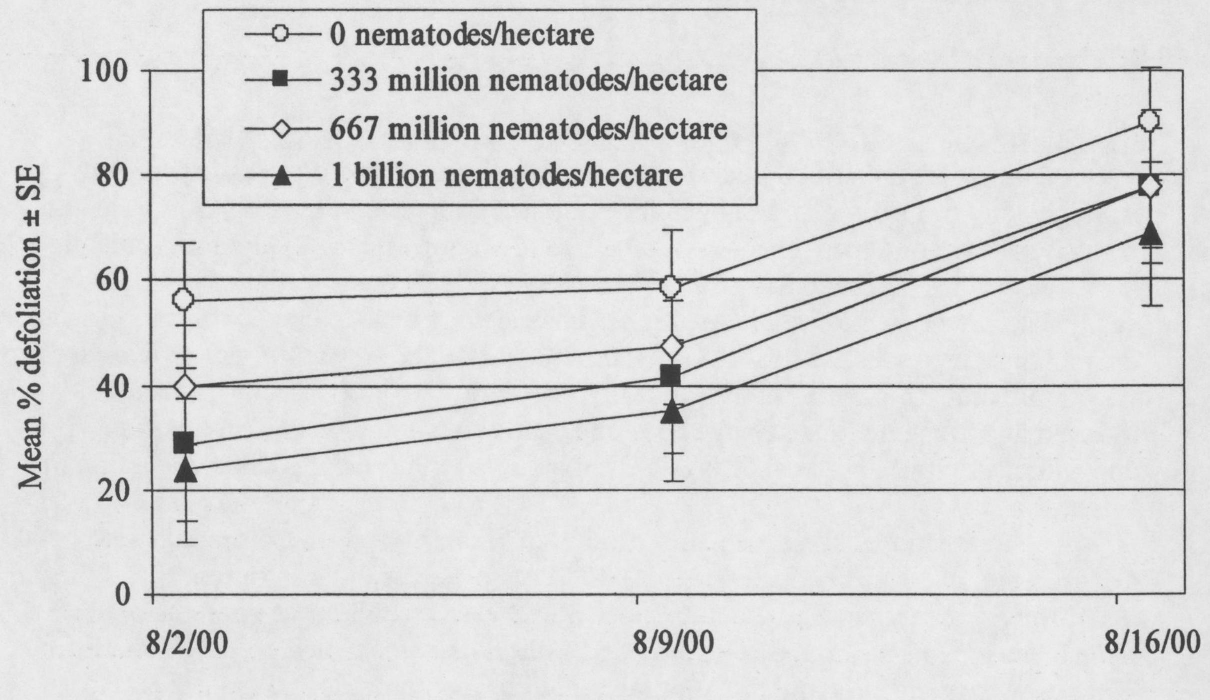

Fig. 2. Percent potato defoliation by Colorado potato beetle vs. *Heterorhabditis marelatus* rate.

temperatures, lower rainfall and high Colorado potato beetle numbers in 2001 compared to 2000.

A study to examine the best time for nematode application for optimal Colorado potato beetle control was conducted at the MSU Horticulture Farm (East Lansing, MI) in 2000 and 2001. Twelve field cages each containing nine potato plants were established and 45 newly hatched Colorado potato beetles were placed on plants in each cage. Nematodes were applied to the soil when 4th instars were first present, at peak 4th instars, or at peak pupation; three cages were left untreated. The number of emerged adults was recorded. Significantly fewer numbers of Colorado potato beetle adults occurred in nematode treated cages than in untreated cages in both years (Figure 3).

For optimal control of Colorado potato beetle, *H. marelatus* should be used with other forms of control such as pesticides, rotation and resistant lines of potatoes.

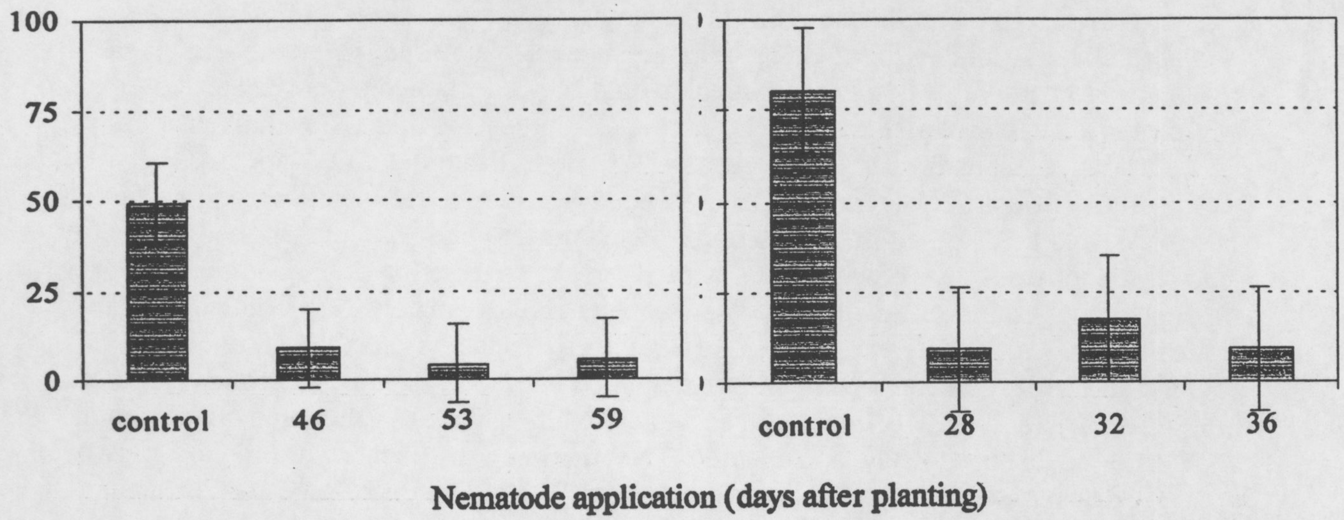

Fig. 3. The effect of nematode application timing on adult CPB emergence. All nematode treatments effectively controlled CPB.

<u>Effects of Admire-poisoning in Colorado potato beetles on predatory ground beetles (Carabidae)</u>

In 1998, ground beetles that fed on poisoned Colorado potato beetles exhibited symptoms of Admire poisoning. Expanded trials in 1999 and 2000 were inconclusive, mostly due to the erratic feeding behavior of the ground beetles.

In 2001, we used pitfall traps to collect ground beetles from the MSU Muck Soils Research Farm and MSU campus, East Lansing, MI. Traps were checked regularly from 1-20 August, and any *Pterostichus melanurus* or *Sclerites* spp. ground beetles that were found were transported to the lab. Beetles were placed in large plastic containers (up to 20 beetles/container) with some soil and pieces of ham and/or crushed dog food. Containers were checked and fed daily.

On 21 August, 26 ground beetles were placed in small petri dishes lined with moist filter paper and randomly given either an untreated Colorado potato beetle or a Colorado potato beetle that had been poisoned by a topical application of imidacloprid. Two different strains of Colorado potato beetle were used, a resistant strain and a susceptible strain. Imidacloprid doses for the susceptible and resistant strains were 0.5 μl and 1.5 μl, respectively. Colorado potato beetles were treated 2 h prior to placement with the ground beetles; this allowed us to use visibly poisoned beetles. Petri dishes were inspected daily for 4 days, and any poisoning or mortality of either Colorado potato beetles or ground beetles was recorded, as was evidence of depredation.

Five ground beetles attacked and consumed their Colorado potato beetle, two were untreated and three were treated susceptible Colorado potato beetles. No poisoning symptoms or mortality was recorded for the ground beetles.

Insecticide tests for Colorado potato beetle control

Nineteen insecticide treatments (Table 4) were tested at the MSU Montcalm Research Farm for control of Colorado potato beetle. 'Snowden' potatoes were planted 12 inches apart with a 34-inch row spacing on 8 May. Treatments were replicated four times in a RCB design. Plots were 40 ft long and three rows wide. Seven treatments were applied at planting. A12425, Admire, Admire + Ridomil Gold, Platinum, and Platinum + Ridomil Gold were applied to seed pieces as infurrow-sprays using a single nozzle hand held boom (30 gpa, 35 psi). Gaucho was applied as a dust to seed pieces (in a plastic tub) and Adage was applied with 200 ml of water using a spray bottle, both prior to planting. Foliar treatments were first applied at approximately 80% Colorado potato beelte hatch on 20 June. Subsequent first-generation sprays were applied on 26 June, 3 July, and 10 July. Three treatments were applied on three spray dates: Avaunt+PBO on 20 June, 26 June, and 10 July; Calypso (low rate) on 20 June, 26 June, and 10 July; and Warrior on 20 June, 3 July, and 10 July. The remaining treatments were applied on two spray dates: Leverage, SpinTor, and both rates of YRC 2894 on 20 June and 26 June, Actara, Confidor, and both rates of Provado on 20 June and 3 July, and Calypso (high rate) on 20 June and 10 July. Post-spray counts were made 2 days after each application and consisted of complete counts of Colorado potato beetle adults and larvae (small and large) on five plants from the middle row of each plot. Defoliation ratings were taken on 5 July and 16 July by assessing five randomly-chosen plants from the middle row of each plot. A maintenance spray of Agrimek was applied to all treatments on 25 July to control second generation Colorado potato beetles. On 18 September, the middle row of each plot was harvested mechanically, and the tubers were separated by size and weighed. Data were analyzed using two-way ANOVA and significance was found at the 0.05 level with Fisher's Protected LSD.

There were significant differences among treatments and check plots in the seasonal means of small larvae, large larvae, and adults (Table 4). All treatments resulted in significantly fewer large larvae than the check on all sampling dates. There were also significant differences among treatments in overall yield (Table 6). Compared with the check, defoliation ratings were significantly lower for all treatments on 16 July.

Table 4. Seasonal mean number of Colorado potato beetle egg masses, small larvae, large larvae, and adults per plant.

Treatment/formulation	Rate	Seasonal mean of 1st-generation CPB/plant			
		Egg Masses	Small Larvae	Large Larvae	Adults
A12425[a]	0.3 lb AI/acre	0.1	0.0a	0.0a	0.1abcd
Actara 25WG	0.02 lb AI/acre	0.3	5.2 gh	0.2abc	0.0a
Adage 5FS[c]	0.8 fl oz/cwt	0.0	0.0a	0.0a	0.0ab
Admire 2F[a]	16 fl oz/acre	0.3	0.6abc	0.4abc	0.1 bcd
Admire 2SC +	0.25 lb AI/acre	0.4	0.7abcd	0.6 bc	0.2 cde
Ridomil Gold 4EC[a]	0.2 lb AI/acre				
Avaunt 30DG+	0.065 lb AI/acre	0.3	4.6 h	0.7 c	0.1abc
PBO	0.25 lb AI/acre				
Calypso 480SC	0.75 fl oz/acre	0.1	1.5 cdefg	0.0a	0.0ab
Calypso 480SC	1.15 fl oz/acre	0.2	2.8 efgh	0.2abc	0.0ab
Confidor 200SL	1.8 fl oz/acre	0.2	5.7 h	0.8 c	0.0ab
Gaucho[b]	12 oz/cwt	0.4	1.5 cdef	0.6abc	0.2 e
Leverage 2.7SC	3.75 fl oz/acre	0.2	1.9 cdefg	0.1ab	0.0ab
Platinum 2SC[a]	0.1 lb AI/acre	0.0	0.5abc	0.0a	0.1abc
Platinum 2SC +	0.1 lb AI/acre	0.1	0.1ab	0.0a	0.2 de
Ridomil Gold 4EC[a]	0.2 lb AI/acre				
Provado 1.6F	1.84 fl oz/acre	0.2	3.4 efgh	0.3abc	0.1abc
Provado 1.6F	3.75 fl oz/acre	0.3	2.5 cdefgh	0.1ab	0.1abc
SpinTor 2SC	4.5 fl oz/acre	0.2	2.3 defgh	0.0a	0.0ab
Warrior T 1CS	0.02 lb AI/acre	0.3	5.6 h	0.3abc	0.1abcd
YRC 2894 240OS	1.5 fl oz/acre	0.2	1.3 bcde	0.0a	0.0ab
YRC 2894 240OS	2.3 fl oz/acre	0.2	3.1 fgh	0.0ab	0.0ab
Untreated check		0.2	4.2 i	3.5 d	0.5 f

Means within a column followed by different letters are significantly different ($P<0.05$, Fisher's Protected LSD).
Data transformed for analysis with log (x+1), means presented in non-transformed units.
[a]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 200 ml water before planting

Table 5. Mean yield (weight/40 row ft) harvested and defoliation ratings taken on two sampling dates.

		Yield (lb/40 row ft)			Defoliation rating[c]	
Treatment/formulation	Rate	Size A	Size B	Total	5 Jul	16 Jul
A12425[a]	0.3 lb AI/acre	77.5 cd	3.1	80.6 de	1.3abcd	1.5abcde
Actara 25WG	0.02 lb AI/acre	73.6 bcd	3.3	76.9 bcde	1.9 fgh	1.9 de
Adage 5FS[c]	0.8 fl oz/cwt	80.3 d	3.0	83.3 e	1.0a	1.3a
Admire 2F[a]	16 fl oz/acre	62.6 b	3.3	65.9 bc	1.3abcde	1.5abcd
Admire 2SC +	0.25 lb AI/acre	64.9 bc	3.8	68.6 bcd	1.2abc	1.8 bcde
Ridomil Gold 4EC[a]	0.2 lb AI/acre					
Avaunt 30DG+	0.065 lb AI/acre	69.0 bcd	2.9	71.9 bcde	1.9 fgh	1.9 de
PBO	0.25 lb AI/acre					
Calypso 480SC	0.75 fl oz/acre	67.0 bcd	3.5	70.5 bcde	1.6 bcdefg	1.8abcde
Calypso 480SC	1.15 fl oz/acre	64.5 bc	3.6	68.1 bcd	1.8 fgh	1.9 cde
Confidor 200SL	1.8 fl oz/acre	70.1 bcd	3.1	73.3 bcde	1.8 efgh	1.8 bcde
Gaucho[b]	12 oz/cwt	76.5 cd	3.6	80.1 de	1.4abcdef	2.0 e
Leverage 2.7SC	3.75 fl oz/acre	72.3 bcd	2.9	75.1 bcde	1.4abcdef	1.4abc
Platinum 2SC[a]	0.1 lb AI/acre	76.5 cd	3.0	79.5 de	1.2ab	1.5abcd
Platinum 2SC +	0.1 lb AI/acre	76.4 cd	3.3	79.6 de	1.0a	1.3ab
Ridomil Gold 4EC[a]	0.2 lb AI/acre					
Provado 1.6F	1.84 fl oz/acre	67.5 bcd	2.4	69.9 bcd	1.9 gh	1.9 cde
Provado 1.6F	3.75 fl oz/acre	70.9 bcd	3.3	74.1 bcde	1.4abcdef	1.7abcde
SpinTor 2SC	4.5 fl oz/acre	67.0 bcd	2.1	69.1 bcd	1.7 defgh	1.8 bcde
Warrior T 1CS	0.02 lb AI/acre	70.9 bcd	3.4	73.5 bcde	1.7 cdefgh	2.0 e
YRC 2894 240OS	1.5 fl oz/acre	74.6 bcd	3.9	78.5 cde	1.8 efgh	1.7abcde
YRC 2894 240OS	2.3 fl oz/acre	61.5 b	2.9	64.4 b	1.5 bcdefg	1.9 def
Untreated check		41.9a	4.4	46.3a	2.1 h	2.8 f

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.

Effect of Host Plant Resistance and Reduced Rates and Frequencies of Fungicide Application to Control Potato Late Blight

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INTRODUCTION

Late blight of potato (*Solanum tuberosum*, L.) caused by *Phytophthora infestans* (Mont de Bary), is a major worldwide threat to the production of high quality potatoes (12). Unchecked, *P. infestans* can rapidly defoliate plants in the field and can infect potato tubers when spores are washed into the soil (15). Since the early 1990s, the population of *P. infestans* throughout much of the world was clonal, mefenoxam/metalaxyl-sensitive, and US1/A1 [genotype/mating type (13)]. Potato late blight control strategies changed following the migration of mefenoxam/metalaxyl-resistant populations of *P. infestans* from Mexico to North America (12) and necessitate cultural control methods and crop protection strategies that rely primarily on protectant foliar fungicide applications (12, 18). Although fungicides have been used to manage late blight, both the efficacy and availability of commonly used fungicides have been threatened. This problem is compounded by the demand to reduce chemical input in agricultural systems (9) and the potential loss of commonly used protectant fungicides such as chlorothalonil (14) and metalaxyl/mefenoxam (17). In addition, the cost of protecting potato crops in the United States against late blight is estimated at $155 million annually (19). Therefore, crop production economics would suggest that more economical, yet still effective methods of disease control need to be developed.

There are several potential methods for reducing fungicide inputs in potato crop management. These include the use of fungicides with less active ingredient, reduced application rates, longer application intervals and a combination of any of these strategies. In addition, Fry (10, 11) observed that a combination of cultivar resistance and regular applications of protective fungicides reduced foliar late blight infection in potato. There are currently no late blight resistant potato cultivars that meet commercial standards in the United States. However, controlled environment and field trials at Michigan State University have identified certain foreign cultivars and advanced breeding lines (ABL) that are less susceptible to foliar late blight in the absence of fungicides than important cultivars grown and developed in the United States (e.g. Snowden, Atlantic, Russet Burbank) (4, 5, 6, 7). Typical fungicide application programs use a 5-7 day spray interval depending on environmental conditions and grower preference. The frequent fungicide spray intervals and rates currently used by growers to control late blight are expensive and more economical control measures are needed. Therefore, the objective of this research was to determine if acceptable control of foliar late blight can be achieved by using increased fungicide spray intervals and reduced application rates of residual contact fungicides on potato germplasm with a range of susceptibility to late blight.

MATERIALS AND METHODS

Five field experiments were performed during 1998 – 2000 to satisfy the objectives of this study. These are referred to in the Materials and Methods and Results Sections as the

"Cultivar/ABL by Fungicide Active Ingredient Trials" (three trials, 1998 – 2000) and the "Fungicide Application Interval And Reduced Dose Rate Trials" (two trials, 1998 and 2000 and 2001).

Potato Germplasm

Previous experiments (5,6,7,8) at Michigan State University have identified potato cultivars and ABL with different responses to foliar late blight. MSG274-3 has consistently been one of the most late blight resistant ABL in four years of testing whereas, Snowden has consistently been one of the most susceptible (5,6,7,8). In the present study, any cultivar/ABL with foliar late blight severity measured as the Relative Area Under the Disease Progress Curve [RAUDPC (1)] value that was not significantly higher than that of MSG274-3 was classified as late blight resistant (R). Any cultivar/ABL with a RAUDPC value significantly higher than that of Snowden or with a RAUDPC value that was not statistically different from that of Snowden was classified as late blight susceptible (S). Cultivars/ABL were classified as moderately resistant (M) if the RAUDPC value was significantly higher than that of MSG274-3 but significantly lower than that of Snowden. The potato cultivars/ABL used to assess the efficacy of reduced fungicide application rate varied among years but always included late blight susceptible controls (e.g. Snowden and Atlantic) and cultivars/ABL classified as moderately resistant or resistant to late blight (5,6,7,8). The susceptible cultivar Snowden and the resistant ABL MSG274-3 were used in both 1999 and 2000 to assess the efficacy of increased fungicide application intervals in combination with reduced application rates of chlorothalonil against potato late blight. The cultivars/ABL included in the trials from 1998 – 2000 are listed in Table 1.

Residual Contact Fungicides

Field experiments to evaluate the efficacy of various fungicide protection strategies against late blight were conducted during 1998-2000. The fungicides chlorothalonil 6SC (Bravo WS 6SC, Syngenta Crop Protection, Inc., Regional Headquarters, P.O. Box 18300, Greensboro, NC 27409) and fluazinam 5SC (non-commercial formulation, ISK Biosciences Corporation, 5966 Heisley Road, PO Box 8000, Mentor, OH 44061-8000) were used. The manufacturer's recommended applications rates (MRAR) for chlorothalonil are 0.87 kg ai/ha/application and 9.2 kg ai/ha/season (20) and 0.15 ai/ha/application and 1.5 kg ai/ha/season for fluazinam (23). Fungicides were applied with an ATV rear-mounted spray boom (R&D Sprayers, Opelousas, LA, U.S.A.) that traveled at 1 m/s, delivered 230 l H_2O/ha (3.5 kg/cm^2 pressure) with three XR11003VS nozzles per row positioned 30 cm apart and 45 cm above the canopy.

In the cultivar by fungicide active ingredient trials, chlorothalonil 6SC (chl) and fluazinam 5SC (flm) were applied at 0, 33 [0.29 (chl) and 0.05 (flm) kg ai/ha], 66 [0.57(chl) and 0.1 kg ai/ha], and 100%[0.87 (chl) and 0.15 (flm) kg ai/ha] MRAR (20,23) resulting in 7 different fungicide treatments that were applied to all cultivars/ABL on a 7 day spray interval. The trials received nine, eight and eight fungicide applications in 1998, 1999 and 2000, respectively.

In the fungicide application interval and reduced dose rates trials, chlorothalonil 6SC was applied at 5, 10 and 15 day intervals at 0, 33, 66 and 100% MRAR (16) to both Snowden and MSG274-3. The first fungicide application occurred at 27 days after planting (DAP) (June 21, 1998), 30 DAP (June 29, 1999) and 22 DAP (July 2, 2000) when potato plants were approximately 15 cm tall. Fungicides were applied until non-treated plots of susceptible controls reached about 100% diseased foliar area. The 5, 10 and 15-day interval treatments received twelve, eight and six applications in 1999 and 2000, respectively.

Experimental Design and Agronomic Practices

All experiments were conducted at the Michigan State University Muck Soils Research Station, Bath, MI (90% organic muck soil). Soils were plowed to 20 cm depth during October following harvest of preceding crops. Soils were prepared for planting with a mechanical cultivator in early May and fertilizer applied during final bed preparation on the day of planting. Cultivars/ABL were planted on May 25, 1998, May 30, 1999 and June 9, 2000 in two-row by 8 m plots (0.9 m row spacing). Fertilizers were applied in accordance with results from soil testing carried out in the spring of each year and about 250 kg N/ha (total N) was applied in two equal doses at planting and hilling. Additional micronutrients were applied according to petiole sampling recommendations and in all years. Approximately 0.2, 0.3 and 0.2 kg/ha boron, manganese and magnesium, respectively were applied as chelated formulations. Cut and whole seed pieces (75-150g) of selected cultivars and ABL were used in all experiments.

The experimental designs for the cultivar by fungicide active ingredient trials were split-block with the four replications as blocks and the seven fungicide treatments as sub-blocks. Cultivars/ABL were randomized within blocks. Data were analyzed using the proc mixed function in SAS and Least Significant Differences at P = 0.05 (LSD) were calculated using the appropriate error terms. LSD was used to determine if there were significant differences among treatments on the same cultivar/ABL and to compare different treatments on different cultivars/ABL.

The experimental design for the fungicide application interval and reduced dose rate trials were randomized complete block designs with four replications. In both trials, if a fungicide treatment on a cultivar/ABL resulted in an RAUDPC that was not significantly higher than non-treated MSG274-3, then it was classified as effective late blight control (E). Any fungicide treatment and cultivar/ABL combination in which the RAUDPC was significantly higher than, or was not significantly different from that of non-treated Snowden was classified as a non-effective (NE) treatment. Furthermore, if a fungicide treatment on a cultivar/ABL resulted in an RAUDPC significantly higher than that of non-treated MSG274-3 but significantly less than that of non-treated Snowden, then the treatment was classified as providing intermediate late blight control (I).

When relative humidity (RH) dipped below 80% (measured with RH sensors mounted within the canopy, described below), a mist irrigation system (described below) was turned on to maintain RH at >95% within the plant canopy. Plots were irrigated as necessary to maintain canopy and soil moisture conditions conducive for development of foliar late blight (16) with turbine rotary garden sprinklers (Gilmour Group, Somerset, PA, U.S.A.) at 1055 l H_2O ha/hr and managed under standard potato agronomic practices. Weeds were controlled by hilling and with metolachlor at 2.3 l/ha 10 days after planting (DAP), bentazon salt at 2.3 l/ha, 20 and 40 DAP and sethoxydim at 1.8 l/ha, 58 - 60 DAP. Insects were controlled with imidacloprid at 1.4 kg/ha at planting, carbaryl at 1.4 kg/ha, 31 and 55 DAP, endosulfan at 2.7 l/ha, 65 and 87 DAP and permethrin at 0.56 kg/ha, 48 DAP. The dates of application were similar for all years.

Pathogen Preparation and Inoculation.

Zoospore suspensions were made from *P. infestans* cultures of a single isolate, [MI 95-7, US8 genotype, insensitive to mefenoxam/metalaxyl, A2 mating type (13)], the predominant biotype present in the major potato growing regions of North America (12), grown on rye agar plates (3) for 14 days in the dark at 15°C. Sporangia were harvested from the rye agar plates by rinsing the mycelial/sporangial mat in cold (4°C) sterile, distilled water and scraping the mycelial/sporangial mat from the agar surface with a rubber policeman. The mycelial/sporangial suspension was stirred with a magnetic stirrer for 1 hour. The suspension was strained through four layers of cheesecloth and the concentration of sporangia was adjusted to about 1 x 10^3 sporangia/ml using a hemacytometer. Sporangial cultures were incubated for 2-3 hours at 4°C to stimulate zoospore release. All plots were inoculated simultaneously through an overhead sprinkler irrigation system, on July 25, 1998; July 23, 1999; and Jul 26, 2000; by injecting the zoospore suspension of *P. infestans* into the irrigation water feed pipeline under 0.5 kg/cm^2 CO_2 pressure and applied at a rate of about 150 ml of inoculum solution/m^2 trial area. The amount and rate of inoculum applied was estimated from prior calibration of the irrigation system (described above) and was intended to expose all potato foliage to inoculum of *P. infestans*.

Disease Evaluation and Data Analysis

As soon as late blight symptoms were detected (about 7 days after inoculation, DAI), each plant within each plot was visually rated at 3 to 5 day intervals for percent leaf and stem (foliar) area with late blight lesions. The mean percent blighted foliar area per treatment was calculated. Evaluations continued until untreated plots of susceptible cultivars reached 100% foliar area diseased (33, 36 and 39 DAI in 1998-2000, respectively). These days after inoculation were used as key reference points for calculation of Relative Area Under the Disease Progress Curve [RAUDPC (1)]. For each plot and assessment date, the area under the disease progress curve [AUDPC (2,16)] was estimated using the formula:

$$AUDPC = (T_{i+1} - T_i) * \left(\frac{D_{i+1} + D_i}{2}\right)$$

where *T* was the time in days since inoculation and *D* was the estimated percentage of area with blighted foliage. As foliar late blight was assessed at various time intervals, the AUDPC was estimated with the area of a right triangle whose side lengths were based on the time interval and amount of late blight in the canopy. To accumulate AUDPC for the entire season and convert it to a rate over time, the formula was:

$$RAUDPC = \frac{\sum (T_{i+1} - T_i) * \left(\frac{D_{i+1} + D_i}{2}\right)}{T_{Total} * 100}$$

Estimated AUDPC for each interval were summed, divided by the total number of days to the 100% diseased foliar area reference point in the non-treated susceptible controls, and multiplied by 100, resulting in an accumulated assessment of seasonal disease estimated as a fraction of one (RAUDPC).

Microclimate Measurement

Climatic variables were measured with a Davis Weather Station equipped with air temperature and humidity sensors located within the potato canopy on site (Spectrum

Groweather ET Station, Spectrum Technologies, Inc., 23839 W. Andrew Road, Plainfield, IL 60544). Microclimate within the potato canopy was monitored beginning when 50% of the potato plants had emerged and ending when canopies of healthy plants reached 100% senescence. The Wallin Late Blight Prediction Model (22) was developed in the Eastern United States under conditions similar to those in Michigan and was adapted to local conditions (1). Late blight disease severity values (DSV) were estimated from the Wallin Late Blight Prediction Model and accumulated from inoculation to final evaluation to estimate the conduciveness of the environment for late blight development.

RESULTS

Microclimate conditions

Late blight developed rapidly during August 1998-2000; non-treated susceptible controls reached about 100% diseased foliar area 33, 36 and 39 DAI in 1998-2000, respectively. Accumulated DSV from inoculation to 100% senescence of healthy plants were 55, 78 and 109 in 1998-2000, respectively. This indicated that in all years, environmental conditions were conducive to late blight development (DSV > 18) (22).

Cultivar/ABL by Fungicide Active Ingredient Trials

1998

Cultivars and ABL were significantly different in response to late blight and were classified and ranked based on mean RAUDPC of untreated plots (Table 2). Of the 17 non-treated cultivars/ABL, three were classified resistant (MSG274-3, Zarevo and Lily), six were classified as susceptible (Atlantic, Snowden, MSE230-6, MSG007-1, MSG297-4 and MSG141-3) and eight were moderately resistant (FL1625, MSE246-5, Matilda, Picasso, MSC103-2, MSA091-1, FL1533 and MSE018-1). For each cultivar/ABL, all fungicide treatments significantly reduced the RAUDPC compared to the corresponding non-treated control with the exception of MSG274-3. There were no significant differences among application rates of either fungicide on the cultivars/ABL that were classified as late blight resistant or moderately resistant but there were significant differences among some of the fungicide treatments on the late blight susceptible cultivars/ABL. In all susceptible cultivars with the exception of Atlantic, one or both of the fungicides applied at 33% MRAR resulted in a significantly higher RAUDPC value than the 100% MRAR treatment. However, all application rates of both fungicides provided effective late blight control on all cultivars and ABL with the exception of 33 and 66% MRAR of chlorothalonil and 33% MRAR of fluazinam on MSG141-3.

1999

Cultivars and ABL were significantly different in response to late blight and were classified and ranked based on mean RAUDPC of non-treated plots (Table 3). Of the nine non-treated cultivars/ABL tested, one was classified as resistant (MSG274-3), three were classified as susceptible (MSE246-5, Atlantic and Snowden) and five were classified as moderately resistant (MSA091-1, FL1625, FL1533, FL1833 and MSE018-1). RAUDPC values in 1999 were higher than in 1998 and fungicide treatments were less effective with most providing only intermediate late blight protection. At 33 and 66% MRAR, chlorothalonil only provided effective control in MSG274-3. However, even at 100% MRAR, chlorothalonil provided effective control for MSG274-3, FL1833, MSE246-5 and Atlantic but only intermediate control on all other cultivars/ABL. Fluazinam at 33% MRAR gave intermediate late blight control in all cultivars/ABL

except MSG274-3 in which it provided effective control. At 66%, MRAR fluazinam gave effective control in four cultivars/ABL (MSG274-3, FL1625, FL1533 and MSE246-5) and intermediate control in all other cultivars/ABL. At 100% MRAR of fluazinam, late blight was effectively controlled in all cultivars/ABL except Atlantic.
There were no significant differences between application rates of either fungicide on MSG274-3, which was classified as resistant. For all cultivars/ABL, all fungicide treatments significantly reduced the RAUDPC compared to the corresponding non-treated control with the exception of 33% MRAR of chlorothalonil on MSA091-1, FL1533 and Atlantic. In all cultivars/ABL classified as moderately resistant or susceptible, 33% MRAR of either chemical resulted in RAUDPC values that were significantly higher than the 100% MRAR treatments. For both fungicides, 66% of MRAR was not significantly different from 100% of MRAR in some cultivars/ABL but was significantly different in others.

<u>2000</u>

Cultivars and ABL were significantly different in response to late blight and were classified and ranked based on RAUDPC of non-treated plots (Table 4). Of the eight non-treated cultivars/ABL, one was classified as resistant (R), five were classified as susceptible (S) and two were classified as intermediate (I). For each cultivar/ABL, all fungicide treatments significantly reduced the RAUDPC compared to the corresponding non-treated control. Thirty-three percent MRAR of both fungicides provided intermediate late blight control on most cultivars with the exception of MSG274-3, in which both fungicides gave effective control. Chlorothalonil applied at 33% of MRAR provided effective control for FL1625 and Snowden, but at 66 and 100% of MRAR, provided effective control on all cultivars/ABL. Fluazinam effectively controlled late blight on FL1625 at 66% of MRAR and on FL1625, MSG124-8P and MSF373-8 at 100% of MRAR. There were no significant differences among application rates of either fungicide on MSG274-3, which was classified as resistant or on FL1625, which was classified as moderately resistant. For the remaining cultivars/ABL which were classified as moderately resistant or susceptible, 33% of MRAR of either fungicide resulted in RAUDPC values that were significantly higher than at 100% of MRAR with the exception of 33% MRAR of chlorothalonil on MSF373-8 and Snowden. At 66% of MRAR, both fungicides resulted in RAUDPC values that were not significantly different from those at 100% of MRAR with the exception of MSG124-8P.

Fungicide Application Interval and Reduced Dose Rate Trials

<u>1999</u>

The mean RAUDPC for non-treated Snowden was 42.04 (susceptible) and the mean for non-treated MSG274-3 was 3.87 (resistant); (Table 5). In Snowden, all fungicide application rates at all spray intervals significantly reduced the RAUDPC compared to the non-treated control. However, only 66 and 100% MRAR of chlorothalonil applied at a 5-day spray interval gave effective late blight control. In MSG274-3, all fungicide treatments significantly reduced the RAUDPC compared to the non-treated control. All application rates at all spray intervals gave effective late blight control but there were no significant differences among the treatments.

2000

Snowden was again susceptible to late blight, but due to slower disease progression the RAUDPC value in the non-treated control (16.67) was less than the RAUDPC value reported for 1999 (42.04); (Table 6). All fungicide application rates at all spray intervals significantly reduced the RAUDPC compared to the non-treated control with the exception of 33 and 66% MRAR of chlorothalonil applied at a 10-day spray interval for Snowden. The lowest RAUDPC values occurred with 66 and 100% MRAR of chlorothalonil applied at a 5 day spray interval and were classified as providing effective late blight control. In addition, 33% MRAR of chlorothalonil applied at a 15 day interval also resulted in effective late blight control which was anomalous with the results from 1999.

The mean RAUDPC for non-treated MSG274-3 was 0.03, which was classified as resistant. In MSG274-3, none of the fungicide treatments significantly reduced the RAUDPC compared to the non-treated control. All treatments gave effective late blight control and there were no significant differences among the treatments.

2001

Varieties were included from the Quad State potato breeding programs. The RAUDPC values are shown in Table 7. Application of fluazinam at full rate of application at a 5 or 7 day interval resulted in effective control in most varieties except those from the North Dakota and Minnesota programs. The mean RAUDPC for non-treated MSG274-3 and Torridon was about 0.03, which were classified as resistant.

DISCUSSION

The results of this study were consistent with previous studies and indicate that a combination of cultivar/ABL resistance and managed application of protective fungicides will reduce foliar late blight to acceptable levels in most situations (10,11,21). However, when environmental conditions were extremely favorable for the development of late blight (e.g. 1999), lower application rates (33 and 66% MRAR) provided unsatisfactory control for moderately resistant and susceptible cultivars/ABL. When conditions were moderately conducive to late blight development (e.g. 1998), reduced amounts of both chlorothalonil and fluazinam were effective at all application rates tested on most cultivars/ABL compared to the non-treated controls. Exceptions occurred, where 33% MRAR of either fungicide gave only intermediate late blight control. In some cultivars/ABL, 33% of the MRAR of either fungicide was sufficient to achieve acceptable control, whereas other cultivars/ABL required 66% MRAR of either fungicide to control late blight. However, there was rarely a further reduction in disease in any cultivar/ABL when either fungicide was applied at the 100% MRAR of either fungicide. In addition, the most resistant cultivars/ABL (e.g. MSG274-3, Zarevo and Lily) did not respond to either fungicide applied at greater than 33% of the MRAR of either fungicide.

On late blight susceptible cultivars, applications of chlorothalonil at 10 and 15-day intervals were not effective for controlling late blight at any dose tested. However, in the resistant line MSG274-3 there was no significant reduction in foliar late blight after applications of chlorothalonil at any application rate or interval. In the cultivar Snowden, all fungicide treatments were significantly different (less foliar late blight) from the non-treated (Snowden) control.

The opportunity to manage late blight by applying reduced rates of fungicides at increased spray intervals to cultivars less susceptible to late blight was demonstrated in this study. However, more critical dose response studies will be required before effective rates of application can be established for new fungicides. In addition, the efficacy of reduced rates and increased application intervals of fungicides against other potato pathogens such as early blight has not been established and may prove to be a major constraint in the adoption of managed fungicide applications.

The application rates and application frequencies of fungicides used in this study were selected to cover the range of responses likely to be exhibited by the range of cultivars/ABL used over the period of the study. In addition, as microclimatic conditions at the experimental site were likely to differ over the study period it was important to have high and low level fungicide input treatments. The study largely supported the dose rates recommended by the manufacturer but also showed that less susceptible potato cultivars required lower levels of input for effective late blight control.

As new cultivars with enhanced late blight resistance are developed and released it will be important to provide growers with recommendations for the most effective and economical chemical control of late blight in these new cultivars. In the future, the type of information gathered in this study will be used to develop models, based on cultivar resistance and response to fungicide application, to advise and guide growers as to which fungicide, rate and frequency of application is required to provide protection against late blight. Climatic conditions within the canopy will also impact choice of fungicide and rate and frequency of application (1). Therefore, new cultivars will need to be carefully screened in the manner described in this study, over several seasons in order to develop accurate models for fungicide application.

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LITERATURE CITED

1.Baker, K.M, J.A. Andresen, W.W. Kirk and J.M. Stein. 2000. Crop disease mitigation: Daily risk modeling for Michigan potato growers. 4th International Conference on Integrating GIS and Environmental Modeling (GIS/EM4). Banff, Alberta, Canada, 2-8 Sept., 2000. http://lithophyte.ngdc.noaa.gov/cgi-bin/subview3.cgi/. Paper 522.

2.Campbell, C.L. 1990. Introduction to plant disease epidemiology. New York, John Wiley and Sons.

3.Deahl, K.L. and S.P. Demuth. 1995. Identification of mating types and metalaxyl resistance in North-American populations of *Phytophthora infestans*. American Pot. J. 74(2): 35-49.

4.Douches, D.S., W.W. Kirk, K. Jastrzebski, C. Long and R. Hammerschmidt. 1997. Susceptibility of potato varieties and advanced breeding lines (*Solanum tuberosum* L.) to *Phytophthora infestans* (Mont.) de Bary in greenhouse screenings. American Pot. J 74:75-86.

5.Douches, D.S., R.W. Chase, K. Jastrzebski, R. Hammerschmidt. W.W. Kirk, C. Long, K. Walters and J. Coombs. 1997. Potato Variety Evaluations. Michigan Potato Research Report: 29:5-32.

6.Douches, D.S. R.W. Chase, K. Jastrzebski, R. Hammerschmidt, W.W. Kirk, C. Long, K. Walters, J. Coombs and J. Greyerbiehl. 1998. Potato Variety Evaluations. Michigan Potato Research Report: 30:11-35.

7.Douches, D.S. R.W. Chase, K. Jastrzebski, R. Hammerschmidt, W.W. Kirk, C. Long, K. Walters, J. Coombs and J. Greyerbiehl. 1999. Potato Variety Evaluations. Michigan Potato Research Report: 31:1-45.

8.Douches, J. Coombs, C. Long, K. Zarka, K. Walters and D. Bisognin. 2000. Potato Variety Evaluations. Michigan Potato Research Report: 32:5-54.

9.Environmental Protection Agency. 1996. The food quality protection act of 1996. http://www.epa.gov/opppsps1/fqpa/.

10.Fry, W.E. 1977a. Integrated effects of polygenic resistance and protective fungicide on development of potato late blight. Phytopathology 65:908-911.

11.Fry, W.E. 1977b. Integrated control of potato late blight- effects of polygenic resistance and techniques of timing fungicide applications. Phytopathology 67:415-420.

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

13.Goodwin, S.B., R.E. Schneider and W.E. Fry. 1995. Use of cellulose-acetate electrophoresis for rapid identification of allozyme genotypes of *Phytophthora infestans*. Plant Dis. 79:1181-1185.

14.Gray, J.I. and M.E. Whalon. 1996. The assessment of pesticides at risk in the future of Michigan food and feed plant agriculture: A process. East Lansing, Michigan, Michigan Agricultural Experiment Station: Special Report: 15.

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

16.Madden, L.V. and G. Hughes. 1995. Plant disease incidence: distributions, heterogeneity, and temporal analysis. Annual Review of Phytopathology 33:529-564.

17.Schwinn FJ and Margot P, Control with chemicals, *In Advances in plant pathology. Phytophthora infestans, the cause of potato late blight*, 7, ed. Ingram DS & PH Williams. Academic Press Limited, San Diego, CA USA,, pp. 225-265 (1991).

18.Secor, G.A. and N.C. Gudmestad. 1999. Managing fungal diseases of potato. Can. J. Plant Pathol. 21:212-221.

19.Sender, A.J. 2000. TIGR develops "potato chip" microarray to aid hunt for disease resistance genes. Agricultural Genomics 3:4-6.

20.Syngenta US Website. 2001. http://www.syngenta.com/.

21.Van der Plank, J.E. 1968. Disease resistance in plants. New York, Academic Press.

22.Wallin, J.R. 1953. The production and survival of sporangia of *Phytophthora infestans* on tomato and potato plants in the field. Phytopathology 43:505-508.

23. Zeneca UK Website. 2001. http://www.zeneca-crop.co.uk/.

Table 1. Potato cultivars and advanced breeding lines from Michigan State University potato breeding program included in cultivar by fungicide interaction trials from 1998-2000.

	Trial				
	Cultivar by Fungicide			Fungicide Timing	
Potato cultivars and advanced breeding lines	1998	1999	2000	1999	2000
North American commercial potato cultivars	Atlantic Snowden FL1533 FL1625	Atlantic Snowden FL1533 FL1625 FL1833	Snowden FL1625 FL1930	Snowden	Snowden
Foreign commercial potato cultivars	Lily Matilda Zarevo Picasso				
Advanced breeding lines (MSU breeding program)	MSA091-1 MSC103-2 MS018-1 MSE230-6 MSE246-5 MSG007-1 MSG141-3 MSG274-3 MSG297-4	MSA091-1 MSE018-1 MSE246-5 MSG274-3	MSE018-1 MSF373-8 MSG050-2 MSG124-8P MSG274-3	MSG274-3	MSG274-3

Table 2. Mean RAUDPC (max = 100) in potato cultivars and ABL inoculated with *P. infestans* (US8, A2) and protected with reduced rates of chlorothalonil or fluazinam applied at a 7-day interval, sorted by order of susceptibility in non-treated control (1998).

	Mean RAUDPC						
	Non-Treated[a]	Percent MRAR Chlorothalonil[bcdef]			Percent MRAR Fluazinam[bcdef]		
Cultivar/ABL	0	33	66	100	33	66	100
MSG274-3	3.05 (R)	1.60 (E)	1.21 (E)	1.16 (E)	2.44 (E)	2.84 (E)	2.45 (E)
Zarevo	4.37 (R)	1.68* (E)	1.28* (E)	1.52* (E)	1.23* (E)	1.16* (E)	1.18* (E)
Lily	5.20 (R)	1.79* (E)	1.69* (E)	1.42* (E)	1.37* (E)	2.06* (E)	1.10* (E)
FL1625	9.30 (M)	1.40* (E)	1.28* (E)	1.26* (E)	1.06* (E)	1.33* (E)	0.98* (E)
MSE246-5	10.20 (M)	1.53* (E)	0.81* (E)	1.06* (E)	2.17* (E)	1.40* (E)	1.26* (E)
Matilda	10.34 (M)	1.60* (E)	1.01* (E)	0.96* (E)	2.31* (E)	1.91* (E)	1.20* (E)
Picasso	11.64 (M)	3.32* (E)	0.91* (E)	1.24* (E)	1.86* (E)	1.77* (E)	1.30* (E)
MSC103-2	12.12 (M)	1.54* (E)	1.30* (E)	1.67* (E)	1.38* (E)	1.79* (E)	1.53* (E)
MSA091-1	13.32 (M)	2.51* (E)	2.63* (E)	0.81* (E)	1.85* (E)	2.44* (E)	1.47* (E)
FL1533	17.70 (M)	3.15* (E)	1.21* (E)	1.75* (E)	2.91* (E)	2.67* (E)	1.41* (E)
MSE018-1	18.72 (M)	3.99* (E)	2.38* (E)	2.37* (E)	3.57* (E)	3.08* (E)	1.11* (E)
MSG141-3	19.76 (S)	7.57* (I)	7.29* (I)	4.69* (E)	8.46* (I)	4.22* (E)	4.33* (E)
MSG297-4	20.48 (S)	3.59* (E)	3.67* (E)	2.21* (E)	5.57* (E)	1.40* (E)	1.82* (E)
MSG007-1	21.01 (S)	5.79* (E)	4.66* (E)	1.46* (E)	5.12* (E)	3.60* (E)	1.59* (E)
Snowden	21.78 (S)	5.72* (E)	2.90* (E)	2.39* (E)	2.75* (E)	1.85* (E)	1.85* (E)
Atlantic	22.16 (S)	2.49* (E)	3.14* (E)	2.36* (E)	2.00* (E)	2.35* (E)	1.91* (E)
MSE230-6	23.63 (S)	4.98* (E)	1.82* (E)	1.28* (E)	2.49* (E)	1.84* (E)	2.02* (E)

[a]Values followed by (R) = late blight resistant, (M) = moderately resistant, (S) = susceptible
[b]Values followed by (E) = effective late blight control, (I) = intermediate late blight control
[c]Values followed by (*) are significantly different from the non-treated control of the same cultivar/ABL, $P = 0.05$
[d]For comparing different treatments for the same cultivar/ABL, $LSD_{0.05} = 2.913$
[e]For comparing different cultivars/ABLs with the same treatment, $LSD_{0.05} = 2.789$
[f]For comparing different treatments and different cultivar/ABL, $LSD_{0.05} = 2.757$

Table 3. Mean RAUDPC (max = 100) in potato cultivars and ABL inoculated with *P. infestans* (US8, A2) and protected with reduced rates of chlorothalonil or fluazinam applied at a 7-day interval, sorted by order of susceptibility in non-treated control (1999).

	Mean RAUDPC						
	Non-Treated[a]	Percent MRAR Chlorothalonil[bcdef]			Percent MRAR Fluazinam[bcdef]		
Cultivar/ABL	0	33	66	100	33	66	100
MSG274-3	6.38 (R)	5.68 (E)	3.14 (E)	2.37 (E)	5.84 (E)	2.72 (E)	1.80* (E)
MSA091-1	22.52 (M)	24.32 (I)	14.59* (I)	14.10* (I)	29.36* (I)	14.03* (I)	8.40* (E)
FL1625	27.80 (M)	22.26* (I)	18.99* (I)	14.42* (I)	18.43* (I)	10.39* (E)	5.97* (E)
FL1533	31.90 (M)	28.49 (I)	14.54* (I)	13.04* (I)	14.37* (I)	10.10* (E)	5.61* (E)
FL1833	33.33 (M)	18.02* (I)	15.27* (I)	9.99* (E)	25.93* (I)	11.88* (I)	7.13* (E)
MSE018-1	37.09 (M)	26.37* (I)	26.63* (I)	20.70* (I)	27.78* (I)	18.39* (I)	6.38* (E)
MSE246-5	39.87 (S)	31.74* (I)	20.24* (I)	10.19* (E)	23.42* (I)	9.75* (E)	7.15* (E)
Atlantic	42.03 (S)	40.54 (NE)	19.15* (I)	8.79* (E)	26.22* (I)	18.35* (I)	11.91* (I)
Snowden	43.38 (S)	31.03* (I)	21.08* (I)	17.93* (I)	31.23* (I)	13.97* (I)	10.22* (E)

[a]Values followed by (R) = late blight resistant, (M) = moderately resistant, (S) = susceptible

[b]Values followed by (E) = effective late blight control, (I) = intermediate late blight control

[c]Values followed by (*) are significantly different from the non-treated control of the same cultivar/ABL, $P = 0.05$

[d]For comparing different treatments for the same cultivar/ABL, $LSD_{0.05} = 4.560$

[e]For comparing different cultivars/ABLs with the same treatment, $LSD_{0.05} = 4.294$

[f]For comparing different treatments and different cultivar/ABL, $LSD_{0.05} = 4.447$

Table 4. Mean RAUDPC (max = 100) in potato cultivars and ABL inoculated with *P. infestans* (US8, A2) and protected with reduced rates of chlorothalonil or fluazinam applied at a 7-day interval, sorted by order of susceptibility in non-treated control (2000).

	Mean RAUDPC						
	Non-Treated[a]	Percent MRAR Chlorothalonil[bcdef]			Percent MRAR Fluazinam[bcdef]		
Cultivar/ABL	0	33	66	100	33	66	100
MSG274-3	0.04 (R)	0.03 (E)	0.03 (E)	0.02 (E)	0.02 (E)	0.03 (E)	0.04 (E)
FL1625	7.69 (M)	1.77* (E)	0.86* (E)	0.64* (E)	4.16* (I)	1.25* (E)	1.50* (E)
MSG124-3P	17.17 (M)	5.41* (I)	2.18* (E)	1.30* (E)	5.07* (I)	3.57* (I)	3.02* (E)
MSF373-8	19.13 (S)	3.20* (I)	3.00* (E)	0.47* (E)	7.88* (I)	3.17* (I)	2.43* (E)
MSG050-2	19.73 (S)	4.36* (I)	2.30* (E)	0.98* (E)	10.45* (I)	4.09* (I)	3.24* (I)
Snowden	21.39 (S)	2.64* (E)	2.52* (E)	1.16* (E)	11.03* (I)	4.06* (I)	3.26* (I)
FL1930	21.40 (S)	6.18* (I)	1.46* (E)	0.79* (E)	8.42* (I)	4.91* (I)	4.56* (I)
MSE018-1	22.77 (S)	4.29* (I)	1.59* (E)	0.94* (E)	14.54* (I)	5.27* (I)	4.98* (I)

[a]Values followed by (R) = late blight resistant, (M) = moderately resistant, (S) = susceptible
[b]Values followed by (E) = effective late blight control, (I) = intermediate late blight control
[c]Values followed by (*) are significantly different from the non-treated control of the same cultivar/ABL, $P = 0.05$
[d]For comparing different treatments for the same cultivar/ABL, $LSD_{0.05} = 3.298$
[e]For comparing different cultivars/ABLs with the same treatment, $LSD_{0.05} = 3.025$
[f]For comparing different treatments and different cultivar/ABL, $LSD_{0.05} = 3.029$

Table 5. Mean RAUDPC (max = 100) in potato cultivars and ABL inoculated with *P. infestans* (US8, A2) and protected with reduced rates of chlorothalonil applied at 5, 10 or 15 day application intervals (1999).

	MSG274-3				Snowden			
	% MRAR Chlorothalonil[abcd]				% MRAR Chlorothalonil[abcd]			
Application Interval (days)	0	33	66	100	0	33	66	100
5	3.87^{+} (R)	0.84* (E)	0.52* (E)	0.15* (E)	42.04^{+} (S)	8.83*$^{+}$ (I)	5.75* (E)	5.08* (E)
10	3.87^{+} (R)	0.84* (E)	0.61* (E)	0.54* (E)	42.04^{+} (S)	30.16*$^{+}$ (I)	23.3*$^{+}$ (I)	17.07*$^{+}$ (I)
15	3.87^{+} (R)	1.45* (E)	1.18* (E)	0.58* (E)	42.04^{+} (S)	33.65*$^{+}$ (I)	32.23*$^{+}$ (I)	25.99*$^{+}$ (I)

[a]Values followed by (*) are significantly different from the non-treated control of the same cultivar/ABL at $P = 0.05$

[b]Values followed by (+) are significantly different from the same cultivar/ABL treated with 100% MRAR at a 5 day application interval ($LSD_{0.05} = 2.38$)

[c]Values followed by (R) = late blight resistant, (M) = moderately late blight resistant, (S) = late blight susceptible

[d]Values followed by (E) = effective late blight control, (I) = intermediate late blight control

Table 6. Mean RAUDPC (max = 100) in potato cultivars and ABL inoculated with *P. infestans* (US8, A2) and protected with reduced rates of chlorothalonil applied at 5, 10 or 15 day application intervals (2000).

	MSG274-3				Snowden			
	% MRAR Chlorothalonil[abcd]				% MRAR Chlorothalonil[abcd]			
Application Interval (days)	0	33	66	100	0	33	66	100
5	0.03 (R)	0.00 (E)	0.01 (E)	0.00 (E)	16.67*+ (S)	7.72*+ (I)	2.84* (E)	1.49* (E)
10	0.03 (R)	0.01 (E)	0.01 (E)	0.01 (E)	16.67*+ (S)	12.91+ (NE)	13.32+ (NE)	10.46*+ (NE)
15	0.03 (R)	0.02 (E)	0.01 (E)	0.02 (E)	16.67*+ (S)	6.01* (E)	10.36*+ (NE)	9.78*+ (I)

[a]Values followed by (*) are significantly different from the non-treated control of the same cultivar/ABL at $P = 0.05$

[b]Values followed by (+) are significantly different from the same cultivar/ABL treated with 100% MRAR at a 5 day application interval ($LSD_{0.05} = 2.38$)

[c]Values followed by (R) = late blight resistant, (M) = moderately late blight resistant, (S) = late blight susceptible

[d]Values followed by (E) = effective late blight control, (I) = intermediate late blight control, (NE) = non-effective late blight control

Table 7. Efficacy of fluazinam applied at reduced rates and frequencies on potato cultivars and Advanced breeding lines from North Central US potato breeding programs, MSU 2001.

Cultivar/ABL	Rate of fluazinam[1]	Application frequency (days) 0 RAUDPC[2]			5			7			10			14		
Jacqueline Lee	0	0.1	a[3]	R[4]												
	33				0.3	ME[5]	a	0.1	ME	a	0.0	ME	a	0.0	ME	a
	66				0.2	ME	a	0.2	ME	a	0.0	ME	a	0.1	ME	a
	100				0.0	ME	a	0.1	ME	a	0.0	ME	a	0.0	ME	a
Torridon	0	0.2	a	R												
	33				0.2	ME	a	0.1	ME	a	0.1	ME	a	0.3	ME	a
	66				0.2	ME	a	0.2	ME	a	0.1	ME	a	0.2	ME	a
	100				0.2	ME	a	0.1	ME	a	0.0	ME	a	0.3	ME	a
MN19350	0	33.5	ab	S												
	33				27.1	NE	abc	31.9	NE	abc	33.2	NE	abc	36.4	NE	a
	66				25.0	PE	bc	27.3	NE	abc	34.7	NE	a	34.3	NE	a
	100				4.6	E	d	10.4	E	cd	24.0	PE	bc	33.1	NE	abc
Snowden	0	37.2	a	S												
	33				24.7	NE	b	21.6	PE	bc	20.3	PE	bc	21.3	PE	bc
	66				8.9	E	def	13.4	E	cdef	16.6	E	bcde	18.5	PE	bcd
	100				2.7	E	f	6.0	E	ef	20.7	PE	bc	19.3	PE	bcd
Dakota Rose	0	38.6	a	S												
	33				15.9	PE	def	30.3	NE	abc	31.7	NE	abc	31.1	NE	abc
	66				15.3	PE	def	23.7	PE	cd	20.1	PE	cd	29.0	NE	bc
	100				6.6	E	f	10.1	E	ef	15.9	PE	fef	30.4	NE	abc
Dakota Pearl	0	40.5	a	S												
	33				29.4	NE	bcd	35.7	NE	abcd	36.7	NE	abc	35.4	NE	abcd
	66				10.7	E	e	25.7	PE	cd	36.8	NE	ab	38.6	NE	a
	100				11.9	E	de	18.2	PE	de	30.0	NE	bcd	33.2	NE	abcd
MNA157-4	0	41.4	a	S												
	33				21.6	PE	efg	28.2	NE	cdef	31.1	NE	bcde	32.2	NE	bcd
	66				9.4	E	h	18.0	PE	fg	23.9	PE	defg	24.4	PE	cdefg
	100				6.8	E	h	11.7	E	gh	22.8	PE	defg	34.6	NE	bc
W1355-1	0	43.9	a	S												
	33				1.4	E	de	11.3	E	bc	11.8	E	bc	24.0	PE	b
	66				1.3	E	e	2.5	E	de	9.3	E	bcd	14.8	E	bc
	100				0.6	E	e	5.7	E	cde	4.3	E	cde	4.2	E	cde

[1] Application rate of fluazinam as percent of manufacturer's recommended rate (full rate = 0.6 pt/A)

[2] Relative area under the disease progress curve from inoculation to 100% late blight in susceptible control (Snowden); max = 100.

[3] Means followed by the same letter were not significantly different at p = 0.05; comparison within cultivars only.

[4] Suceptibility of nontreated control to late blight; R = Resistant, not significantly different from Jacqueline Lee (nontreated); S = Susceptible, not significantly different from Snowden (nontreated); I = Intermediate, significantly different from both Jacqueline Lee and Snowden (nontreated).

[5] Effectiveness of fungicide treatment in comparison to Snowden treated with a full application rate of fluazinam at a 7-day interval or with nontreated Snowden control; ME (More effective) = significantly lower RAUDPC; E = nsd from treated Snowden control; PE significantly diffement diff from treated Snowden control and nontreated control; NE = f nsd from Snowden nontreated control at p = 0.05.

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

Late blight; *Phytophthora infestans*

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EVALUATION OF KQ667 AND KP481 MIXED PROGRAMS FOR POTATO LATE BLIGHT CONTROL, 200 Potatoes (cut seed) were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 15 Jun int two-row by 25-ft plots (34-in row spacing) replicated four times in a randomized complete block design. The two-row bec were separated by a five-foot unplanted row. Plots were irrigated as needed with sprinklers and were hilled immediatel before sprays began. All rows were inoculated (3.4 fl oz/25-ft row) with a zoospore suspension of *Phytophthora infestar* US8 biotype (insensitive to mefenoxam, A2 mating type) at 10^4 spores/fl oz on 23 Jul. Fungicides were applied weekl (unless otherwise stated) from 25 Jun to 13 Aug (9 applications) with an ATV rear-mounted R&D spray boom delivering 2 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Weeds were controlled by hilling and with Dual 8E (2 pt/ 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 2 (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) ar Pounce 3.2EC (8 oz/A on 28 Jul). Plots were rated visually for percentage foliar area affected by late blight on 27 Jul; 2 23, 29 Aug and 7 [17 days after final application (DAFA)] and 12 Sep (22 DAFA) when there was 100% foliar infection the untreated plots. The relative area under the disease progress curve was calculated for each treatment from date inoculation, 27 Jul to 12 Sep, a period of 47 days. Vines were killed with Reglone 2EC (1 pt/A on 16 Sep). Plots (2 x 25- row) were harvested on 5 Oct and individual treatments were weighed and graded.

Late blight developed slowly after inoculation then rapidly during Aug, and untreated controls reached 85 - 95% foli infection by 12 Sep. Over the period from 50% emergence to harvest, 109 late blight disease severity values we accumulated. The bulk of these DSV were accumulated between inoculation and desiccation. Taking 42 days aft inoculation (DAI) as a key reference point, all fungicide programs with seven-day application intervals reduced the level late blight foliar infection significantly compared to the untreated control. The application program Manzate 200DF 1.5 [applications (apps) 1,2] followed by (fb) Quadris 2SC 0.38 pt (app 3) fb Curzate 60WP 0.21 lb + Supertin 80WP 0.16 (apps 4 - 9) had the least foliar late blight and significantly less than the application program KQ667 68.75WDG 0.69 (apps 1 - 5) fb KQ667 68.75WDG 1.03 lb + Curzate 60WP 0.21 lb (apps 6 - 9) but did not have significantly less foliar la blight than any other program. All other programs were not significantly different from each other. Taking 47 DAI as a k reference point, there was almost complete defoliation of the untreated control due to late blight and all fungicide prograr had significantly less foliar late blight than the untreated control. The application program Manzate 200DF 1.5 lb (apps 1, fb Quadris 2SC 0.38 pt (app 3) fb Curzate 60WP 0.21 lb + Supertin 80WP 0.16 lb (apps 4 - 9) and KP481 50WDG 0.5 had the least foliar late blight (<11%) and significantly less than the application program KQ667 68.75WDG 0.51 lb (apps - 5) fb KQ667 68.75WDG 0.69 lb + Curzate 60WP 0.21 lb (apps 6 - 9) and KQ667 68.75WDG 0.69 lb (apps 1 - 5) KQ667 68.75WDG 1.03 lb + Curzate 60WP 0.21 lb (apps 6 - 9) and the KQ667 68.75WDG 1.38 lb programs but did n have significantly less foliar late blight than any other programs with less than about 32% foliar late blight. Average amou of foliar late blight over the season (RAUDPC)from 0 to 47 DAI was significantly reduced by all fungicide programs wi seven-day application intervals compared to the untreated control. The lowest RAUDPC values (< 3 and NSD from ea other) were recorded in the programs Manzate 200DF 1.5 lb (apps 1,2) fb Quadris 2SC 0.38 pt (app 3) fb Curzate 60V 0.21 lb + Supertin 80WP 0.16 lb (apps 4 - 9); Manzate 200DF 1.5 lb (apps 1,2) fb Quadris 2SC 0.38 pt (app 3) fb Curza 60WP 0.21 lb + Equus 1.5 pt (apps 4 - 9) and KQ667 68.75WDG 1.38 lb however these programs did not ha significantly lower RAUDPC values than any other application program. Yields were moderately high despite late plantir Yield was not well correlated with increasing severity of foliar late blight and there was no significant difference betwe any treatment in terms of marketable or total yield. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar late blight (%) 42DAI[1] 17 DAFA[2]		Foliar late blight (%) 47DAI 22 DAFA		RAUDPC[3] max = 100 0 - 47 DAI		Yield (cwt/acre) US1		Yield (cwt/acre) Total	
KQ667 68.75WDG 0.51 lb (A,B,C,D,E)[4] KQ667 68.75WDG 0.69 lb + (F,G,H,I) Curzate 60WP 0.21 lb	11.3	bc[5]	41.3	b	4.96	b	245	a	320	a
KQ667 68.75WDG 0.69 lb (A,B,C,D,E) KQ667 68.75WDG 1.03 lb + (F,G,H,I) Curzate 60WP 0.21 lb	17.5	b	36.3	bc	5.44	b	268	a	334	a
KQ667 68.75WDG 1.03 lb (A,B,C,D,E,F,G,H,I)..	9.5	bc	23.8	bcd	3.36	b	241	a	315	a
KQ667 68.75WDG 1.38 lb (A,B,C,D,E,F,G,H,I)..	10.8	bc	35.0	bc	4.31	b	244	a	302	a
KP481 50WDG 0.5 lb (A,C,E,G,I) Manzate 200DF 1.5 lb (B,D,F,H)	10.8	bc	25.0	bcd	3.62	b	267	a	342	a
KP481 50WDG 0.75 lb (A,C,E,G,I) Manzate 200DF 1.5 lb (B,D,F,H)	12.0	bc	31.3	bcd	4.00	b	231	a	283	a
KP481 50WDG 0.38 lb + (A,B,C,D,E,F,G,H,I) Manzate 200DF 0.94 lb	7.8	bc	25.0	bcd	3.10	b	278	a	349	a
KP481 50WDG 0.5 lb + (A,B,C,D,E,F,G,H,I) Manzate 200DF 0.94 lb	9.5	bc	27.5	bcd	3.54	b	283	a	362	a
KP481 50WDG 0.5 lb (A,B,C,D,E,F,G,H,I)	3.3	bc	10.8	d	1.32	b	238	a	312	a
Manzate 200DF 1.5 lb (A,B) Quadris 2SC 0.38 pt (C) Curzate 60WP 0.21 lb + (D,E,F,G,H,I,) Equus ZN 6SC 1.5 pt	5.8	bc	16.3	cd	2.10	b	245	a	321	a
Manzate 200DF 1.5 lb (A,B) Quadris 2SC 0.38 pt (C) Curzate 60WP 0.21 lb + (D,E,F,G,H,I,) Supertin 80WP 0.16 lb	2.0	c	10.8	d	1.13	b	202	a	269	a
Untreated	90.0	a	96.5	a	26.10	a	230	a	303	a

[1] Days after inoculation with *Phytophthora infestans*, US8, A2.
[2] Days after final application of fungicide.
[3] RAUDPC, relative area under the disease progress curve calculated from the day of inoculation to the last evaluation of late blight.
[4] Application dates: A= 23 Jun; B= 1 Jul; C= 8 Jul; D= 15 Jul; E= 22 Jul; F= 30 Jul; G= 7 Aug; H= 14 Aug; I= 21 Aug.
[5] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

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

Late blight; *Phytophthora infestans*

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EVALUATION OF MIXED FUNGICIDE PROGRAMS FOR POTATO LATE BLIGHT CONTROL, 2001: Potatc (cut seed) were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 15 Jun into two-rc by 25-ft plots (34-in row spacing) replicated four times in a randomized complete block design. The two-row beds we separated by a five-foot unplanted row. Plots were irrigated as needed with sprinklers and were hilled immediately befc sprays began. All rows were inoculated (3.4 fl oz/25-ft row) with a zoospore suspension of *Phytophthora infestans* U biotype (insensitive to mefenoxam, A2 mating type) at 10^4 spores/fl oz on 23 Jul. Fungicides were applied weekly (unle otherwise stated) from 25 Jun to 13 Aug (9 applications) with an ATV rear-mounted R&D spray boom delivering 25 gal (80 p.s.i.) and using three XR11003VS nozzles per row. Weeds were controlled by hilling and with Dual 8E (2 pt/A on 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 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 Poun 3.2EC (8 oz/A on 28 Jul). Plots were rated visually for percentage foliar area affected by late blight on 27 Jul; 20, 23, Aug and 7 [17 days after final application (DAFA)] and 12 Sep (22 DAFA) when there was 100% foliar infection in t untreated plots. The relative area under the disease progress curve was calculated for each treatment from date of inoculatic 27 Jul to 12 Sep, a period of 47 days. Vines were killed with Reglone 2EC (1 pt/A on 16 Sep). Plots (2 x 25-ft row) we harvested on 5 Oct and individual treatments were weighed and graded.

Late blight developed slowly after inoculation then rapidly during Aug, and untreated controls reached 85 - 95% fol infection by 12 Sep. Over the period from 50% emergence to harvest, 109 late blight disease severity values we accumulated. The bulk of these DSV were accumulated between inoculation and desiccation. Taking 42 days af inoculation (dai) as a key reference point, all fungicide programs with seven-day application intervals reduced the level late blight foliar infection significantly compared to the untreated control except Planthelper 4SC 1.2 pt. The applicati programs of Planthelper 4SC 1.2 pt and Bravo WS 6SC 1.5 pt (apps 1 - 4) followed by (fb) Messenger 3WDG 0.42 lb (ap 5 - 9) were not significantly different from each other but had significantly greater late blight than all other progran Taking 47 dai as a key reference point, there was almost complete defoliation of the untreated control due to late blight a all fungicide programs had significantly less foliar late blight than the untreated control except Planthelper 4SC 1.2 pt. T application programs of Planthelper 4SC 1.2 pt and Bravo WS 6SC 1.5 pt (apps 1 - 4) fb Messenger 3WDG 0.42 lb (apps 9) were not significantly different from each other but had significantly greater late blight than all other programs. Ma programs gave intermediate control of late blight with approximately > 16% and < 40% foliar late blight however the Bra WS 6SC 1.5 pt alternated with Messenger 3WDG 0.42 lb program had significantly greater foliar late blight than progra with less than 16% foliar late blight. Average amount of foliar late blight over the season (RAUDPC) from 0 to 47 dai v significantly reduced by all fungicide programs with seven-day application intervals compared to the untreated cont except Planthelper 4SC 1.2 pt. The application programs of Planthelper 4SC 1.2 pt and Bravo WS 6SC 1.5 pt (apps 1 - 4 Messenger 3WDG 0.42 lb (apps 5 - 9) were not significantly different from each other but had significantly higher RAUD values than all other programs (approximately > 15). All other programs had RAUDPC values < 5 and were significantly different from each other. Yields were moderately high despite late planting. Yield was not well correlated w increasing severity of foliar late blight but the untreated plots and Planthelper 4SC 1.2 pt had numerically the low marketable yield in comparison with other treatments however there was no significant difference between any treatmen terms of marketable or total yield. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar late blight (%) 42DAI[1] 17 DAFA[2]	47DAI 22 DAFA	RAUDPC[3] max = 100 0 - 47 DAI	Yield (cwt/acre) US1	Total
Equus 6SC 1.5 pt (A,B,C,D,E,F,G,H,I)[3]........................	6.5 c[4]	18.8 cd	2.16 c	318 a	402 a
Equus DF 82.5 DF 1.4 lb (A,B,C,D,E,F,G,H,I)........................	10.8 c	31.3 cd	3.77 c	245 a	321 a
Equus ZN 6SC 2.13 pt (A,B,C,D,E,F,G,H,I)........................	3.8 c	7.5 d	1.15 c	307 a	397 a
Echo 720 6SC 1.5 pt (A,B,C)........................ Echo 720 6SC 1.5 pt + (D,E,F,G,H,I) Curzate 60WP 0.13 lb	5.8 c	11.3 d	1.77 c	317 a	397 a
Echo 720 6SC 1.5 pt (A,B,C,D,E)........................ Echo 720 6SC 1.5 pt + (F,G,H,I) Supertin 80WP 0.23 lb	5.3 c	10.0 d	1.63 c	328 a	402 a
Echo ZN 6SC 2.13 pt (A,C,E,G,H,I)........................ Echo ZN 6SC 2.13 pt + (B,D,F) Headline 2SC 0.58 pt	7.0 c	13.8 d	2.09 c	321 a	394 a
Echo ZN 6SC 2.13 pt (A,C,E,G,H,I)........................ Echo ZN 6SC 2.13 pt + (B,D,F) Quadris 2SC 0.58 pt	3.5 c	10.0 d	1.18 c	337 a	424 a
Gavel 75WDG 2.0 lb (A,B,C,D,E,F)........................ Dithane RS 75DF 1.2 lb (G,H,I)	10.3 c	28.8 cd	3.59 c	293 a	374 a
Gavel 75WDG 2.0 lb (A,B,D,F,G,H,I)........................ Quadris 2SC 0.4 pt (C,E)	5.8 c	16.3 cd	1.87 c	297 a	372 a
Dithane RS 75DF 2.0 lb (A,B,C,D,E,F,G,H,I)........................	5.0 c	14.5 d	1.62 c	302 a	380 a
Quadris 2SC 0.4 pt (A)........................ Polyram 80DF 2.0 lb (B,D,E,F,G,H,I) Quadris 2SC 0.4 pt (C)	7.0 c	23.8 cd	2.52 c	305 a	379 a
Quadris 2SC 0.4 pt (A)........................ Polyram 80DF 2.0 lb + (B,D,E,F,G,H,I) Curzate 60WP 0.21 lb Quadris 2SC 0.4 pt (C)	3.8 c	13.3 d	1.44 c	316 a	399 a
Quadris 2SC 0.4 pt (A)........................ Polyram 80DF 2.0 lb + (B,D,E,F,G) Supertin 80WP 0.16 lb Quadris 2SC 0.4 pt (C) Bravo WS 1.5 pt (H,I)	5.5 c	12.8 d	1.65 c	316 a	397 a
Bravo WS 1.5 pt (A,B,E,F,H.I)........................ Acrobat 50WP 0.31 lb + (C,D,G) Polyram 80DF 1.88 lb	4.5 c	8.8 d	1.26 c	333 a	408 a
Polyram 80DF 1.88 lb + (A.B,C,D,E,F,G.H.I)........................ Supertin 80WP 0.16 lb	5.5 c	15.8 cd	1.89 c	299 a	375 a
Planthelper 4SC 1.2 pt (A.B,C,D,E,F,G.H.I)........................	62.5 ab	87.5 ab	17.67 ab	235 a	363 a

[1] Days after inoculation with *Phytophthora infestans*, US8, A2.
[2] Days after final application of fungicide.
[3] RAUDPC, relative area under the disease progress curve calculated from the day of inoculation to the last evaluation of late blight.

4 Application dates: A= 23 Jun; B= 1 Jul; C= 8 Jul; D= 15 Jul; E= 22 Jul; F= 30 Jul; G= 7 Aug; H= 14 Aug; I= 21 Aug.
5 Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

Treatment and rate/acre	Foliar late blight (%) 42DAI[1] 17 DAFA[2]	Foliar late blight (%) 47DAI 22 DAFA	RAUDPC[3] max = 100 0 - 47 DAI	Yield (cwt/acre) US1	Yield (cwt/acre) Total
Bravo WS 6SC 1.5 pt (A,C,E,G,I)[3]............................. Messenger 3WDG 0.42 lb (B,D,F,H)	7.0 c[4]	38.8 c	3.34 c	279 a	360 a
Messenger 3WDG 0.42 lb (A,B,C,D).. Bravo WS 6SC 1.5 pt (E,F,G,H,I)	5.0 c	13.3 d	1.64 c	260 a	341 a
Bravo WS 6SC 1.5 pt (A,B,C,D).. Messenger 3WDG 0.42 lb (E,F,G,H,I)	51.3 b	73.3 b	14.92 b	236 a	320 a
Bravo WS 1.5 pt + (A,B,C,D).. Champ DP 4.6 FL 2.67 pt Dithane RS 75 DF 1.5 + (E,F,G,H,I) Champ DP 4.6 FL 2.0 pt + AgriTin 80WP 0.13 lb	7.8 c	26.3 cd	3.24 c	263 a	349 a
Bravo WS 1.5 pt + (A,B,C,D).. Champ DP 4.6 FL 2.67 pt Dithane RS 75 DF 1.5 + (E,F,G,H,I) Champ DP 4.6 FL 2.0 pt + Phostrol 53.6SC 8.0 pt	2.5 c	15.0 cd	1.30 c	303 a	375 a
Bravo WS 1.5 pt + (A,B,C,D).. Champ DP 4.6 FL 2.67 pt Champ DP 4.6 FL 2.67 pt + (E,F,G,H,I) Phostrol 53.6SC 8.0 pt	5.5 c	26.3 cd	2.46 c	258 a	359 a
Quadris 2SC 0.4 pt + (A)... Bravo WS 6SC 1.5 pt Bravo WS 6SC 1.5 pt + (B,D) Champ DP 4.6 FL 2.67 pt Acrobat 50WP 0.31 lb + (C,H) Bravo WS 6SC 1.5 pt Dithane RS 75 DF 1.5 + (E,F,G,I) Champ DP 4.6 FL 2.0 pt + AgriTin 80WP 0.13 lb + Phostrol 53.6SC 8.0 pt	3.3 c	13.8 d	1.37 c	247 a	321 a
Quadris 2SC 0.4 pt + (A)... Equus WS 6SC 1.5 pt Equus WS 6SC 1.5 pt (B) Acrobat 50WP 0.31 lb + (C,H) Equus WS 6SC 1.5 pt Equus WS 6SC 1.5 pt + (E,F,G) Kocide 4.6FL 2.67 pt Manzate 75WP 2.0 lb + (I) Supertin 80WP 0.16	4.3 c	8.8 d	1.22 c	296 a	371 a
Untreated...	76.3 a	100.0 a	23.53 a	224 a	316 a

[1] Days after inoculation with *Phytophthora infestans*, US8, A2.
[2] Days after final application of fungicide.
[3] RAUDPC, relative area under the disease progress curve calculated from the day of inoculation to the last evaluation of late blight.
[4] Application dates: A= 23 Jun; B= 1 Jul; C= 8 Jul; D= 15 Jul; E= 22 Jul; F= 30 Jul; G= 7 Aug; H= 14 Aug; I= 21 Aug.
[5] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

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

Late blight; *Phytophthora infestans*

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EVALUATION OF HEADLINE PROGRAMS FOR POTATO LATE BLIGHT CONTROL, 2001: Potatoes (cut see were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 15 Jun into two-row by 25- plots (34-in row spacing) replicated four times in a randomized complete block design. The two-row beds were separated b a five-foot unplanted row. Plots were irrigated as needed with sprinklers and were hilled immediately before sprays bega All rows were inoculated (3.4 fl oz/25-ft row) with a zoospore suspension of *Phytophthora infestans* US8 bioty (insensitive to mefenoxam, A2 mating type) at 10^4 spores/fl oz on 23 Jul. Fungicides were applied weekly (unless otherwi stated) from 25 Jun to 13 Aug (9 applications) with an ATV rear-mounted R&D spray boom delivering 25 gal/A (80 p.s. and using three XR11003VS nozzles per row. Weeds were controlled by hilling and with Dual 8E (2 pt/A on 20 Ju 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 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 oz/A on 28 Jul). Plots were rated visually for percentage foliar area affected by late blight on 27 Jul; 20, 23, 29 Aug and [17 days after final application (DAFA)] and 12 Sep (22 DAFA) when there was 100% foliar infection in the untreated plo The relative area under the disease progress curve was calculated for each treatment from date of inoculation, 27 Jul to Sep, a period of 47 days. Vines were killed with Reglone 2EC (1 pt/A on 16 Sep). Plots (2 x 25-ft row) were harvested on Oct and individual treatments were weighed and graded.

Late blight developed slowly after inoculation then rapidly during Aug, and untreated controls reached 85 - 95% foli infection by 12 Sep. Over the period from 50% emergence to harvest, 109 late blight disease severity values we accumulated. The bulk of these DSV were accumulated between inoculation and desiccation. Taking 42 days aft inoculation (DAI) as a key reference point, all fungicide programs with seven-day application intervals reduced the level late blight foliar infection significantly compared to the untreated control. The application program of Quadris 2SC 0.98 had a significantly greater amount of foliar late blight than applications programs with less than about 12% foliar late blig All other programs were not significantly different from each other. Taking 47 DAI as a key reference point, there w almost complete defoliation of the untreated control due to late blight and all fungicide programs had significantly less foli late blight than the untreated control. The application programs of Quadris 2SC 0.98 pt had significantly greater foliar la blight than all other programs with less than about 23% foliar late blight and was not significantly different form t Headline 2SC 058 pt program. The Headline 2SC 058 pt program had significantly greater foliar late blight than progra with less than about 8% foliar late blight which included the Headline 2SC 058 pt + Bravo WS 6SC 1.5 pt and the Bravo W 6SC 1.5 pt program. Programs with less than about 12% foliar late blight were not significantly different from each oth Average amount of foliar late blight over the season (RAUDPC) from 0 to 47 DAI was significantly reduced by all fungici programs with seven-day application intervals compared to the untreated control. The application programs of Quadris 2S 0.98 pt had significantly higher RAUDPC values than all other programs (approximately > 3.5. All other programs h RAUDPC values < 3.75 and were not significantly different from each other. Yields were moderately high despite l planting. Yield was not well correlated with increasing severity of foliar late blight but the untreated plots had numerica the lowest marketable yield in comparison with other treatments however there was no significant difference between a treatment in terms of marketable or total yield. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar late blight (%) 42DAI[1] 17 DAFA[2]	47DAI 22 DAFA	RAUDPC[3] max = 100 0 - 47 DAI	Yield (cwt/acre) US1	Total
Headline 2SC 0.58 pt (A,B,C,D,E,F,G,H,I)[4]........................	5.5 bc[5]	23.8 bc	2.38 bc	203 a	283 a
Headline2SC 0.58 pt + (A,B,C,D,E,F,G,H,I)..................... Bravo WS 6SC 1.5 pt	2.3 c	5.8 d	0.72 c	226 a	299 a
Acrobat 50WP 0.4 lb + (A,B,C,D,E,F,G,H,I)................... Polyram 80WDG 2.0 lb + Silwet 70SC 0.13 pt	2.8 c	11.5 cd	1.14 c	260 a	314 a
Bravo WS SC 1.5 pt (A,B,C,D,E,F,G,H,I).........................	1.8 c	7.3 d	0.73 c	247 a	300 a
Quadris 2.08SC 0.96 pt (A,B,C,D,E,F,G,H,I)....................	19.5 b	38.8 b	5.20 b	223 a	289 a
Untreated..	62.5 a	92.5 a	19.16 a	135 a	205 a

[1] Days after inoculation with *Phytophthora infestans*, US8, A2.
[2] Days after final application of fungicide.
[3] RAUDPC, relative area under the disease progress curve calculated from the day of inoculation to the last evaluation of late blight.
[4] Application dates: A= 23 Jun; B= 1 Jul; C= 8 Jul; D= 15 Jul; E= 22 Jul; F= 30 Jul; G= 7 Aug; H= 14 Aug; I= 21 Aug.
[5] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

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

Late blight; *Phytophthora infestans*

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EVALUATION OF FLUAZINAM , RANMAN AND CHLOROTHALONIL MIXED PROGRAMS FOR POTAT LATE BLIGHT CONTROL, 2001: Potatoes (cut seed) were planted at the Michigan State University Muck Soi Experimental Station, Bath, MI on 15 Jun into two-row by 25-ft plots (34-in row spacing) replicated four times in randomized complete block design. The two-row beds were separated by a five-foot unplanted row. Plots were irrigated needed with sprinklers and were hilled immediately before sprays began. All rows were inoculated (3.4 fl oz/25-ft row) wi a zoospore suspension of *Phytophthora infestans* US8 biotype (insensitive to mefenoxam, A2 mating type) at 10^4 spores/fl on 23 Jul. Fungicides were applied weekly (unless otherwise stated) from 25 Jun to 13 Aug (9 applications) with an AT rear-mounted R&D spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Weeds we 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 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 Ju 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 percenta foliar area affected by late blight on 27 Jul; 20, 23, 29 Aug and 7 [17 days after final application (DAFA)] and 12 Sep (DAFA) when there was 100% foliar infection in the untreated plots. The relative area under the disease progress curve w calculated for each treatment from date of inoculation, 27 Jul to 12 Sep, a period of 47 days. Vines were killed with Reglo 2EC (1 pt/A on 16 Sep). Plots (2 x 25-ft row) were harvested on 5 Oct and individual treatments were weighed and graded.

Late blight developed slowly after inoculation then rapidly during Aug, and untreated controls reached 85 - 95% fol infection by 12 Sep. Over the period from 50% emergence to harvest, 109 late blight disease severity values we accumulated. The bulk of these DSV were accumulated between inoculation and desiccation. Taking 42 days af inoculation (DAI) as a key reference point, all fungicide programs with seven-day application intervals reduced the level late blight foliar infection significantly compared to the untreated control. All application programs were not significan different from each other. Taking 47 DAI as a key reference point, there was almost complete defoliation of the untreat control due to late blight and all fungicide programs had significantly less foliar late blight than the untreated control. T application programs BAS 536 18.7 WDG 2.14 lb alternated with Ranman 40SC 0.17 pt and BAS 536 18.7 WDG 2.14 alternated with Ranman 40SC 0.09 pt [applications (apps) 2 and 4], Ranman 40SC 0.13 pt (apps 6 and 8) followed by (Ranman 40SC 0.17 pt had significantly less foliar late blight than Quadris 2SC 0.97 pt alternated with Bravo WS 6SC 1.5 application program but did not have significantly less foliar late blight than any other application program. Average amou of foliar late blight over the season (RAUDPC)from 0 to 47 DAI was significantly reduced by all fungicide programs w seven-day application intervals compared to the untreated control (RAUDPC = 25.9). All application programs had less th RAUDPC = 3.1 and were not significantly different from each other. Yields were moderately high despite late plantir Yield was not well correlated with increasing severity of foliar late blight and there was no significant difference betw any treatment in terms of marketable or total yield however numerically all application programs had higher marketable a total yield than the untreated control. Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar late blight (%) 42DAI[1] 17 DAFA[2]		Foliar late blight (%) 47DAI 22 DAFA		RAUDPC[3] max = 100 0 - 47 DAI		Yield (cwt/acre) US1		Yield (cwt/acre) Total	
Omega 5SC 0.4 pt (A,B,C,D,E,F,G,H,I)[4].......	2.5	b[5]	12.0	bc	1.9	b	320	a	384	a
Quadris 2SC 0.8 pt (A,C,E,G,I)............................. Bravo WS 6SC 1.5 pt (B,D,F,H,)	2.0	b	10.8	bc	1.9	b	278	a	356	a
Quadris 2SC 0.97 pt (A,C,E,G,I)........................... Bravo WS 6SC 1.5 pt (B,D,F,H)	2.3	b	20.0	b	3.1	b	309	a	371	a
Ranman 40SC 0.13 pt (A,B,C,D,E,F,G,H,I)..........	1.5	b	14.0	bc	2.0	b	297	a	367	a
Ranman 40SC 0.17 pt (A,B,C,D,E,F,G,H,I)..........	1.1	b	10.8	bc	1.3	b	295	a	372	a
BAS 536 18.7 WDG 2.14 lb (A,C,E,G,I)............... Ranman 40SC 0.17 pt (B,D,F,H)	1.3	b	9.5	c	1.4	b	320	a	390	a
BAS 536 18.7 WDG 2.14 lb (A,C,E,G)................. Ranman 40SC 0.09 pt (B,D) Ranman 40SC 0.13 pt (F,H) Ranman 40SC 0.17 pt (I)	1.0	b	8.8	c	1.1	b	311	a	380	a
Headline 2SC 0.8 pt (A,D,G)................................. Headline 2SC 0.8 pt + (B,E,H) Polyram 80DF 2.0 lb Ranman 40SC 0.17 pt (C,F,I)	2.0	b	11.3	bc	1.6	b	321	a	392	a
Headline 2SC 0.8 pt (A,B,D,E,G.H)............... Ranman 40SC 0.17 pt (C,F,I)	2.0	b	15.0	bc	2.4	b	324	a	395	a
Bravo WS 6SC 1.5 pt (B,D,F,H)...........................	1.8	b	10.0	bc	1.6	b	317	a	383	a
Untreated...	53.8	a	95.0	a	25.9	a	235	a	303	a

[1] Days after inoculation with *Phytophthora infestans*, US8, A2.
[2] Days after final application of fungicide.
[3] RAUDPC, relative area under the disease progress curve calculated from the day of inoculation to the last evaluation of late blight.
[4] Application dates: A= 23 Jun; B= 1 Jul; C= 8 Jul; D= 15 Jul; E= 22 Jul; F= 30 Jul; G= 7 Aug; H= 14 Aug; I= 21 Aug.
[5] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

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

Late blight; *Phytophthora infestans*

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EVALUATION OF PREVICUR, REASON AND SCALA MIXED PROGRAMS FOR POTATO LATE BLIGH CONTROL, 2001: Potatoes (cut seed) were planted at the Michigan State University Muck Soils Experimental Statio Bath, MI on 15 Jun into two-row by 25-ft plots (34-in row spacing) replicated four times in a randomized complete blo design. The two-row beds were separated by a five-foot unplanted row. Plots were irrigated as needed with sprinklers a were hilled immediately before sprays began. All rows were inoculated (3.4 fl oz/25-ft row) with a zoospore suspension *Phytophthora infestans* US8 biotype (insensitive to mefenoxam, A2 mating type) at 10^4 spores/fl oz on 23 Jul. Fungicid were applied weekly (unless otherwise stated) from 25 Jun to 13 Aug (9 applications) with an ATV rear-mounted R& spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Weeds were controlled by hilli 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 we 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. 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 late blight on 27 Jul; 20, 23, 29 Aug and 7 [17 days after final application (DAFA)] and 12 Sep (22 DAFA) when there w 100% foliar infection in the untreated plots. The relative area under the disease progress curve was calculated for ea treatment from date of inoculation, 27 Jul to 12 Sep, a period of 47 days. Vines were killed with Reglone 2EC (1 pt/A on Sep). Plots (2 x 25-ft row) were harvested on 5 Oct and individual treatments were weighed and graded.

Late blight developed slowly after inoculation then rapidly during Aug, and untreated controls reached 85 - 95% fol infection by 15 Sep. Over the period from 50% emergence to harvest, 109 late blight disease severity values we accumulated. The bulk of these DSV were accumulated between inoculation and desiccation. Taking 40 days af inoculation (DAI) as a key reference point, all fungicide programs with seven-day application intervals reduced the level late blight foliar infection significantly compared to the untreated control. The application programs of Bravo WS 6SC 0. (apps 1 - 3) pt followed by (fb) Previcur 6SC 1.2 pt + Bravo WS 6SC 0.75 pt (apps 4 - 9); Bravo WS 6SC 0.75 pt (apps 3) fb Reason 4SC 0.76 pt + Previcur 6SC 0.73 pt (apps 4 - 9); and Bravo WS 6SC 0.75 pt (apps 1 - 3) fb Reason 4SC 0.76 + Bond 3.84SC 0.25 pt (apps 4 - 9) had significantly greater late blight than the programs Bravo WS 6SC 0.76 pt (apps 1 - fb Bravo WS 6SC 1.5 pt (apps 4 - 9); Bravo WS 6SC 0.76 pt (apps 1 - 3) fb Previcur 6SC 1.2 pt + Bravo WS 6SC 0.76 (apps 4 - 6) fb Bravo WS 6SC 1.5 pt (apps 7 - 9) programs which had the least foliar late blight. All other programs were significantly different from programs or treatments with less than 24% foliar late blight. Taking 47 DAI as a key refere point when there was almost complete defoliation of the untreated controls and all fungicide programs with had significan less foliar late blight than the untreated control. Programs with less than 40% foliar late blight were not significan different from the Bravo WS 6SC 0.76 pt (apps 1 - 3) fb Previcur 6SC 1.2 pt + Bravo WS 6SC 0.76 pt (apps 4 - 6) fb Bra WS 6SC 1.5 pt (apps 7 - 9); program which had the least amount of foliar late blight, 48 DAI, included the programs Br WS 6SC 0.76 pt (apps 1 - 3) fb Bravo WS 6SC 1.5 pt (apps 4 - 9); Polyram 80DF 1.0 lb (apps 1 - 3) fb Polyram 80DF 2.0 (apps 4 - 9); and Polyram 80DF 1.0 lb (apps 1 - 3) fb Previcur 6SC 1.2 pt + Bravo WS 6SC 0.76 pt (apps 4 - 6) fb Bravo 6SC 1.5 pt (apps 7 - 9). Other programs provide intermediate levels of late blight control. Average amount of foliar l blight over the season (RAUDPC)from 0 to 47 DAI was significantly reduced by all fungicide programs with seven- application intervals compared to the untreated control. The lowest RAUDPC values ($\leq$5 and NSD from each other) w recorded in the programs Bravo WS 6SC 0.76 pt (apps 1 - 3) fb Previcur 6SC 1.2 pt + Bravo WS 6SC 0.76 pt (apps 4 - 6 Bravo WS 6SC 1.5 pt (apps 7 - 9); Bravo WS 6SC 0.76 pt (apps 1 - 3) fb Bravo WS 6SC 1.5 pt (apps 4 - 9); Polyram 80 1.0 lb (apps 1 - 3) fb Polyram 80DF 2.0 lb (apps 4 - 9); and Polyram 80DF 1.0 lb (apps 1 - 3) fb Previcur 6SC 1.2 p Bravo WS 6SC 0.76 pt (apps 4 - 6) fb Bravo WS 6SC 1.5 pt (apps 7 - 9). Other programs gave intermediate control of fo late blight. Yields were moderately high despite late planting. Yield was quite well correlated with late blight susceptibi and the untreated plots had numerically the lowest total yield and marketable yield in comparison with other treatments were significantly less than the Polyram 80DF 1.0 lb (apps 1 - 3) fb Polyram 80DF 2.0 lb (apps 4 - 9) progr Phytotoxicity was not noted in any of the treatments.

Treatment and rate/acre	Foliar late blight (%) 42DAI[1] 17 DAFA[2]	47DAI 22 DAFA	RAUDPC[3] max = 100 0 - 47 DAI	Yield (cwt/acre) US1	Total
Bravo WS 6SC 0.75 pt (A,B,C)[4]................... Bravo WS 6SC 1.5 pt (D,E,F,G,H,I)	7.5 d[5]	22.5 ef	2.74 f	315 ab	378 ab
Polyram80DF 1.0 lb (A,B,C)........................ Polyram80DF 2.0 lb (D,E,F,G,H,I)	9.5 cd	30.0 def	3.42 ef	339 a	405 a
Polyram80DF 1.0 lb (A,B,C)........................ Previcur 6SC1.2 pt + (D,E,F) Polyram 80DF 1.0 lb Polyram 80DF 2.0 lb (G,H,I)	10.8 cd	22.5 ef	3.22 ef	271 ab	331 ab
Bravo WS 6SC 0.75 pt (A,B,C)..................... Previcur 6SC 1.2 pt + (D,E,F) Bravo WS 6SC 0.75 pt Bravo WS 6SC 1.5 pt (G,H,I)	7.8 d	15.0 f	2.23 f	307 ab	367 ab
Bravo WS 6SC 0.75 pt (A,B,C)..................... Previcur 6SC 1.2 pt + (D,E,F,G,H,I) Bravo WS 6SC 0.75 pt	27.5 bc	50.0 bcd	7.75 bcd	237 ab	303 ab
Bravo WS 6SC 0.75 pt (A,B,C)..................... Reason 4 SC 0.36 pt + (D,E,F,G,H,I) Scala 3.2 SC 0.67 pt	23.8 bcd	45.0 cde	6.75 cde	274 ab	331 ab
Bravo WS 6SC 0.75 pt (A,B,C)..................... Reason 4SC 0.36 pt + (D,E,F,G,H,I) Previcur 6SC 0.73 pt	40.0 b	72.5 b	11.53 b	258 ab	321 ab
Bravo WS 6SC 0.75 pt (A,B,C)..................... Reason 4 SC 0.18 pt + (D,E,F,G,H,I) Bond 3.84SC 0.25 pt	36.3 b	68.8 bc	10.60 bc	242 ab	311 ab
Untreated...	81.3 a	95.8 a	23.68 a	215 b	278 b

[1] Days after inoculation with *Phytophthora infestans*, US8, A2.
[2] Days after final application of fungicide.
[3] RAUDPC, relative area under the disease progress curve calculated from the day of inoculation to the last evaluation of late blight.
[4] Application dates: A= 23 Jun; B= 1 Jul; C= 8 Jul; D= 15 Jul; E= 22 Jul; F= 30 Jul; G= 7 Aug; H= 14 Aug; I= 21 Aug.
[5] Values followed by the same letter are not significantly different at P = 0.05 (Tukey Multiple Comparison).

2001 REPORT ON RESEARCH PROJECT: Calcium Nutrition – The Key to Improving Quality and Storage of Potato Tubers?

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Producing the highest quality tubers is critical to success in the potato industry. High quality at harvest, and maintaining quality through extended storage over many months is particularly important for chip potatoes. Calcium nutrition is thought - by some - to be the foundation of high quality, blemish free potato tubers. This is logical, as calcium is crucial to building cell wall and membrane integrity and it may enhance resistance to storage rots. There is some evidence that calcium may help optimize tuber reconditioning (Palta, 1996). However, the benefits of applying calcium is debated. Frequently no clear yield benefits are obtained and quality benefits may be erratic.

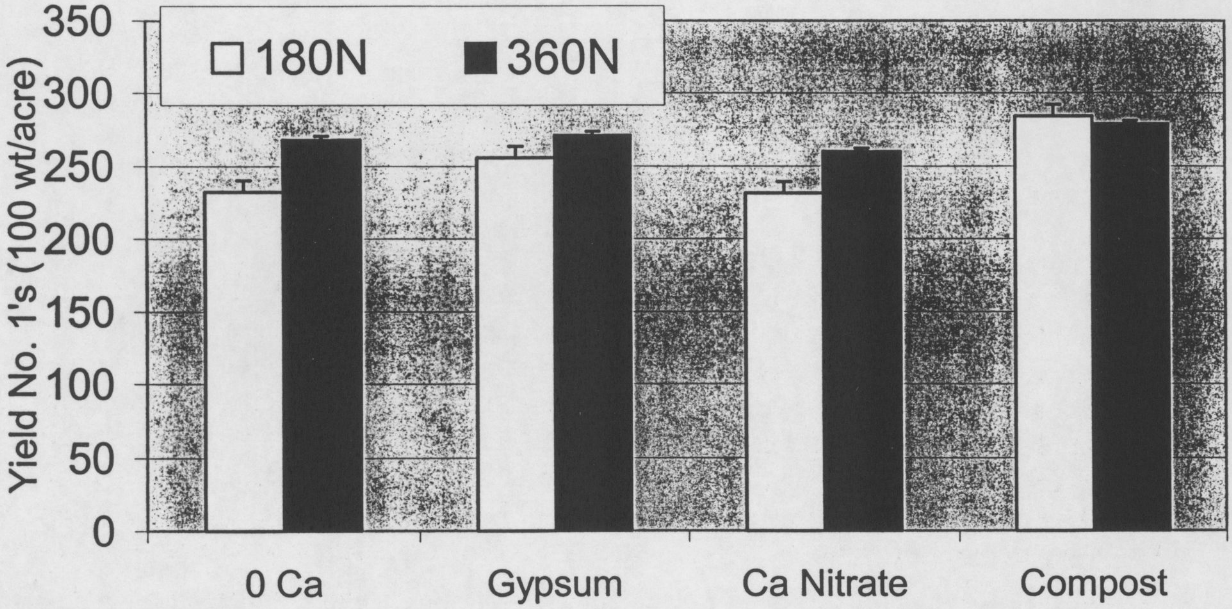
To address this complex issue we are investigating calcium and nitrogen nutrition at a trial on the Montcalm research farm, and through on-farm monitoring. The chip variety 'Pike' was grown at a sandy site at MRF in 2001 to evaluate if addition of 200 lb actual calcium could reduce internal defects in this variety. Pike was chosen as it is susceptible to internal necrosis or a brown netlike defect. The calcium treatments compared were: no calcium fertilizer to gypsum (calcium sulfate) applied once or multiple splits, calcium nitrate + calcium chloride applied once or multiple times, and poultry compost (at 10% calcium this is slow release calcium fertilizer). Poultry compost was applied at 2000 lb/acre as a pre-plant fertilizer, banded along the seed piece row. All calcium treatments were evaluated for effectiveness at two nitrogen fertility levels, 180 lb nitrogen per acre and 360 lb nitrogen per acre. Nitrogen was applied as a pre-plant basal fertilizers and four split applications over the season were side-dressed, using Urea and Calcium Nitrate sources to balance treatments. In addition to yield quality and quantity measurements, a bruising evaluation was conducted.

Yield results: Cumulative growing degree days for this plot was 2122, indicating the plots were harvested slightly early. As shown in figure 1, fertilizer treatments did not influence potato yields. There was a 40 cwt potato yield increase from application of poultry compost-calcium, significant at 0.05. Yield benefit from calcium treatments on this site – which has sufficient calcium @ 800 lb/a soil available calcium - is expected to be almost nil. This experiment primarily targets improving tuber quality, both at harvest and during extended storage.

Quality results: There were very low levels of internal necrosis or brown spot in any treatment monitored at harvest: only 2.5% in the control (no calcium added), 0.6% with gypsum, 1% with calcium nitrate/calcium chloride and 1.4% with compost. Potato bruising was not consistently influenced by any calcium source or nitrogen treatment either (data not shown). Tuber quality measurements have been started and will continue over the next eight months of storage in the Cargill demonstration storage facility. Fry chip color ratings and sugar profiles are being monitored in collaboration with Techmark, Inc.

On-farm monitoring results: Last season on-farm monitoring was conducted of Pike tubers from around Michigan grown under different calcium nutrition regimes. Tubers were stored until mid-June and we note that tubers with an acceptable fry color score (1.5) after this extended storage all had high pulp calcium levels –at least 250 ppm (Fig. 2). Initial findings from monitoring conducted in 2001 is suggestive that Pike tubers treated with higher levels of calcium fertilizer have slightly lower glucose profiles and fewer chip defects (Fig. 3). Support for this research by the Michigan Potato Industry Commission is gratefully acknowledged.

Figure 1. Yield of No. 1 Pike tubers treated with different calcium sources, all at 200 lb Ca/acre except the 0 Calcium control. Nitrogen levels applied were as multiple splits, for a total of 180 lb N/acre (recommended) and 360 lb N/acre (very high rate to delay maturity).



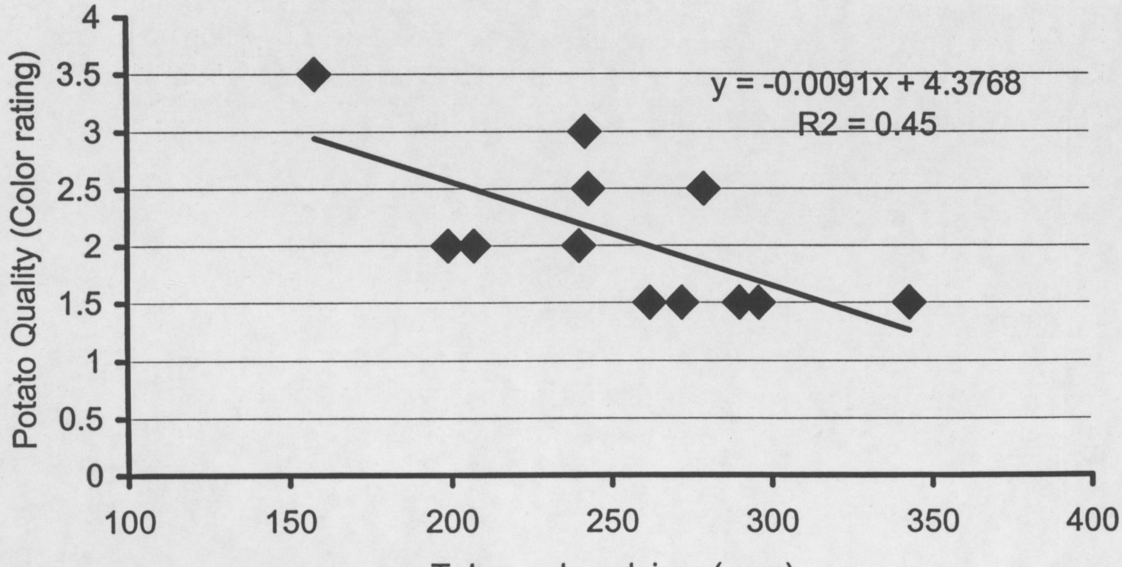


Figure 2. Characteristics of Pike tubers from fields grown in 2000, stored through June 2001.

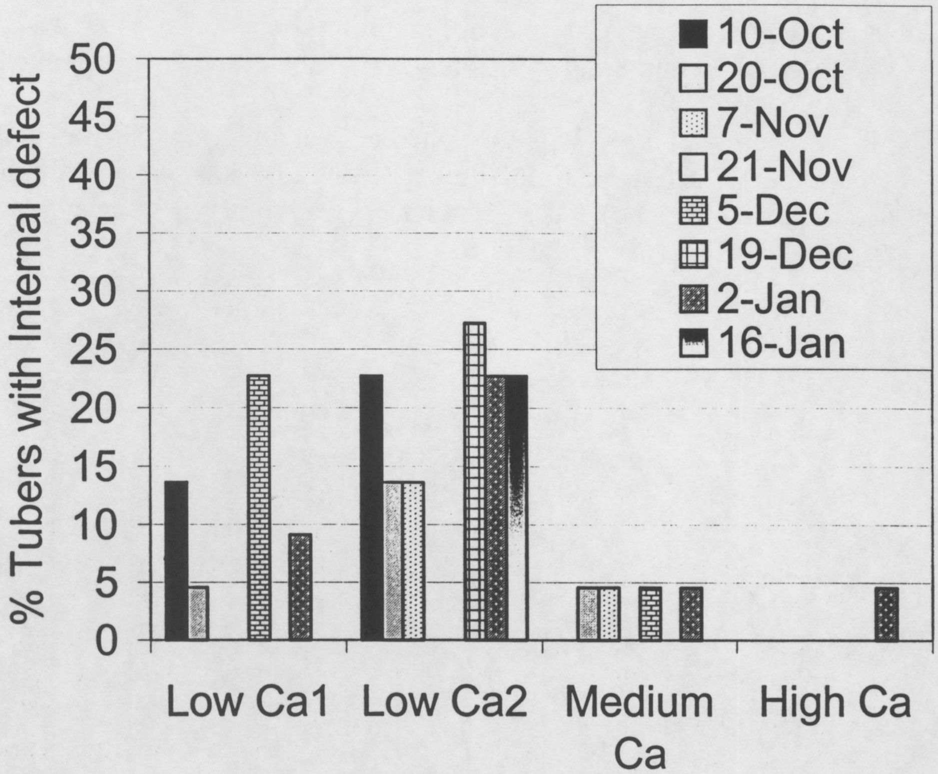


Figure 3. Internal necrosis defects of Pike tubers from four calcium regimes grown on-farm and stored in demonstration bins, monitored on a biweekly basis from 10 Oct, 2001 through 2002. At each sampling date, tubers are cut lengthwise and evaluated for presence of internal defect (% with defect reported for 22 tubers monitored). Low calcium treatment was applied as gypsum at cultivation (60 lb Ca/acre), medium calcium = 120 lb Ca/acre (as gypsum: 60 lb at cultivation and 60 lb at hilling) and high calcium = 236 lb Ca/acre (in addition to the medium calcium regime, calcium nitrate was applied 3 weeks after hilling).

Funding: MPIC

2000-2001
Dr. B. F. (Burt) Cargill Potato Demonstration Storage Report

Brian Sackett, Chris Long, Dick Crawford, Todd Forbush (Techmark, Inc.), Steve Crooks, Greg Perkins, Tim Young, Gary Walther, Don Smucker (Montcalm CED)

BACKGROUND

Round white potato production leads the market share in the state of Michigan. Michigan growers continue to look for promising new round white varieties that will meet necessary production and processing criteria, as well as, grower and processor approval. There are many variety trials underway in Michigan which evaluate chipping varieties for yield potential, solids, disease resistance and chipping quality in the hope of exhibiting to growers and processors the positive attributes of these lines. Extended storage chip quality and storability are areas of growing importance in round white potato production. Because of the importance of these factors, all new varieties with the potential to become a commercial chip processor should have storage profiles developed. Being able to examine new varieties for long-term storage and processing ability is a way to keep the Michigan chip industry at the leading edge of the snack food industry. This information can position an industry to make informed decisions about the value of adopting these varieties into commercial production. The construction of the Burt Cargill Potato Demonstration Storage has given the Michigan potato industry this opportunity. The demonstration storage utilizes six 500 cwt bins to provide storage profiles on varieties. A storage profile consists of bi-weekly sampling of potatoes to obtain; sucrose and glucose levels, chip color and defect curves. With this information, the storage history of each variety tested can be created. The storage profile of a variety will give the industry a clear picture of where a line can or cannot be utilized in the snack food industry. The Michigan potato industry hopes to use these storage profiles to improve in areas such as long-term storage quality, deliverability of product and ultimately market share.

OBJECTIVE

The goal of the MPIC Storage and Handling Committee for the 2000-2001 storage season was to develop storage profiles on three commercially significant potato varieties and answer questions that would aid the potato industry in the storage and handling of these varieties. The committee wanted to address how long these potatoes could be stored at a given temperature regime and still recondition? Also of interest was the level of pressure bruise damage that may be incurred given the above conditions.

PROCEDURE

Each bin was filled under contract with a local potato producer in the Montcalm County area. The MPIC paid a field contract price per 100 cwt for the potatoes. The potatoes were delivered to the demonstration storage. Pressure bruise samples were taken and designated bins were filled. Varieties and storage management of these varieties were established by the MPIC Storage and Handling Committee. In the 2000-2001 storage season; bin numbers 1 and 2 were filled with Snowden, bins 3 and 4 were leased to Frito-Lay, and bins 5 and 6 were filled with Pike. The Snowden were grown by V & G Farms. Bins 1 and 2 were filled on October 20, 2000. Bins 5 and 6 were filled with Pike grown by Anderson Brothers. Bin 5 was filled on September 27, 2000 and bin 6 was filled on September 20, 2000. Twelve 20 to 25 lb. pressure bruise samples were taken as each bin was being filled. Four samples were placed at three different levels within the pile. The sample locations were approximately 3, 6, and 9 feet from the storage floor. The samples were evaluated 1 to 6 days after the bin was unloaded. A set of 25 tubers were randomly selected from each bag and visually inspected for pressure bruise. Each bruise was evaluated for discoloration by removing the tuber skin with a knife. A visual rating was given to the bruise for the presence or absence of flesh color (blackening of flesh). Percent weight loss in each tuber sample was calculated as they were removed from the storage.

Results

A. Bin 1.

These Snowdens were shipped June 13, 2001 to UTZ foods. A 9% defect score was reported. On June 7, Sucrose and Glucose levels were 0.879 and .005 respectively (Table 1). The storage temperature of this bin was 46°F. The average number of tubers without bruises at 3', 6' and 9' were 14.25, 23.00 and 20.25 respectively (Table 5). Total tuber weight loss on average ranged from 5.91% to 6.62% over the storage period of October 20, 2000 through June 13, 2001 (Table 5).

B. Bin 2.

These Snowdens were shipped June 13, 2001 to UTZ foods. A 5% defect score was reported. On June 7, Sucrose and Glucose levels were 0.699 and .005 respectively (Table 2). The storage temperature of this bin was 42°F. The average number of tubers without bruises at 3', 6' and 9' were 11.25, 17.50 and 23.00 respectively (Table 6). Total tuber weight loss on average ranged from 6.06% to 7.82% over the storage period of October 20, 2000 through June 13, 2001 (Table 6).

C. Bins 3 and 4

These potatoes were shipped to Frito-Lay and the results were sent directly to Frito-Lay.

D. Bin 5.

These Pikes were shipped March 21, 2001 to UTZ foods. A 2% defect score was reported. On March 21, Sucrose and Glucose levels were 0.363 and .005 respectively (Table 3). The storage temperature of this bin was 52°F. The average number of tubers without bruises at 3', 6' and 9' were 7.75, 10.50 and 19.25 respectively (Table 7). Total tuber weight loss on average ranged from 4.71% to 6.85% over the storage period of September 27, 2000 through March 21, 2001 (Table 7).

E. Bin 6.

These Pikes were shipped May 22, 2001 to UTZ foods. A 9% defect score was reported. On May 22, Sucrose and Glucose levels were 0.761 and .023 respectively (Table 4). The storage temperature of this bin was 48°F. The average number of tubers without bruises at 3', 6' and 9' were 6.25, 11.50 and 15.25 respectively (Table 8). Total tuber weight loss on average ranged from 5.74% to 6.53% over the storage period of September 20, 2000 through May 22, 2001 (Table 8).

TABLE 1. 2000-2001 SUGAR CONCENTRATION AND AVERAGE PILE TEMPERATURE CURVES FOR THE MPIC DEMONSTRATION STORAGE BIN #1 (SNOWDEN)

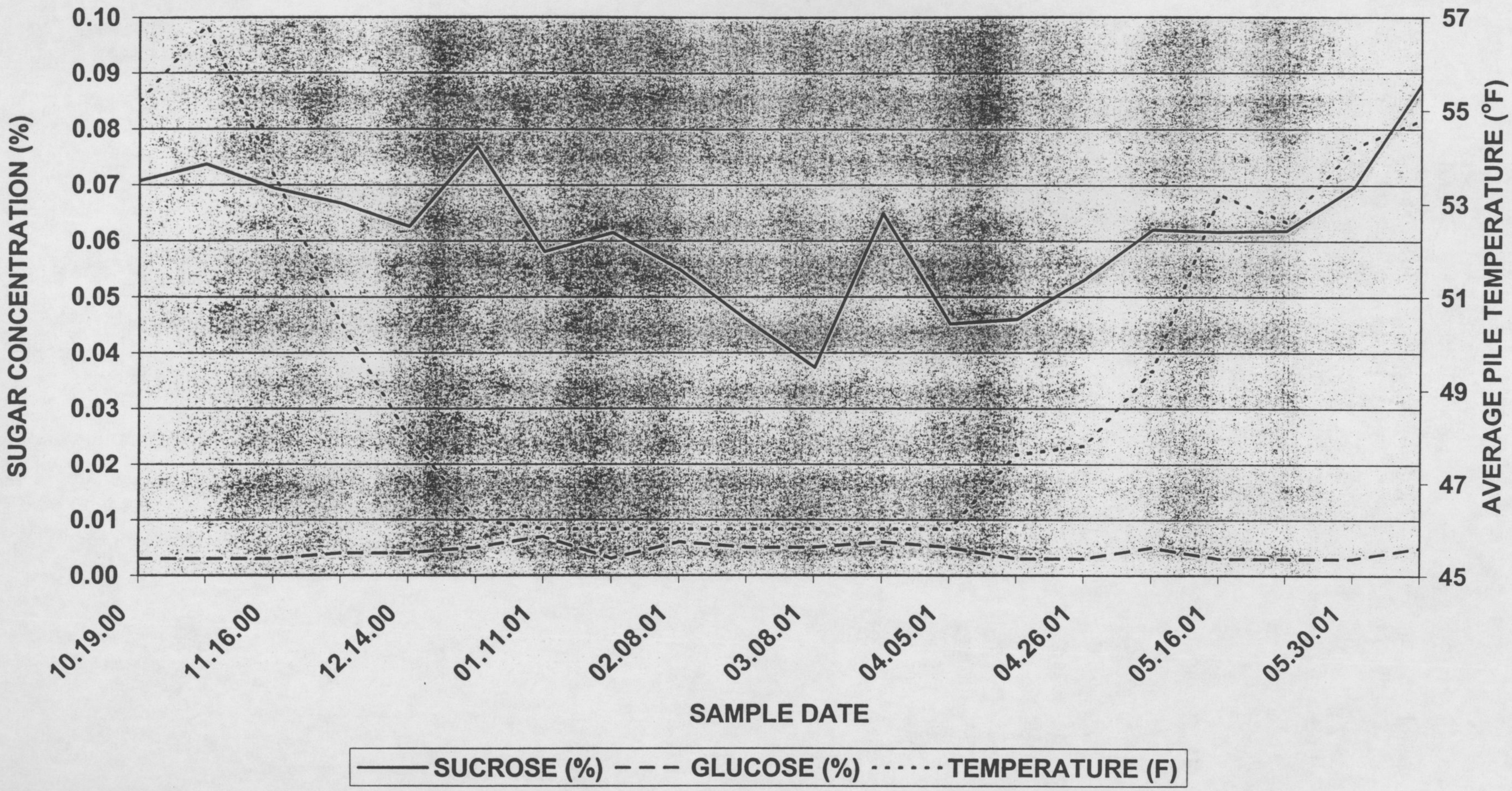


TABLE 2. 2000-2001 SUGAR CONCENTRATION AND AVERAGE PILE TEMPERATURE CURVES FOR THE MPIC DEMONSTRATION STORAGE BIN #2 (SNOWDEN)

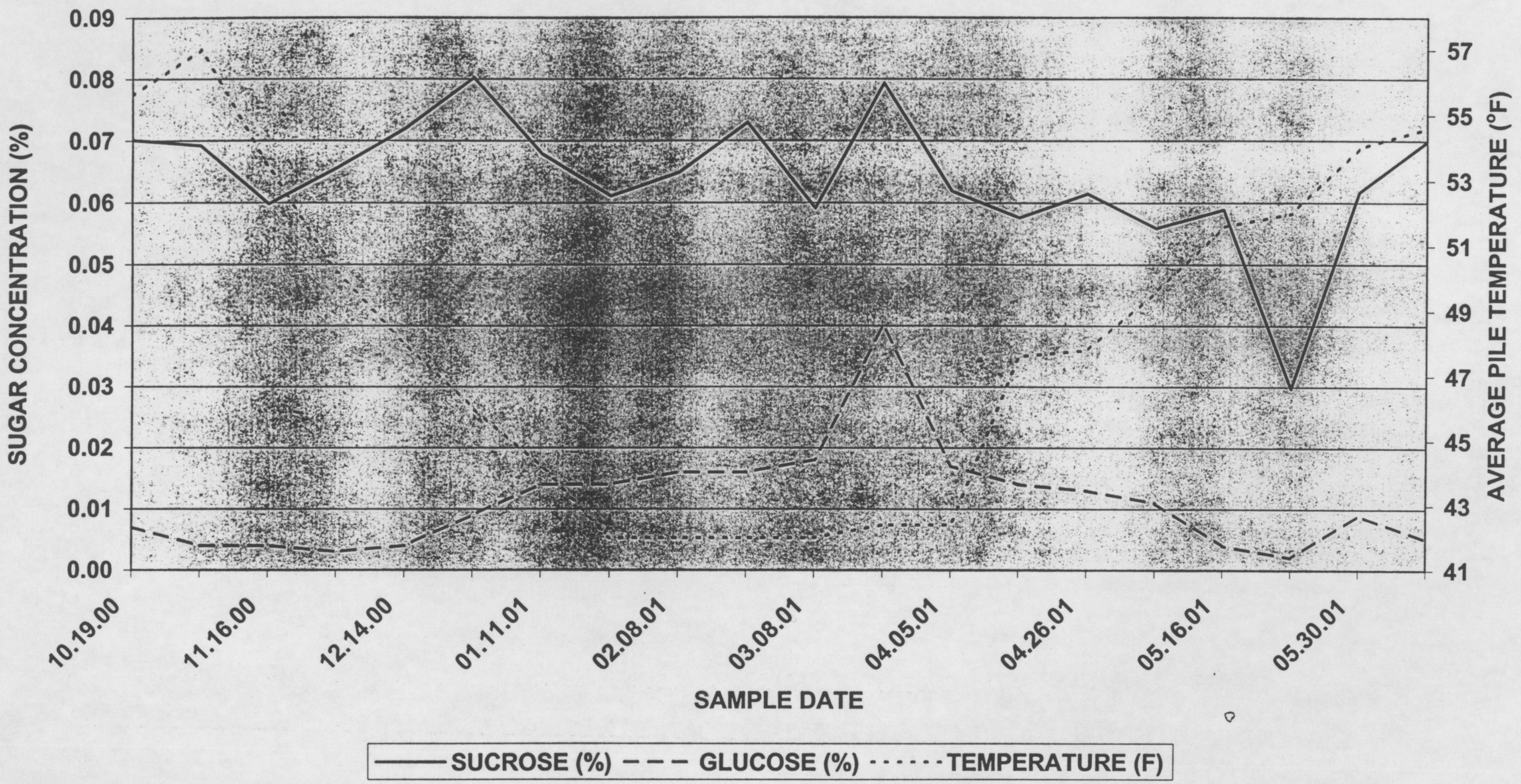


TABLE 3. 2000-2001 SUGAR CONCENTRATION AND AVERAGE PILE TEMPERATURE CURVES FOR THE MPIC DEMONSTRATION STORAGE BIN #5 (PIKE)

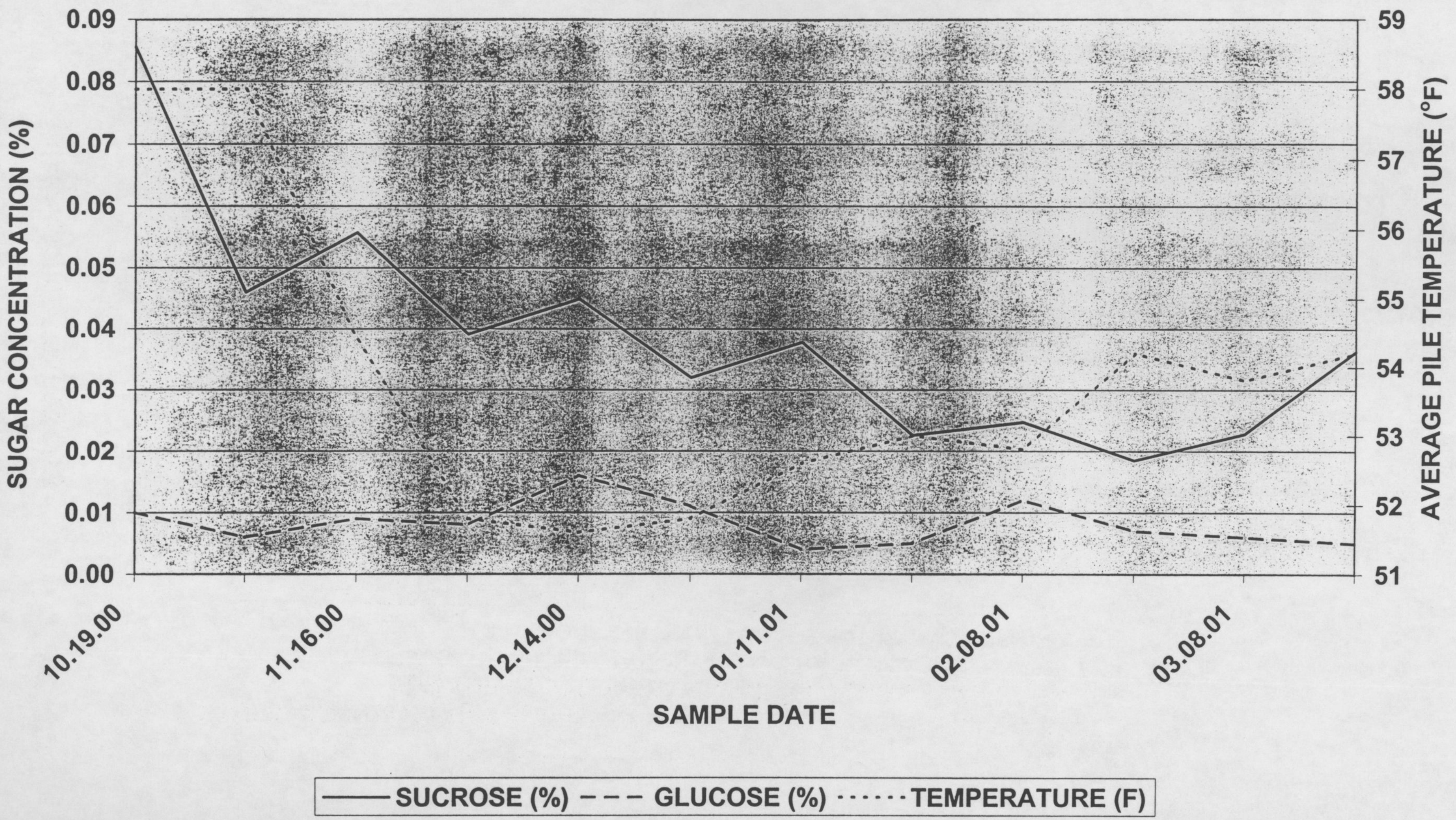


TABLE 4. 2000-2001 SUGAR CONCENTRATION AND AVERAGE PILE TEMPERATURE CURVES FOR THE MPIC DEMONSTRATION STORAGE BIN #6 (PIKE)

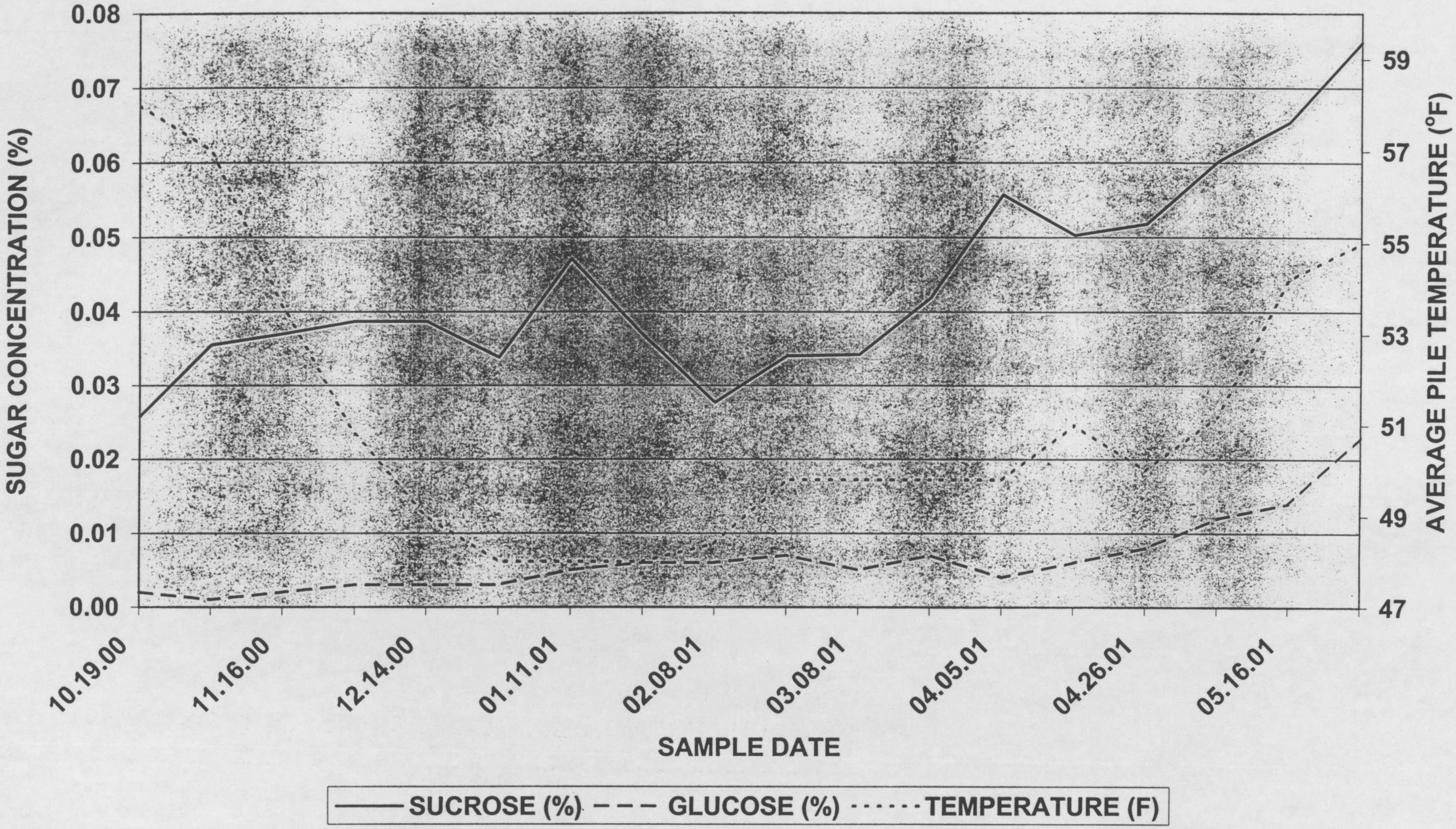


Table 5.

2000-2001 PRESSURE BRUISE DATA BIN #1 (SNOWDEN)

Bin Position	Bag Location	Weight in lbs. At Date BAG#	10.20.00	6.13.01	% Weight Loss	Number Of External Pressure Bruises Per Tuber 0*	1*	1 with color **	2*	2 with color**	3 or More*	3 with color**	Total # of Tubers
High	9'	**8**	15.75	14.88	5.52	20	5	0	0	0	0	0	25
High	9'	**16**	18.20	16.98	6.70	21	3	1	1	0	0	0	25
High	9'	**7**	16.50	15.56	5.70	20	5	0	0	0	0	0	25
High	9'	**3**	17.80	16.78	5.73	20	5	0	0	0	0	0	25
				Average	5.91	20.25	4.50	0.25	0.25	0.00	0.00	0.00	25.00
Medium	6'	**15**	20.65	19.20	7.02	24	1	0	0	0	0	0	25
Medium	6'	**25**	26.50	24.77	6.53	23	2	0	0	0	0	0	25
Medium	6'	**10**	23.95	22.59	5.68	20	5	1	0	0	0	0	25
Medium	6'	**23**	28.20	26.82	4.89	25	0	0	0	0	0	0	25
				Average	6.03	23.00	2.00	0.25	0.00	0.00	0.00	0.00	25.00
Low	3'	**18**	20.50	19.26	6.05	12	7	0	5	2	1	0	25
Low	3'	**22**	16.90	15.51	8.22	14	11	1	0	0	0	0	25
Low	3'	**24**	19.40	18.18	6.29	11	10	1	4	2	0	0	25
Low	3'	**17**	27.75	26.11	5.91	20	5	0	0	0	0	0	25
				Average	6.62	14.25	8.25	0.50	2.25	1.00	0.25	0.00	25.00

* Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.

** A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored "with color".

Bin Fill Date 10.20.00
Pulp Temperature at Filling 57.2 °F

Bin Unloaded 6.13.01
Bin Target Storage Temperature 46 °F

Pressure Bruise Evaluation Date 6.19.01
Ending Temperature 54 °F

Table 6.

2000-2001 PRESSURE BRUISE DATA BIN #2 (SNOWDEN)

Bin Position	Bag Location	BAG#	Weight in lbs. At Date 10.20.00	6.13.01	% Weight Loss	Number Of External Pressure Bruises Per Tuber 0*	1*	1 with color **	2*	2 with color**	3 or More*	3 with color**	Total # of Tubers
High	9'	**9**	21.65	20.32	6.14	23	2	1	0	0	0	0	25
High	9'	**14**	24.70	23.22	5.99	23	2	0	0	0	0	0	25
High	9'	**2**	19.75	18.52	6.23	22	2	0	1	0	0	0	25
High	9'	**19**	23.55	22.17	5.86	24	1	0	0	0	0	0	25
				Average	6.06	23.00	1.75	0.25	0.25	0.00	0.00	0.00	25.00
Medium	6'	**1**	21.60	20.35	5.79	21	3	0	1	0	0	0	25
Medium	6'	**12**	23.10	21.52	6.84	17	7	1	1	0	0	0	25
Medium	6'	**20**	24.10	22.35	7.26	16	8	1	1	0	0	0	25
Medium	6'	**13**	22.00	20.62	6.27	16	9	1	0	0	0	0	25
				Average	6.54	17.50	6.75	0.75	0.75	0.00	0.00	0.00	25.00
Low	3'	**21**	18.45	16.71	9.43	12	8	2	5	0	0	0	25
Low	3'	**4**	24.60	23.05	6.30	13	12	0	0	0	0	0	25
Low	3'	**11**	21.25	19.50	8.24	9	6	0	8	2	2	0	25
Low	3'	**6**	26.70	24.75	7.30	11	10	1	2	0	2	0	25
				Average	7.82	11.25	9.00	0.75	3.75	0.50	1.00	0.00	25.00

* Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.

** A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored "with color".

Bin Fill Date 10.20.00

Pulp Temperature at Filling 57.4 °F

Bin Unloaded 6.13.01

Bin Target Storage Temperature 42 °F

Pressure bruise Evaluation Date 6.19.01

Ending Temperature 54 °F

Table 7.

2000-2001 PRESSURE BRUISE DATA BIN #5 (PIKE)

Bin Position	Bag Location	BAG#	Weight in lbs. At Date 9.27.00	Weight in lbs. At Date 3.21.01	% Weight Loss	Number Of External Pressure Bruises Per Tuber: 0*	1*	1 with color **	2*	2 with color**	3 or More*	3 with color**	Total # of Tubers
High	9'	**2**	32.60	31.05	4.75	18	6	0	1	0	0	0	25
High	9'	**3**	24.25	23.20	4.33	19	6	0	0	0	0	0	25
High	9'	**6**	22.40	21.25	5.13	18	5	0	2	0	0	0	25
High	9'	**8**	22.65	21.60	4.64	22	2	0	1	0	0	0	25
				Average	4.71	19.25	4.75	0.00	1.00	0.00	0.00	0.00	25.00
Medium	6'	**12**	25.15	23.50	6.56	9	6	0	8	1	2	0	25
Medium	6'	**13**	24.40	23.20	4.92	12	9	0	4	0	0	0	25
Medium	6'	**14**	24.20	22.95	5.17	9	11	2	5	1	0	0	25
Medium	6'	**17**	22.30	20.30	8.97	12	5	0	6	3	2	1	25
				Average	6.40	10.50	7.75	0.50	5.75	1.25	1.00	0.25	25.00
Low	3'	**5**	23.20	21.85	5.82	8	8	0	9	0	0	0	25
Low	3'	**11**	17.75	16.70	5.92	5	10	0	8	2	2	1	25
Low	3'	**16**	21.05	18.90	10.21	9	5	2	11	2	0	0	25
Low	3'	**18**	22.95	21.70	5.45	9	13	1	3	1	0	0	25
				Average	6.85	7.75	9.00	0.75	7.75	1.25	0.50	0.25	25.00

* Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.

** A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored "with color".

Bin Fill Date 9.27.00 | Bin Unloaded 3.21.01 | Pressure Bruise Evaluation Date 3.22.01

Pulp Temperature at Filling 57 °F | Bin Target Storage Temperature 52 °F | Ending Temperature 54 °F

Table 8.

2000-2001 PRESSURE BRUISE DATA BIN #6 (PIKE)

Bin Position	Bag Location	BAG#	Weight in lbs. At Date 9.27.00	3.21.01	% Weight Loss	Number Of External Pressure Bruises Per Tuber 0*	1*	1 with color **	2*	2 with color**	3 or More*	3 with color**	Total # of Tubers
High	9'	**5**	18.88	17.60	6.78	15	9	0	1	0	0	0	25
High	9'	**21**	15.81	14.75	6.70	17	2	0	6	0	0	0	25
High	9'	**10**	21.81	20.40	6.46	17	8	0	0	0	0	0	25
High	9'	**1**	24.19	22.70	6.16	12	11	2	2	0	0	0	25
				Average	6.53	15.25	7.50	0.50	2.25	0.00	0.00	0.00	25.00
Medium	6'	**24**	28.94	27.20	6.01	11	11	1	2	0	1	0	25
Medium	6'	**19**	29.38	27.75	5.55	15	9	1	1	0	0	0	25
Medium	6'	**9**	18.81	17.75	5.64	8	12	2	4	0	1	0	25
Medium	6'	**15**	22.44	21.15	5.75	12	10	2	3	1	0	0	25
				Average	5.74	11.50	10.50	1.50	2.50	0.25	0.50	0.00	25.00
Low	3'	**7**	17.63	16.45	6.69	2	17	2	4	0	2	0	25
Low	3'	**20**	24.56	23.20	5.54	8	5	1	13	0	0	0	25
Low	3'	**22**	24.69	22.90	7.25	3	12	0	6	1	3	0	25
Low	3'	**23**	21.81	20.45	6.24	12	6	1	5	0	2	0	25
				Average	6.43	6.25	10.00	1.00	7.00	0.25	1.75	0.00	25.00

* Sample of 25 tubers randomly selected. Each tuber was first evaluated for the number of visual pressure bruises 0, 1, 2, 3+.

** A cut slice was removed just below the skin of each bruised area. If any flesh was darkened, it was scored "with color".

Bin Fill Date 9.20.00

Pulp Temperature at filling is Not Available

Bin Unloaded 5.22.01

Bin Target Storage Temperature 48 °F

Pressure Bruise Evaluation Date 5.24.01

Ending Temperature 53.4 °F