1986 MICHIGAN POTATO RESEARCH REPORT

VOLUME 18

MICHIGAN STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

IN COOPERATION WITH

THE MICHIGAN POTATO INDUSTRY COMMISSION

THE MICHIGAN POTATO INDUSTRY COMMISSION

March 20, 1987

TO ALL MICHIGAN POTATO GROWERS AND SHIPPERS:

The Michigan Potato Industry Commission and the Agricultural Experiment Station of Michigan State University are happy to provide you with a copy of the results of the 1986 potato research projects.

This years report includes research projects funded by the MPIC as well as projects funded through a special federal grant that the Michigan Potato Industry Commission helped secure. The federal grant data completes the second year of a five year project. Also included are reports on projects carried out by MSU which were not subsidized by the industry.

Providing research funding and direction to researchers is a major function of the MPIC on behalf of Michigan growers and shippers. Input from the industry regarding research is most welcome at any time.

Sincerely,

The Michigan Potato Industry Commission

THE MICHIGAN POTATO INDUSTRY COMMISSION • 13109 SCHAVEY RD., SUITE 7 • DEWITT, MI 48820 • (517) 669-8377

TABLE OF CONTENTS

1986 POTATO RESEARCH REPORT[1]

R.W. Chase, Coordinator
Department of Crop and Soil Sciences
Michigan State University

INTRODUCTION AND ACKNOWLEDGEMENTS

The 1986 Potato Research Report has been expanded to include many additional reports of potato research projects in addition to those conducted at the Montcalm Research Station. We are also using this report to include the research of the projects funded under the special Federal Grant, in addition to those funded by the MPIC and other sources. As you review the various reports, you will note that we have attempted to identify the source of the support for those projects funded by the special Federal Grant and by the MPIC.

I wish to acknowledge the excellent support that the MPIC and the Michigan potato industry have given to MSU potato research. We also want to acknowledge the many contributions made in fertilizers, chemicals, seed, equipment, technical assistance, personal services and monetary grants. Appreciation is also expressed to Dick Kitchen and Theron Comden in the coordination and production management needs of the Montcalm Research Station.

Dr. Burt Cargill

We also want to acknowledge the loss of one of our very dedicated and sincere research and extension colleagues, Dr. Burt Cargill. Burt was well known for the hard work, sincerity and dedication that he put forth for the betterment of the Michigan potato industry. Burt was very creative in his storage management ideas and principles and the results of his efforts will long be remembered.

WEATHER

The 1986 Montcalm Research Farm rainfall and temperature data from April to September, as compared with the 15 year average, are summarized in Tables 1 and 2. Temperature during April and May (particularly April) were above the average which resulted in warm soils and allowed for early planting. In June, July, August and September, temperature resembled closely the 15-year average.

Rainfall in August was well below the average. In September, however, record levels of rainfall (18.6 inches) were received. All the rain occurred after September 9, starting with 7.8 inches on September 10.

---

[1] Printing and distribution of this 1986 Potato Research Report was made possible by the Michigan Potato Industry Commission.

SOIL TESTS

Soil test results for the general plot area were:

	(lbs/A)				% Organic
pH	P	K	Ca	Mg	Matter
6.0	407	232	842	175	2.10

FERTILIZERS USED

The previous crop was corn for the 2 ranges where the variety trials were conducted. For the entire 1986 research area, winter rye was planted in late fall of 1985. Except for the specific fertility studies where the fertilizers are specified in the report, the following fertilizers were used on the potato plot area:

plowdown	0-0-60	200 lbs/A
banded at planting	15-10-15-12S	500 lbs/A
sidedress with irrigation	46-0-0	225 lbs/A

HERBICIDES AND HILLING

Most of the hillings were completed by the end of May. The procedure used was to delay the herbicide application until the potatoes were just cracking the ground. The potatoes were then hilled by building a wide and flattened hill and placing just enough soil over the top of the ridge to protect them. Immediately after hilling, a tank mix of metolachlor (Dual) 2 lbs/A plus metrabuzin (Lexone 4L) ½ lb/A was applied. No further tillage was required until harvest.

IRRIGATION

Twelve supplementary irrigations were applied on June 23, July 2, 7, 10, 18, 23, August 2, 7, 15, 19, 22 and 26. Irrigation was based on the Michigan State University irrigation scheduling program. The minimum profile moisture content allowed was 50%. The amount of water applied ranged from 0.3 to 1.0 inches per application. Urea was incorporated into irrigation on June 23, July 2, 18 and 29.

INSECT AND DISEASE CONTROL

Aldicarb (Temik 15G) was applied at planting at 20 lbs/A with the fertilizer. The foliar fungicide applications were initiated on June 20 and 9 applications were made throughout the balance of the season. Fungicides used were Bravo (3 applications) and Dithane M45 (5 applications). One application of Ridomil MZ-58 was made on August 21.

Foliar insecticides used were Imidan on June 30, Furadan on July 21 and Pydrin on July 23. The principal insect problems were Colorado potato beetles, cutworms and flea beetles.

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

Year	April		May		June		July		August		September		6-Month Average	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1972	47	30	70	47	72	50	79	57	76	57	69	49	73	48
1973	54	36	63	42	77	58	79	60	80	60	73	48	74	51
1974	57	36	62	41	73	52	81	57	77	56	68	45	70	48
1975	48	28	73	48	75	56	80	57	79	58	65	44	70	49
1976	58	35	63	41	79	57	81	58	80	53	70	46	71	48
1977	62	37	80	47	76	50	85	61	77	52	70	53	75	50
1978	50	31	67	45	78	50	81	56	82	57	75	52	72	49
1979	50	33	66	44	74	55	82	57	77	55	76	47	71	49
1980	49	31	69	42	73	50	81	58	81	58	70	49	71	48
1981	56	35	64	39	73	50	77	51	78	53	67	47	69	46
1982	53	28	72	46	70	44	80	53	76	48	66	44	70	44
1983	47	28	60	38	76	49	85	57	82	57	70	46	70	46
1984	54	34	60	39	77	54	78	53	83	55	69	45	70	47
1985	58	38	70	44	71	46	81	55	75	54	70	50	71	48
1986	60	36	70	46	77	50	82	59	77	51	72	50	73	49
15-YR. AVG.	53	34	67	43	75	52	81	56	79	55	70	48	71	48

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
1972	1.35	1.96	2.51	3.83	7.28	2.60	19.53
1973	3.25	3.91	4.34	2.36	3.94	1.33	19.13
1974	4.07	4.83	4.69	2.39	6.18	1.81	23.97
1975	1.81	2.05	4.98	2.71	11.25	3.07	25.87
1976	3.27	4.03	4.22	1.50	1.44	1.40	15.86
1977	1.65	0.46	1.66	2.39	2.61	8.62	17.39
1978	2.34	1.35	2.55	1.89	5.90	2.77	16.80
1979	2.58	1.68	3.77	1.09	3.69	0.04	12.85
1980	3.53	1.65	4.37	2.64	3.21	6.59	21.99
1981	4.19	3.52	3.44	1.23	3.48	3.82	19.68
1982	1.43	3.53	5.69	5.53	1.96	3.24	21.38
1983	3.47	4.46	1.19	2.44	2.21	5.34	19.11
1984	2.78	5.14	2.93	3.76	1.97	3.90	20.48
1985	3.63	1.94	2.78	2.58	4.72	3.30	18.95
1986	2.24	4.22	3.20	2.36	2.10	18.60	32.72
15-YR. AVG.	2.77	2.97	3.45	2.57	4.13	4.42	20.31

Funding: Federal Grant

1986 POTATO VARIETY EVALUATIONS

R.W. Chase, G.H. Silva, R.B. Kitchen, R. Leep and R. Hammerschmidt
Departments of Crop and Soil Sciences and Botany and Plant Pathology

The potato variety evaluation program is designed: (a) to search for improved cultivars well-adapted to Michigan for fresh pack, chip and frozen processing industry; and (b) to conduct intensive evaluations of selected varieties to determine the production management inputs that improve potato quality.

In variety evaluations, special attention was given to quality parameters such as tuber size distribution, appearance, dry matter, internal defects, chip color and after cooking darkening. Other characteristics monitored were overall vigor in relation to emergence and plant stand, resistance to important diseases, notably scab, early blight and tuber bruising. Tuber samples were kept in 3 storage environments (40, 46, 52°F) for subsequent quality evaluations.

A. DATES-OF-HARVEST TRIAL

The 1986 dates-of-harvest trial was conducted at the Montcalm Research Farm. Eighteen selected varieties were tested for their marketable maturity and adaptability to Michigan. These included 9 released varieties and 9 advanced selections. The performances of these varieties were evaluated at 3 harvest dates, 99, 120, and 142 days after planting. Four replications of a randomized complete block design were harvested at each harvest date. Plots were 23 ft x 34 inches in size and the within row spacing was 12 inches. The trial was planted on April 30.

The previous crop was corn and a winter rye cover crop. Fertilizers used were 200 lbs/A 0-0-60 plowdown, 500 lbs/A 15-10-15-12S in the planter and a sidedressing of 100 lbs N as urea in 4 split applications with irrigation water. Aldicarb (Temik 15G) was applied at 20 lbs/A at planting. The hilling and herbicide application were all made just as the potatoes were emerging which was done on May 18. Immediately after hilling, a tank mix of Dual at 2 lbs/A plus Lexone at ½ lb/A were applied for weed control and no further tillage was performed until harvest. The crop was irrigated 13 times, according to the MSU irrigation scheduling program. The minimum profile moisture content allowed was 50%. The amount of water applied ranged from 0.3 to 1.0 inch per application.

Results

The yield, size distribution and quality of the potato varieties at the 3 harvest dates are presented in Tables 1, 2 and 3. In general, 1986 was a exceptionally good year for potatoes. Inspite of the heavy rainfall (13 inches) received between the second and third harvests, the specific gravity of the tubers remained high at the third harvest. With the exception of rainfall, weather conditions were generally favorable through the growing season.

The vigor, maturity and early blight data are presented in Table 4. The culinary quality of after cooking darkening recorded on November 10 is summarized in Table 5. Peeled halves of 3 tubers selected at random and cooked uniformly in steam were evaluated 0, 1 and 24 hours for darkening.

The chip color ratings after 120 days of storage at 50-55°F, as compared to those at harvest are presented in Table 6. Susceptibility to blackspot bruising was evaluated in artificially bruised and check treatments. Artificial bruising was done by placing potatoes inside a wooden drum and turning 10 revolutions at a moderate speed. In the check treatments, potatoes were tested without artificial bruising, so that any blackspot observed are only those incurred at the harvesting and handling operations. The results of blackspot evaluation are summarized in Table 7. The tendency to develop internal defects in oversized potatoes was determined by cutting 40 tubers of diameter >3¼ inches from each variety at the 120- and 142-day harvests. The results of this study are presented in Table 8.

Among the early maturing varieties, Onaway produced the highest U.S. #1 yield and was free of internal defects. However, it had a low gravity, and a tendency to produce a higher % of oversize tubers and growth cracks. Conestoga produced average yields but was highly susceptible to early blight.

Among the medium maturing varieties, MS 700-83, MS 704-10, MS 716-15, Atlantic and Krantz performed well. MS 700-83 produced good yields with a higher % of U.S. #1 tubers. MS 704-10 is a golden flesh variety with a high specific gravity. MS 716-15 produced above average yields of excellent quality and high gravity. It had the best chip color among all varieties. Atlantic had the highest gravity but was susceptible to internal necrosis. Krantz produced acceptable yields but its gravity was lower than Russet Burbank. Norking Russet had a poor marketable yield. In MS 702-91, tuber type was too variable and dry matter was insufficient for chips.

Among the late maturing varieties, MS 700-70 was a prolific yielder with the highest U.S. #1 yield at both 120- and 142-day harvests. A 76147-2 was another prolific yielder but with a slightly lower gravity than Russet Burbank. Acadia Russet produced above average yields with high gravity and good internal quality. Russet Burbank produced a poor marketable yield and an undesirably high % of undersize and knobby tubers.

In the culinary tests, undesirable levels of after cooking darkening occurred in MS 700-83, MS 700-79, ND 534-4, Onaway and Atlantic. In previous years, some of these varieties, particularly MS 700-83, had showed little or no after cooking darkening. Seasonal effects, such as heavy rainfall and fertilization, seem to have influenced this test. The chip color following 120 days of storage at 50-55°F was excellent in MS 716-15, MS 702-80, MS 702-91, Krantz and Atlantic. Acceptable chip color was found in MS 700-70, MS 704-10, MS 700-79, Conestoga and Sunrise.

The results of the bruising study indicated that in artificially bruised tubers, the varieties that were highly resistant to blackspot were ND 534-4 and Norking Russet. Moderate levels of resistance were found in MS 702-80, MS 700-83, Onaway, Sunrise, A 76147-2, MS 702-91 and Conestoga. Krantz and Acadia Russet were found to be very susceptible. In the check treatments, most varieties showed no blackspot.

The varieties that exhibited the least amount of internal defects in oversized tubers were MS 716-15, ND 534-4, Norking Russet, Krantz, Onaway and Russet Burbank. These varieties had less than 10% hollow heart and internal necrosis symptoms at the last two harvest dates.

Variety Characteristics

MS 700-79 - Round white, mid-season maturity with average yields and specific gravity. Has some scab resistance, but is susceptible to hollow heart. This seedling will be deleted from further tests.

MS 700-83 - Round white, mid-season maturity and above average yields with medium gravity. Does chip out of field. In some years, after cooking darkening can be a problem. Possesses some scab resistance.

MS 702-80 - Round white, mid-season maturity and average yields with medium gravity. Chips well and has good scab tolerance.

MS 702-91 - Round white, mid-season maturity and high yield potential. Tuber shape tends to be variable and the gravity is too low for chipping. Has moderate scab resistance. This seedling will be deleted from further tests.

MS 704-10 - Round tubers with yellow flesh. Mid-season maturity. Produces average yields with high specific gravity. Sets heavy and produces a golden color chip when processed from field and short term storage.

MS 716-15 - Round white, medium-late maturity and above average yields with high gravity. Well shaped, smooth general appearance and has excellent chip color.

MS 700-70 - Round white, late maturity and very high yields. Tubers have high gravity and good general appearance. Chip color is acceptable.

A 76147-2 - Long, light russet, late maturity and very high yields with medium gravity. Good external appearance and minimal internal defects. Has potential for count pack market.

ND 534-4 - Oblong to long russet, early to mid-season maturity and produced below average yields. Tubers have very smooth external appearance with gravity lower than Russet Burbank. Good resistance to blackspot and minimal internal defects in 1986. Has potential for count pack market.

Norking Russet - Oblong russet, medium-late maturity with very poor sizing in 1986. Yields below average with gravity higher than ND 534-4 but lower than Russet Burbank. Has good scab tolerance. Very smooth external appearance and minimal internal defects in 1986. Has potential for count pack market.

Acadia Russet - Long russet, late maturity and above average yields with high gravity. Fair general appearance, minimal internal defects in 1986. It is susceptible to scab and blackspot.

Krantz - Oblong russet, mid-late season maturity with average yields and gravity. Minimal internal defects in 1986.

Onaway - Round white, early maturity and above average yields with low gravity. Susceptible to early blight and growth cracks. Minimal internal defects.

Atlantic - Round white, mid-late season maturity and above average yields at all 3 harvest dates with high gravity. Has good chip color, however, hollow heart and internal necrosis is a problem. It is susceptible to scab.

Conestoga - Round-oblong white, early maturity with average yields and gravity. Produces an acceptable chip. Very susceptible to early blight.

Shepody - Long white, mid-late season maturity and average yields. Matures 2-3 weeks earlier than Russet Burbank but has similar gravity. Slow early establishment in the field. Sets fewer tubers than Russet Burbank but sizes quickly. Some susceptibility to scab but minimal internal defects in 1986. Good for French fry industry.

Sunrise - Round-oblong, early maturity with average yields and low gravity. Chip color is acceptable. Susceptible to growth cracks and scab.

Russet Burbank - Long russet, late maturity with very poor sizing and type. Below average yields but high gravity. Minimal internal defects in 1986.

B. UPPER PENINSULA TRIAL

Sixteen potato varieties were tested in a randomized complete block design with 4 replications in the Upper Peninsula. The trial was planted on May 22 and harvested on September 29, 1986. The results of this trial are presented in Table 9.

The varieties MS 704-10, Acadia Russet, Onaway, A 76147-2 and MS 700-83 produced the highest U.S. #1 yields. The size distribution and dry matter content of most varieties in this trial were excellent.

C. NORTH CENTRAL REGIONAL TRIAL

This trial is conducted in 14 states and provinces with entries from various breeding programs to obtain data from a wide range of adaptability prior to the release decision. Two MSU seedlings, MS 700-83 and MS 704-10 were included in the 1986 trial. Twenty varieties (10 round whites, 6 reds, 4 russets) were tested in a randomized complete block design with 4 replications. The results of this trial are presented in Tables 10 and 11.

The round whites that performed well in the trial were MS 700-83, W 832, MN 12161 and ND 651-9. W 879 had the highest gravity (1.090) but the tuber shape (very flattened) was unacceptable. The highest U.S. #1 yield was produced by W 848R, a red variety which also had a high specific gravity. Two russets that appeared promising were NE 165.75-2 and NEA 71.72-1, with high gravity and smooth tuber appearance. On a general merit rating based on appearance alone (disregarding maturity, yield and gravity), the 5 best varieties were ND 671-4 Russ, MN 12567, MS 704-10, NEA 71.72-1 and W 832. Chip color was excellent in MS 700-83 and ND 860-2, and was acceptable in MS 704-10, W 832, MN 12161 and MN 82328.

D. PRELIMINARY TRIAL

Six varieties reported to have good chipping characteristics were tested for yield and quality in a randomized complete block design with 4 replications. Plot size, fertilizer use and pest management were the same as for the dates-of-harvest study. The results are summarized in Table 12.

The U.S. #1 yields were high in F 72004, F 74123 and A 7411-2. Although F 72004 and F 7411-2 had sufficient dry matter for chipping, only F 7411-2 produced an acceptable chip color and warranted further testing. BR 7093-24 was late maturing and susceptible to hollow heart. ND 1538-1 and ND 651-9 had low U.S. #1 yields owing to poor sizing.

E. EIGHT-HILL SELECTIONS FROM NEW SEEDLING INTRODUCTIONS

New seedling introductions, 16 from Michigan State University, 51 from North Dakota, 35 from New York and 65 from USDA-Aberdeen (Ore-Ida Foods, Inc.) were tested in 8-hill single plots. At harvest, 41 lines were selected on the basis of external appearance, size distribution and scab resistance in the field. These lines were further evaluated for dry matter, internal defects, chip color and after cooking darkening. Characteristics of the lines selected from MSU, North Dakota and New York are presented in Tables 13, 14 and 15, respectively. Those seedlings that meet the industry requirements for fresh market, chip and frozen processing will be further tested in 1987 in larger plots.

F. VARIETY EVALUATIONS FOR SCAB

Potato scab continues to be of concern with several of the newer varieties. Each year Dr. Ray Hammerschmidt conducts evaluations of varieties and advanced seedlings to assess their tolerance or susceptibility to scab. Locations are selected on cooperators farms where scab is known to have been a problem. Table 16 classes the several varieties evaluated for their reactions to scab in 1986.

Table 1. First date of harvest yield data (99 days). Harvested August 7, 1986.

	Yield cwt/A[1]		% Size Distribution							Internal Defects[2]		
Variety	U.S. #1	Total	U.S. #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Chip Score[3]	HH	Vas. Dis.	Int. Necrosis
A 76147-2	397	489	81	16	67	14	3	1.069	2.5	0	0	0
MS 700-83	392	446	88	10	85	3	2	1.073	1.5	0	0	2
Onaway	386	477	81	10	71	10	9	1.068	3.0	0	0	0
MS 702-91	365	433	84	9	75	9	7	1.071	1.5	0	0	2
Atlantic	346	406	85	13	79	6	2	1.081	1.5	0	0	0
MS 700-70	335	425	79	18	78	1	3	1.079	1.5	0	1	4
MS 716-15	333	392	85	14	78	7	1	1.079	1.0	0	0	1
MS 704-10	327	423	77	22	75	2	1	1.077	1.5	0	0	1
Conestoga	327	385	85	13	76	9	2	1.076	1.5	0	0	0
Sunrise	320	395	81	13	73	8	6	1.071	1.5	0	0	0
Krantz	296	389	76	17	68	8	7	1.069	2.0	0	0	0
MS 702-80	295	347	85	15	82	3	0	1.072	1.5	0	0	4
ND 534-4	278	383	72	23	64	8	5	1.069	2.0	0	0	0
Shepody	274	356	77	20	67	10	3	1.078	2.0	0	0	0
MS 700-79	254	315	81	16	77	4	3	1.073	1.5	0	0	1
Acadia Russet	218	381	57	41	56	1	2	1.076	2.5	0	0	0
Norking Russet	189	327	58	40	57	1	2	1.078	2.0	0	0	0
Russet Burbank	181	361	50	45	50	0	5	1.078	2.0	0	0	4
Average	306	396						1.074				

[1]BLSD for U.S. #1 = 51 cwt/A. CV = 8.8%.

[2]20 tubers cut to determine internal defects.

[3]PC/SFA 1-5 scale, 1 = lightest; 5 = darkest.

Table 2. Second date of harvest yield data (120 days). Harvested August 28, 1986.

	Yield cwt/A[1]		% Size Distribution							Internal Defects[2]		
Variety	U.S. #1	Total	U.S. #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Chip Score[3]	HH	Vas. Dis.	Int. Necrosis
MS 700-70	550	618	89	7	65	24	4	1.088	1.5	0	2	2
A 76147-2	543	664	82	12	49	33	6	1.076	2.5	0	0	1
Atlantic	460	510	90	8	67	23	2	1.088	1.5	0	0	1
MS 700-83	445	503	88	9	67	21	2	1.074	1.5	0	0	2
Onaway	432	550	79	11	63	16	11	1.066	3.5	0	0	0
Shepody	401	523	77	12	51	26	11	1.086	1.5	0	2	0
MS 716-15	396	458	86	10	62	24	3	1.085	1.0	0	0	0
MS 702-91	383	453	85	8	67	18	7	1.072	1.5	0	2	4
MS 704-10	381	487	78	18	64	14	3	1.082	1.5	0	2	0
Acadia Russet	374	534	70	24	61	9	6	1.086	3.5	1	0	2
Krantz	355	457	78	13	56	22	9	1.071	2.0	0	5	2
MS 702-80	345	420	82	10	64	18	7	1.073	1.5	0	0	0
Conestoga	332	397	83	12	73	10	4	1.071	1.5	0	0	1
Sunrise	319	418	76	15	58	18	8	1.067	1.5	0	0	0
ND 534-4	300	411	74	20	49	25	6	1.070	2.5	0	0	1
MS 700-79	287	347	83	13	75	8	4	1.076	2.0	2	1	0
Russet Burbank	233	458	52	31	49	3	17	1.086	2.0	0	0	3
Norking Russet	187	357	53	43	47	6	4	1.082	2.0	0	2	1
Average	374	476						1.078				

[1]BLSD for U.S. #1 = 71 cwt/A. CV = 13.6%.

[2]20 tubers cut to determine internal defects.

[3]PC/SFA 1-5 scale, 1 = lightest; 5 = darkest.

Table 3. Third date of harvest yield data (142 days). Harvested September 22, 1986.

	Yield cwt/A[1]		% Size Distribution							Internal Defects[2]		
Variety	U.S. #1	Total	U.S. #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Chip Score[3]	HH	Vas. Dis.	Int. Necrosis
MS 700-70	620	676	92	6	66	26	2	1.084	2.0	0	2 sl	5
A 76147-2	611	747	82	12	51	31	6	1.077	3.0	0	1 sl	4
Atlantic	521	569	91	6	65	26	3	1.090	1.5	0	1 sl	6
Acadia Russet	504	663	76	20	65	11	4	1.086	4.5	0	4 sl	0
MS 716-15	488	545	89	7	64	25	4	1.086	1.5	1	1 sl	0
MS 702-91	488	534	91	7	67	24	2	1.073	1.5	0	1 sl	0
MS 700-83	468	522	89	9	63	26	2	1.074	2.0	0	2 sl	0
Onaway	445	547	81	6	66	15	9	1.072	4.0	0	2 sl	1
Shepody	430	558	77	14	54	23	9	1.083	2.0	0	2 sl	1
MS 702-80	428	473	90	8	69	21	2	1.076	1.5	0	0	3
MS 704-10	394	499	79	17	69	10	4	1.080	1.5	0	2	1
ND 534-4	372	485	76	17	51	26	6	1.073	3.0	0	1 sl	0
Krantz	363	468	78	14	61	17	8	1.075	2.0	0	3 sl	0
Sunrise	354	429	82	10	66	16	8	1.072	1.5	0	0	1
Russet Burbank	347	567	61	25	51	10	14	1.086	2.5	0	3 sl	0
Conestoga	341	400	85	12	69	16	3	1.076	1.5	0	3 sl	0
MS 700-79	311	376	83	14	69	14	3	1.077	2.0	3	1 sl	2
Norking Russet	250	395	63	35	60	3	2	1.078	2.0	0	0	1
Average	430	525						1.079				

[1]BLSD for U.S. #1 = 83 cwt/A. CV = 13.8%.

[2]20 tubers cut to determine internal defects.

[3]PC/SFA 1-5 scale, 1 = lightest; 5 = darkest.

Table 4. The vigor, maturity and early blight ratings of potato varieties in the dates of harvest trial.

Variety	Vigor[1]	Maturity[2]	Early Blight[3]
MS 700-79	3.8	3.0	1.0
MS 700-83	4.5	2.8	1.1
MS 702-80	3.7	3.5	1.0
MS 702-91	3.8	2.8	1.3
MS 704-10(Y)	4.3	2.8	1.2
MS 716-15	4.5	3.7	1.0
MS 700-70	5.0	4.0	1.0
A 76147-2	4.4	4.0	1.0
ND 534-4	3.8	2.2	1.7
Norking Russet	4.3	2.5	1.3
Acadia Russet	4.7	4.2	1.0
Krantz	4.7	3.1	1.4
Onaway	4.9	2.0	2.1
Atlantic	5.0	3.8	1.0
Conestoga	4.3	1.0	3.3
Shepody	4.6	4.0	1.1
Sunrise	4.1	2.0	1.4
Russet Burbank	4.3	4.5	1.0

[1]Vigor: When tops have reached maximum size, before visible signs of maturity. Taken 68 days after planting. Scale of 1-5, 1 = poor; 5 = excellent.

[2]Maturity: When tops show differences in maturity. Taken 93 days after planting. Scale of 1-5, 1 = early; 5 = very late.

[3]Early Blight Rating: Scale of 1-5, 1 = resistant; 5 = highly susceptible.

Table 5. After-cooking-darkening[1] of potato varieties grown in the 1986 dates-of-harvest trial.

Variety	0 Hours	1 Hour	24 Hours	Comments
MS 700-79	1.5	2.5	2.5	All 3 tubers darkened
MS 700-83	2.0	3.0	3.5	All 3 tubers darkened
MS 702-80	1.5	1.5	1.5	1 with dark end
MS 702-91	1.0	1.5	1.5	1 with dark end
MS 704-10	1.0	1.0	1.0	
MS 716-15	1.0	1.5	1.5	Some sloughing
MS 700-70	1.0	1.5	1.5	
A 76147-2	1.0	1.5	2.0	
ND 534-4	1.0	2.0	2.0	dark color overall
Norking Russet	1.0	1.0	1.0	
Acadia Russet	1.0	1.5	1.5	dark color overall
Krantz	1.0	1.0	1.0	
Onaway	1.0	1.0	1.0	
Atlantic	1.5	2.0	2.0	2 dark stem ends
Conestoga	1.5	1.5	1.5	2 dark stem ends
Shepody	1.0	1.0	1.0	
Sunrise	1.5	1.5	2.0	3 dark ends
Russet Burbank	1.0	1.0	1.0	

[1]Tubers stored at 50-55°F since harvest. Rating scale 1-5, 1 = no darkening; 5 = severe darkening (black) overall.

Table 6. The chip color of potato varieties at harvest and after 120 days of storage at 55°F.

Variety	Chip Score[1] At Harvest	Chip Score[1] 120 Days
MS 700-79	2.0	1.5
MS 700-83	1.5	2.0
MS 702-80	1.5	1.0
MS 702-91	1.5	1.0
MS 704-10	1.5	1.5
MS 716-15	1.0	1.0
MS 700-70	1.5	1.5
A 76147-2	2.5	2.5
ND 534-4	2.5	3.5
Norking Russet	2.0	2.0
Acadia Russet	3.5	3.5
Krantz	2.0	1.0
Onaway	3.5	3.5
Atlantic	1.5	1.0
Conestoga	1.5	1.5
Shepody	1.5	2.0
Sunrise	1.5	1.5
Russet Burbank	2.0	2.0

[1]Chip Score: PC/SFA scale 1-5, 1 = lightest; 5 = darkest.

Table 7. Blackspot susceptibility of potato varieties in the dates-of-harvest trial[1].

Variety	Artificially Bruised		Check	
	% Tubers with Blackspot	Severity[2] Index	% Tubers with Blackspot	Severity[2] Index
MS 702-91	20	0.2	0	0
MS 700-79	30	0.4	0	0
MS 716-15	30	0.5	0	0
MS 702-80	20	0.2	0	0
MS 704-10	40	0.4	10	0.1
MS 700-83	20	0.2	0	0
Norking Russet	10	0.1	0	0
Krantz	40	0.4	0	0
Russet Burbank	30	0.6	0	0
Acadia Russet	80	2.5	10	0.1
Onaway	20	0.2	10	0.2
Shepody	30	0.3	0	0
Sunrise	20	0.2	0	0
A 76147-2	20	0.2	10	0.1
Conestoga	20	0.3	0	0
ND 534-4	0	0.0	0	0
Atlantic	30	0.6	0	0

[1]Potatoes were stored at 40°F for 120 days following harvest. The bruised tubers and the check treatments were placed at 55°F for one week before peeling.

[2]Severity Index: Number of blackspot bruises per tuber.

Table 8. Internal defects in oversized tubers at 2 dates of harvest.

	% Tubers			
	Hollow Heart		Internal Necrosis	
Variety	120 Days	142 Days	120 Days	142 Days
MS 700-79	12	28	4	12
MS 700-83	10	10	5	10
MS 702-80	6	4	3	14
MS 702-91	5	5	20	16
MS 704-10	13	22	3	8
MS 716-15	5	8	0	2
MS 700-70	10	5	10	12
A 76147-2	5	10	0	2
ND 534-4	3	5	6	5
Norking Russet	4	3	0	0
Acadia Russet	10	8	4	0
Krantz	0	0	0	0
Onaway	0	0	3	0
Atlantic	16	13	10	12
Conestoga	3	16	13	5
Shepody	3	10	0	2
Sunrise	12	11	3	2
Russet Burbank	0	6	0	0

Table 9. Tuber yield, size distribution and specific gravity of potato varieties in the Upper Peninsula.

Variety	Yield cwt/A		% Size Distribution					Specific Gravity
	U.S. #1	Total	U.S. #1	<2	2-3¼	>3¼	Pick Outs	
MS 704-10	352	369	95	4	52	44	0	1.087
Acadia Russet	336	382	88	6	53	35	5	1.081
Onaway	317	328	97	3	30	66	0	1.079
A 76147-2	303	326	93	3	32	61	4	1.072
MS 700-83	302	323	93	4	50	43	3	1.081
Russet Burbank	270	325	83	8	54	29	9	1.080
Krantz	267	288	93	4	54	39	3	1.081
ND 534-4	266	288	92	5	53	40	3	1.079
MS 702-80	259	274	94	5	50	45	1	1.082
Atlantic	250	272	92	7	52	39	1	1.090
MS 716-15	243	253	96	4	50	46	0	1.088
MS 702-91	243	266	92	3	60	32	5	1.082
MS 700-70	230	246	93	7	47	46	0	1.081
NorKing Russet	213	230	92	5	62	30	3	1.080
Conestoga	187	190	99	1	78	21	0	1.081
Nooksack	163	175	93	5	69	24	2	1.084
Average	263	283						1.082

Table 10. Tuber yield, solids, maturity and chip quality of potato varieties in the North Central Regional Trial.

Selection Number or Variety	Aver.1/ Mat.	Most2/ Representative Scab Area-Type	CWT/A Aver. Yield	CWT/A Aver. Yield US #1	Aver. Percent US #1	(Not Solids/a) Aver. Total Solids	Gen.3/ Merit Rating	Chip4/ Color	Early5/ Blight Reading	Comments and General Notes
EARLY										
Norland	1.0	0	376	315	84	16.5		2.5	3.0	
ND651-9	2.0	0	493	383	77	18.6		2.5	3.0	
ND860-2	1.0	0	339	259	76	18.8		1.0	3.0	
W832	3.0	0	459	405	89	19.9	5	1.5	4.0	High % of oversize tubers.
MEDIUM TO LATE										
MS700-83	3.0	1 - 1	541	468	87	19.0		1.0	3.7	Nice tuber appearance.
MS704-10	3.0	0	471	311	66	20.1	3	1.5	3.7	Flesh br. yellow, high % <2".
MN12161	3.5	0	485	361	75	19.9		1.5	4.0	
MN12567	3.8	0	506	388	77	18.6	2	2.5	4.0	
MN82328	3.5	0	427	297	70	19.2		1.5	4.0	Sprouts early.
NE165.75-2	4.5	0	453	390	86	19.4		2.5	5.0	High % of oversize tubers.
NEA71.72-1	3.5	0	448	361	81	19.4	4	2.5	4.5	Nice smooth tubers.
BN9803-1	3.0	0	410	316	77	20.5		2.0	4.0	Rough, irregular shape, knobs.
ND671-4Russ	2.8	0	490	311	63	18.4	1	2.5	3.7	High % of tubers <4 oz.
NDT9-1068-11R	3.2	0	593	504	85	16.9		3.5	3.5	Prominent growth cracks.
W879	3.0	0	445	377	85	21.8		2.0	3.7	Flat tubers, irregular shape.
W948R	3.0	0	655	557	85	19.9		2.5	4.0	
Red Pontiac	3.5	1 - 2	473	388	82	17.5		3.5	4.2	
Russet Burbank	4.5	0	613	283	46	21.2		3.0	4.2	High % of tubers <4 oz.
Norgold Russet	3.0	0	347	197	57	18.2		4.0	3.7	High % of tubers <4 oz.
Norchip	3.0	0	441	356	80	19.9		2.0	3.5	
~~La12-59~~			-	-	-					

1/ 1-Very Early-Norland maturity; 2-Early-Irish Cobbler maturity; 3-Medium-Red Pontiac maturity; 4-Late-Katahdin maturity; 5-Very Late-Kennebec or Russet Burbank maturity.

2/ AREA - T-less than 1%; 1 - 1020%; 2 - 21-40%; 3 - 41-60%; 4 - 61-80; 5 - 81-100%. TYPE - 1. Small, superficial; 2. Larger, superficial; 3. Larger, rough pustules; 4. Larger pustules, shallow holes; 5. Very large pustules, deep holes.

3/ Place top five among all entries including check varieties; disregard maturity classification. (Rate first, second, third, fourth and fifth (in order) for overall worth as a variety).

4/ Chip Color - ~~PCII~~ Color Chart ~~XXXXXXXXX~~. SFA Score 1 = lightest, 5 = darkest.

5/ Early Blight - 1-suspectible; 5-highly resistant.

Table 11. Summary of external and internal grade defects of potato varieties in the North Central Regional Trial.

Selection Number or Variety	Scab (3)	Growth Cracks	Second Growth	* Sun Green	Total (4) Tubers Free of External Defects	Hollow Heart	Internal Necrosis	Vascular Discoloration	Normal Tubers (5)	% Pic Outs (6)
EARLY										
Norland	0	0	0		100	2	2	4 sl	92	1
ND651-9	0	8	0		92	0	0	24 sl	76	2
ND860-2	0	2	0		98	0	4	2 s, 6 sl	88	1
W832	0	0	0		100	4	0	4 s, 2 sl	90	4
MEDIUM TO LATE										
MS700-83	2	2	0		96	4	14	6 sl	76	1
MS704-10	0	4	0		96	0	6	2 s, 6 sl	86	3
MN12161	0	0	0		100	0	0	0	100	2
MN12567	0	2	0		98	0	2	36 sl	62	1
MN82328	0	0	0	D	100	0	2	4 sl	94	2
NE165.75-2	0	0	4	R	96	2	4	4 s, 6 sl	84	6
NEA71.72-1	0	0	0	A	100	10	4	6 sl	80	1
BN9803-1	0	2	8	G	90	24	2	2 sl	72	8
ND671-4Russ	0	0	0	E	100	0	0	2 sl	98	3
NDT9-1068-11R	0	6	4	R	90	2	0	4 s, 6 sl	88	7
W879	0	0	0	S	100	0	0	6 sl	94	4
W948R	0	0	0	I	100	0	2	20 sl	78	1
Red Pontiac	2	4	0	D	94	14	0	12 sl	74	5
Russet Burbank	0	2	14		84	0	4	4 sl	92	22
Norgold Russet	0	2	2		96	2	2	0	96	8
Norchip	0	2	6		92	0	0	6 sl	94	5
La12-59	-	-	-		-	-	-	-	-	-

(1) Based on four 25 tuber samples (one from each replication). Percentage based on number of tubers.

(2) Based on four 25 tuber samples (one from each replication). Percentage based on number of tubers.

(3) Includes <u>all</u> tubers with scab lesions whether merely surface, pitted or otherwise and regardless of area. <u>Be sure</u> to count tubers with any amount of scab in this category.

(4) This total - tubers free from any external defect of any sort.

(5) Percentage normal tubers are those showing no internal defects. Some individual tubers will have more than one type of internal defects.

(6) Percent pick-outs (knobs, growth crack) determined at time of field grading and percentage of total weight. Pick outs are discarded so are <u>not</u> included in sample when external and internal defects are determined.

Table 12. Yield, size distribution and quality of potato varieties tested in the preliminary trial.

	Yield cwt/A		% Size Distribution									Internal Defects[1]		
Variety	U.S. #1[2]	Total	U.S. #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Chip Score[3]	Maturity[4]	Early Blight[5]	HH	Vas. Dis.	Int. Necrosis
F 72004	523	564	93	5	67	26	2	1.081	2.5	3.1	2.0	0	2	1
F 74123	462	554	83	11	68	15	6	1.072	2.5	2.5	1.8	3	0	3
A 7411-2	442	515	86	10	59	27	4	1.091	1.5	3.8	2.2	3	0	2
BR 7093-24	363	436	83	13	67	16	4	1.079	2.0	4.6	1.2	8	0	2
ND 1538-1	330	455	73	25	66	7	2	1.079	2.5	2.2	2.0	1	0	0
ND 651-9	260	428	61	39	61	0	0	1.072	1.5	2.9	2.0	0	2	2
Average	397	492						1.079						

[1]20 tubers cut to determine internal defects.

[2]LSD for U.S. #1 = 57 cwt/A. CV = 9.5%.

[3]PC/SFA scale 1-5, 1 = lightest; 5 = darkest.

[4]Maturity: 1 = early, 5 = very late maturity.

[5]Early Blight: 1 = resistant, 5 = susceptible to early blight

Table 13. Characteristics of MSU seedlings selected from 8-hill plots.

Variety	Yield (lbs) No. 1	Yield (lbs) Total	% Size Distribution #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Mat[1]	EB[2]	Internal Defects HH	IN	VD	Chip Color[3]	ACD
MS 401-5	27.5	29.5	93	7	83	10	0	1.090	5.0	2	9	2	0	1.5	1.
MS 401-2	26.5	27.5	96	4	93	3	0	1.090	4.0	2	0	0	0	1.5	1.
MS 401-3	23.0	25.3	91	8	85	6	1	1.086	3.0	2	0	8	0	2.0	2
MS 402-7	23.0	26.0	88	12	73	15	0	1.078	2.5	2	0	2	1 sl	3.5	1.
MS 401-7	22.7	28.0	81	18	78	3	1	1.091	3.5	1	1	6	1 sl	2.5	1
MS 402-3	21.7	23.2	94	6	91	3	0	1.082	?	?	0	4	1 sl	3.0	1.
MS 402-1	21.0	23.0	92	4	59	33	4	1.079	3.0	2	1	2	0	3.0	1
MS 402-6	20.0	22.5	89	2	89	0	9	1.076	2.0	2	0	6	1 sl	2.5	1
MS 401-6	17.5	18.2	96	4	63	33	0	1.086	3.0	1	1	8	0	2.0	1
MS 401-8	16.0	17.8	90	8	70	20	2	1.086	2.5	2	0	3	0	1.5	1
MS 402-5	16.0	19.0	84	16	76	8	0	1.078	2.0	2	0	18	1 sl	4.0	1
MS 402-8	15.0	16.0	94	6	72	22	0	1.076	2.0	2	0	2	2 sl	2.5	1
MS 401-1	15.0	21.0	71	29	71	0	0	1.086	2.0	2	0	4	0	1.0	1
MS 402-2	14.0	16.5	85	15	85	0	0	1.077	2.0	1	3	3	0	2.5	1
MS 402-4	12.5	18.0	69	28	69	0	3	1.074	1.5	1	0	1	1 sl	2.5	1
Russet Burbank	10.5	16.2	65	34	65	0	1	1.088	5.0	1	0	0	1 sl	3.0	1
MS 401-4	8.0	13.5	59	41	59	0	0	1.082	1.5	1	1	1	1 sl	2.0	1

[1]Maturity: 1 = early, 5 = very late maturity.

[2]Early Blight: 1 = resistant, 5 = highly susceptible.

[3]PC/SFA 1-5 scale: 1 = lightest, 5 = darkest.

[4]After cooking darkening score after 1 hour: 1 = no darkening, 5 = very dark.

Table 14. Characteristics of North Dakota seedlings selected from 8-hill plots.

Variety	Yield (lbs) No. 1	Yield (lbs) Total	% Size Distribution #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Mat[1]	EB[2]	Internal Defects HH	IN	VD	Chip Color[3]	ACD[4]
ND 1719-5	27.0	28.5	95	5	84	11	0	1.079	2.0	2	0	0	1 sl	3.5	1.0
ND 1725-13	26.5	34.0	78	21	69	9	1	1.082	2.5	2	1	1	1 sl	1.0	1.5
ND 2233-2	25.0	26.0	96	4	85	11	0	1.081	3.5	3	0	1	2 sl	3.0	1.0
ND 2112-2	24.0	25.8	93	6	76	17	1	1.078	1.5	2	0	0	1 sl	1.5	2.0
ND 2126-11	21.5	25.0	86	14	80	6	0	1.081	1.5	2	0	1	1 sl	2.0	1.0
ND 1859-3	21.0	23.5	89	11	89	0	0	1.087	3.0	3	0	2	1 sl	3.0	1.0
ND 2135-3-R	20.0	27.0	74	19	74	0	7	1.076	2.0	2	1	0	0	3.5	1.5
ND 2179-10	20.0	23.0	87	13	74	13	0	1.084	2.0	2	0	1	1 sl	3.5	1.5
Atlantic	19.0	24.5	78	22	78	0	0	1.094	3.5	3	0	1	1 sl	1.5	1.0
ND 862-8	18.5	23.0	80	20	80	0	0	1.068	1.5	2	0	2	1 sl	2.0	1.0
ND 2126-7	17.7	26.7	66	34	64	2	0	1.077	3.0	2	0	3	1 sl	1.5	1.0
ND 2109-7	17.0	23.5	72	28	60	12	0	1.083	2.5	2	0	0	1 sl	1.0	2.0
ND 1215-1	15.2	20.7	73	27	67	6	0	1.076	3.5	3	0	1	1 sl	2.0	1.0
ND 2212-9	12.7	17.7	72	11	48	24	17	1.072	2.0	2	1	0	0	3.5	1.5
ND 1850-5	11.0	15.0	73	27	60	13	0	1.073	1.5	2	0	0	2 sl	3.0	1.0

[1] Maturity: 1 = early, 5 = very late maturity.

[2] Early Blight: 1 = resistant, 5 = highly susceptible.

[3] PC/SFA 1-5 scale: 1 = lightest, 5 = darkest.

[4] After cooking darkening score after 1 hour: 1 = no darkening, 5 = very dark.

Table 15. Characteristics of New York seedlings selected from 8-hill plots.

Variety	Yield (lbs) No. 1	Yield (lbs) Total	% Size Distribution #1	<2	2-3¼	>3¼	Pick Outs	Specific Gravity	Mat[1]	EB[2]	Internal Defects HH	IN	VD	Chip Color[3]	ACD[4]
NY 191-2	38.0	42.0	90	10	83	7	0	1.065	3.5	2	0	1	1	3.5	1.0
NY 123-4	34.0	36.0	94	3	72	22	3	1.071	2.5	2	2	0	1	3.0	1.0
NY 191-1	27.6	33.6	82	18	73	9	0	1.079	4.0	1	0	0	0	3.5	1.[illegible]
NY 85-10	25.5	30.5	84	16	77	7	0	1.075	5.0	1	0	1	1 sl	3.0	1.0
NY 130-4	25.5	30.0	85	13	72	13	2	1.082	3.0	1	0	5	0	1.0	1.0
NY 130-5	25.5	26.0	98	2	83	15	0	1.085	5.0	2	2	3	1 sl	2.0	1.5
NY 140-2	25.2	29.7	85	13	71	14	2	1.075	2.0	2	3	0	1 sl	2.5	1.[illegible]
NY 195-11	21.2	24.0	88	12	76	12	0	1.088	3.0	2	2	1	0	1.0	1.0
NY 143-9	20.5	28.2	73	26	73	0	1	1.084	3.0	2	0	1	1 sl	4.0	1.0
NY 125-6	19.5	23.5	83	17	74	9	0	1.090	3.0	3	0	3	0	1.5	1.5
NY 164-9	19.0	21.7	87	12	78	9	1	1.092	2.5	2	2	3	0	1.5	1.5
NY 195-3	18.2	23.2	79	17	76	3	0	1.089	2.5	2	0	2	1 sl	1.5	1.[illegible]
Russet Burbank	10.0	16.0	63	25	63	0	12	1.090	5.0	1	1	0	1	3.0	1.0

[1]Maturity: 1 = early, 5 = very late maturity.

[2]Early Blight: 1 = resistant, 5 = highly susceptible.

[3]PC/SFA 1-5 scale: 1 = lightest, 5 = darkest.

[4]After cooking darkening score after 1 hour: 1 = no darkening, 5 = very dark.

Table 16. Variety reactions to scab.

Resistant	Intermediate	Susceptible
Alasclear	Islander	Acadia Russet
Krantz	Nooksack	Atlantic
Norking Russet	MS 700-83	Chipbelle
Onaway	MS 702-91	Conestoga
Ontario		Crystal
Pungo		Denali
Rideau		Jemseg
Russet Burbank		Katahdin
Superior		Monona
MS 700-79		Oceania
MS 702-80		Rosa
MS 714-10		Sebago
		Shepody
		Simcoe
		Snowchip
		Yukon Gold
		Yankee Chipper
		Yankee Supreme
		MS 700-70
		MS 701-22
		MS 704-10(Y)
		MS 716-15
		MS 718-16

Funding: Federal Grant

THE EFFECTS OF PRE-CUTTING AND FUNGICIDE TREATMENT OF POTATO SEED

R.W. Chase, G.H. Silva, and R.B. Kitchen
Department of Crop and Soil Sciences
Michigan State University

Pre-cutting of seed has been suggested as a remedy for potato varieties that are slow to emerge and establish in the field. Shepody and Yukon Gold are examples of such varieties that are grown commercially in Michigan. The germination is often slow and erratic resulting in poor vigor and uneven plant stands. Also, the delayed emergence predispose the seed pieces to rot organisms in the soil. In 1986, a 2 x 2 factorial experiment was conducted at the Montcalm Experiment farm to investigate the merits of:

(a) Pre-cut (2 weeks before planting) vs. fresh-cut seed.

(b) Fungicide (Tops-2.5D®) treatment of seed pieces vs. no treatment.

Two cultivars, Shepody and Yukon Gold were used in the study. For pre-cutting, the seed potatoes were taken out of storage two weeks before the planting date and hand-cut to produce seed pieces between 50-60 grams. Fresh-cut seed was cut and planted on the same day. Fungicide treatment was done immediately after cutting at the recommended rate (1 lb Tops-2.5D®/100 lbs cut seed). The treatments were tested in a randomized complete block design with four replications.

The trial was planted on May 5, 1986. The fertilizers applied were 200 lbs/A 0-0-60 at plowdown, 500 lbs/A 15-10-15-12S with planter, and 75 lbs/A N as urea as sidedressing (June 17, 1986). Management practices were similar to those applied for the dates-of-harvest study. The trial was harvested on September 16, 1986. Data on emergence, plant stand, tuber yield and quality were recorded.

The results obtained with cultivar Shepody are presented in Table 1. Plants from pre-cut seed emerged earlier and produced a higher plant stand compared with fresh-cut seed. The uniformity and the vigor of the pre-cut treatment was very evident at the early stage of the crop. Analysis of variance showed that the combined yield produced by the pre-cut seed (with and without fungicide treatment) was significantly higher than the fresh-cut seed. Treatment of cut seed with Tops-2.5D® produced no significant advantages in plant stand and tuber yield. The interaction between time of cutting and fungicide treatment was not significant. Quality parameters such as specific gravity and size distribution of potatoes were not substantially different among treatments.

The results obtained with Yukon Gold are not presented here because of poor plant stands in the trial. The seed used for this trial was of inferior quality and the overall germination was only about 50%. Therefore the data was not statistically analyzed. In this trial, treatment with Tops-2.5D® helped to alleviate some of the germination problems associated with Yukon Gold.

The preliminary results are encouraging for the use of pre-cutting and possibly fungicide treatment of cut seed as a means of overcoming the slow and poor establishment of some potato varieties. These experiments are to be expanded and repeated in 1987 to further validate the 1986 findings.

Table 1. Yield of Shepody in relation to time of cutting and fungicide treatment of seed.

Treatment	Yield (cwt/A) U.S. #1[1]	Yield (cwt/A) Total	% Size Distribution U.S. #1	<4	4-10	>10	Pick Outs	Specific Gravity	Days 50% Emergence	% Stan
Pre-cut/No Tops	417 a	515	81	17	67	14	2	1.086	22	97
Pre-cut/Tops	410 ab	509	81	19	68	13	0	1.086	23	97
Fresh-cut/No Tops	373 bc	457	82	18	72	10	0	1.089	24	93
Fresh-cut/Tops	367 c	466	79	20	69	10	1	1.090	24	93

[1]Means followed by the same letter are not significantly different (Duncan's multiple range test at 5% level).

Time of cutting : significant
Tops treatment : not significant
Interaction : none

CV = 6.7%

Funding: Federal Grant

EVALUATION OF PRODUCTION MANAGEMENT INPUTS TO IMPROVE QUALITY AND YIELD OF THREE MSU SEEDLINGS

G.H. Silva, R.W. Chase, and R.B. Kitchen
Department of Crop and Soil Sciences
Michigan State University

Three new potato seedlings from Michigan State University, MS 716-15, MS 700-83 and MS 704-10 have done consistently well in Michigan and in several other states, and are being considered for variety releases from MSU. MS 716-15 is a round white, medium-late maturing seedling with above average yields and high specific gravity. Tubers have a smooth general appearance and excellent chip quality. MS 700-83 is a round white, mid-season maturing seedling with above average yield and medium gravity. It has a good general appearance and has potential for fresh market and chipping out of field. MS 704-10 is a yellow flesh variety that sets heavy and produces average yields with high specific gravity. It has potential for fresh market and chipping out of field and short term storage.

The management practices recommended for new releases are generally based on standard practices adapted for commonly grown varieties. In 1986, the nitrogen and spacing requirements of the three MSU seedlings were studied using three levels of nitrogen (100, 150, 200 lbs/A) and three within-row spacings (6", 9", 12") in a factorial experiment. The treatments were tested in a randomized complete block design with four replications. In addition to determining the optimum requirements of nitrogen and spacing, the economics of each input level were investigated.

MS 716-15

In this study both nitrogen and spacing effects were significant (Table 1). The highest nitrogen level (200 lbs) and the closest spacing (6") produced significantly higher yields than all other treatments. At 12" spacing, there was a slight tendency to produce a higher % of oversized tubers. The specific gravity of the potatoes, although not significantly different between treatments, were higher at lower nitrogen levels and closer spacings.

The cost/revenue analysis showed that the higher yield produced at 200 lbs of N and 6" spacing far outweighed the costs associated with increased nitrogen and seed for closer spacing at this input level (Table 2).

MS 700-83

In this study only nitrogen effects were significant and spacing effects were not significant. Although the highest U.S. #1 yield was produced at 200 lbs N and 6" spacing, yield differences were not significantly different from seven other treatment combinations. At closer spacing, there was a slight tendency to produce a higher % of undersized tubers with a corresponding decrease in the % U.S. #1 tubers. The specific gravity again was slightly higher in low nitrogen, closely spaced treatments.

The cost/revenue analysis showed that a combination of 150-200 lbs N and a wider spacing of 12" was the most appropriate for MS 700-83.

MS 704-10

In this study the yield differences between treatments was somewhat similar to those obtained with MS 700-83. Only nitrogen effects were significant and spacing effects were not significant. Although the highest U.S. #1 yield was again produced at 200 lbs N and 6" spacing, the yield differences were not significant from seven other treatment combinations. At closer spacing, there was a tendency to produce a higher % of undersized tubers with a corresponding decrease in % U.S. #1 tubers.

The cost/revenue analysis showed that a nitrogen level of 150 lbs/A and a spacing of 12" was the most desirable input combination for MS 704-10.

The combined specific gravities of the three seedlings at the three different N levels and spacings are presented in Figures 1 and 2. Increasing levels of nitrogen resulted in a reduced specific gravity, and to a lesser degree, there was a trend to a lower specific gravity with a wider in-row spacing.

Table 1. Influence of nitrogen and spacing on tuber yield of MS 716-15.

Nitrogen[1] (lbs/A)	Spacing[1] (inches)	Yield (cwt/A) U.S. #1[2]	Yield (cwt/A) Total	% Size Distribution U.S. #1	<2"	2-3¼	>3¼	Pick Outs	Specific Gravity
200	6	532 a	593	90	9	76	14	1	1.092
200	9	480 b	521	91	7	80	11	1	1.091
150	6	446 bc	510	87	12	79	8	1	1.093
150	12	437 bcd	480	91	7	76	15	2	1.091
150	9	433 bcd	482	90	9	81	9	1	1.091
200	12	415 cd	467	91	7	64	27	2	1.090
100	6	407 cd	466	87	12	81	6	1	1.093
100	9	397 cd	451	89	10	83	6	1	1.092
100	12	390 d	426	91	8	79	12	1	1.092

[1]Both nitrogen and spacing effects were significant.

[2]Means followed by the same letter are not significantly different (Duncan's multiple range test at 5%).

CV = 7.4%

Table 2. Nitrogen and seed costs/acre analysis for MS 716-15.

N Applied[1] (lbs/A)	N + Application Cost($)[2] A	Spacing (inches)	Seed[3] Cost ($) B	N + Seed Cost($) A+B	Yield (cwt/A)	Gross[4] Revenue ($) C	Net ($) C-(A+B)
200	52	6	266	318	532	3499	3181
200	52	9	182	234	480	3149	2915
150	39	6	266	305	446	2919	2614
150	39	12	133	172	437	2876	2704
150	39	9	182	221	433	2836	2615
200	52	12	133	185	415	2759	2574
100	26	6	266	292	407	2659	2367
100	26	9	182	208	397	2594	2386
100	26	12	133	159	390	2561	2402

[1]Nitrogen 100, 150, and 200 lbs applied in 2, 3, and 4 applications.

[2]Nitrogen cost = $0.20/lb. Cost per application = $3.00/A.

[3]Seed cost = $7.00/cwt.

[4]Revenue on the basis of $6.50/cwt for tubers 2-3¼" and
$7.00/cwt for tubers >3¼

Table 3. Influence of nitrogen and spacing on tuber yield of MS 700-83.

Nitrogen[1] (lbs/A)	Spacing[2] (inches)	Yield (cwt/A) U.S. #1[3]	Yield (cwt/A) Total	% Size Distribution U.S. #1	<2"	2-3¼	>3¼	Pick Outs	Specific Gravity
200	6	455 a	555	82	16	78	5	1	1.079
200	12	446 a	516	87	11	73	14	0	1.079
150	6	442 ab	539	82	17	77	5	1	1.081
150	9	437 ab	503	87	13	80	7	0	1.080
150	12	436 ab	504	87	13	80	7	0	1.079
100	6	423 ab	501	84	15	82	2	1	1.082
200	9	422 ab	508	83	17	76	7	0	1.080
100	12	409 ab	466	88	12	82	6	0	1.080
100	9	397 b	468	84	15	80	4	1	1.082

[1]Nitrogen effect : significant.

[2]Spacing effect : not significant.

[3]Means followed by the same letter are not significantly different (Duncan's multiple range test at 5%).

CV = 7.9%

Table 4. Nitrogen and seed costs/acre for MS 700-83.

N Applied[1] (lbs/A)	N + Application[2] Cost($) A	Spacing (inches)	Seed[3] Cost ($) B	N + Seed Cost($) A+B	Yield (cwt/A)	Gross[4] Revenue ($) C	Net ($) C-(A+B)
200	52	6	266	318	455	3007	2689
200	52	12	133	185	446	2934	2759
150	39	6	266	305	442	2887	2582
150	39	9	182	221	437	2858	2637
150	39	12	133	172	436	2851	2679
100	26	6	266	292	423	2754	2462
200	52	9	182	234	422	2761	2527
100	26	12	133	159	409	2672	2513
100	26	9	182	208	397	2590	2382

[1]Nitrogen 100, 150, and 200 lbs applied in 2, 3, and 4 applications.

[2]Nitrogen cost = \$0.20/lb. Cost per application = \$3.00/A.

[3]Seed cost = \$7.00/cwt.

[4]Revenue on the basis of \$6.50/cwt for tubers 2-3¼" and
\$7.00/cwt for tubers >3¼"

Table 5. Influence of nitrogen and spacing on tuber yield of MS 704-10.

Nitrogen[1] (lbs/A)	Spacing[2] (inches)	Yield (cwt/A) U.S. #1[3]	Yield (cwt/A) Total	% Size Distribution U.S. #1	<2"	2-3¼	>3¼	Pick Outs	Specific Gravity
200	6	315 a	437	72	22	63	9	6	1.084
150	12	302 ab	403	75	19	65	10	6	1.085
200	9	301 ab	406	75	19	62	13	6	1.086
150	6	301 ab	427	70	27	61	9	3	1.084
200	12	300 ab	395	76	19	65	11	5	1.086
150	9	293 ab	403	73	22	63	10	5	1.086
100	12	289 ab	382	76	21	71	5	3	1.088
100	9	266 ab	360	74	24	67	7	2	1.086
100	6	253 b	368	69	28	64	5	3	1.088

[1]Nitrogen effect : significant.

[2]Spacing effect : not significant.

[3]Means followed by the same letter are not significantly different (Duncan's multiple range test 5%).

CV = 11.3%

Table 6. Nitrogen and seed costs/acre for MS 704-10.

N Applied[1] (lbs/A)	N + Application[2] Cost($) A	Spacing (inches)	Seed[3] Cost ($) B	N + Seed Cost($) A+B	Yield (cwt/A)	Gross[4] Revenue ($) C	Net ($) C-(A+B)
200	52	6	266	318	315	2067	1749
150	39	12	133	172	302	1983	1811
200	52	9	182	234	301	1982	1748
150	39	6	266	305	301	1976	1671
200	52	12	133	185	300	1972	1787
150	39	9	182	221	293	1925	1704
100	26	12	133	159	289	1888	1729
100	26	9	182	208	266	1741	1533
100	26	6	266	292	253	1653	1361

[1]Nitrogen 100, 150, and 200 lbs applied in 2, 3, and 4 applications.

[2]Nitrogen cost = $0.20/lb. Cost per application = $3.00/A.

[3]Seed cost = $7.00/cwt.

[4]Revenue on the basis of $6.50/cwt for tubers 2-3¼" and
$7.00/cwt for tubers >3¼"

Figure 1. Relationship between N and specific gravity.

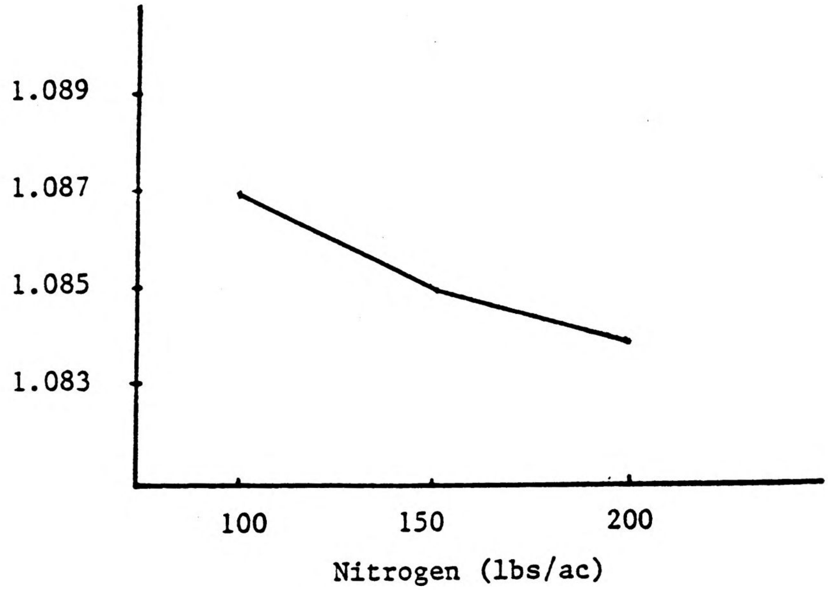
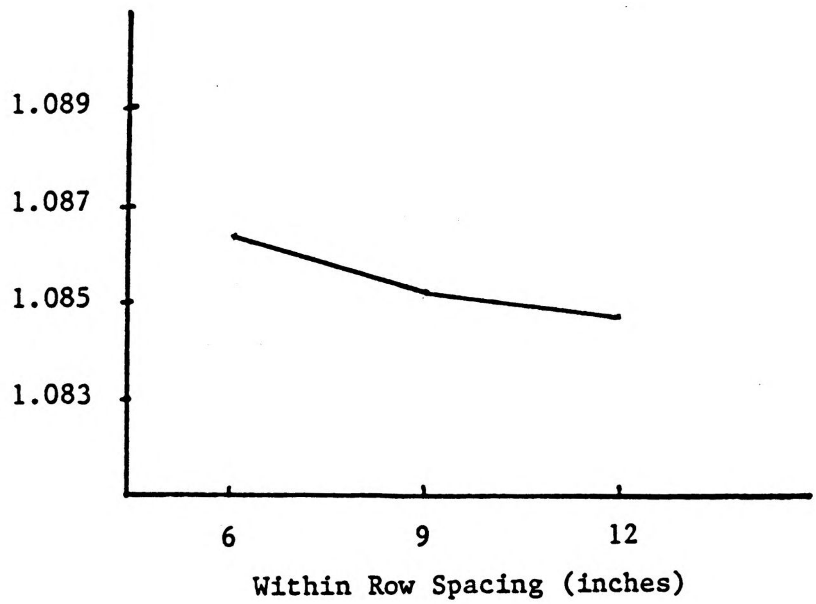


Figure 2. Relationship between spacing and specific gravity.



<u>Title</u>: EFFECTS OF RESPOND® TREATMENTS ON YIELD AND QUALITY OF POTATOES

<u>Investigators</u>: R.W. Chase, G.H. Silva and R.B. Kitchen
Department of Crop and Soil Sciences, Michigan State University
(Supported by Grower Services, Inc., Lansing)

<u>Cultivar</u>: Atlantic

<u>Treatments</u>: The experiment compared 5 treatments:

#1 - Respond 1% solution applied in-furrow, at planting
#2 - Respond 0.5% solution applied in-furrow, at planting
#3 - Respond at 24 oz/A applied to foliage, at hook stage
#4 - Respond at 12 oz/A applied to foliage, at hook stage
#5 - Control treatment, with no Respond application

<u>Design</u>:

The treatments were field tested in a randomized complete block design with 5 replications. Individual plots were 23 feet x 34 inches in size. Plants were spaced 9 inches apart in the row.

<u>Location</u>: Montcalm Experiment Station, Michigan State University

<u>Soil Type</u>: McBride Sandy Loam

<u>Date of Planting</u>: May 8, 1986

<u>Date of Harvest</u>: September 16, 1986

<u>Fertilizer application</u>: 200 lbs/A 0-0-60 plowdown
500 lbs/A 15-10-15-12S with planter
75 lbs/A N as urea as sidedressing (June 17, 1986)

<u>Respond Application</u>:

The in-furrow application for treatments #1 and 2 was made at the time of planting. The application was done with a knapsack sprayer to single drop seed before closing of the furrow. No surfactant was used. The temperature and relative humidity at application was 55°F and 60%, respectively.

The foliar application for treatments #3 and 4 was done on June 9, 1986 (31 days after planting) to correspond with the early hook storage. The temperature and relative humidity at application was 65°F and 55%, respectively.

<u>Observations</u>:

The data on emergence, plant stand, maturity, tuber yield, size distribution and specific gravity were collected.

Results and Conclusions:

The results are summarized in Table 1. Analysis of variance on U.S. #1 yield data indicated no significant differences between treatments. The highest U.S. #1 yield (466 cwt/A) was obtained with Respond 24 oz furrow application. The control treatment produced 456 cwt/A. In this experiment, a yield difference of at least 35 cwt/A was required to produce statistical significance between treatments.

Days for 50% emergence, % stand and maturity date showed no substantial differences between treatments. Quality parameters such as specific gravity and size distribution of the tubers also were not affected by the Respond treatment.

Under 1986 conditions, Respond application did not appear to produce any desirable or undesirable effects on tuber yield and quality in Atlantic variety. However, a complete understanding of the effects of Respond treatment on potatoes requires further tests extended over several seasons and different cultivars.

Table 1. Effects of Respond® treatments on potato yield and quality.

Treatment	Yield cwt/A[1] U.S. #1	Yield cwt/A[1] Total	% Size Distribution U.S. #1	<2	2-3¼	>3¼	Pick Outs	S.G.[2]	Days 50% Emergence	% Stand	Maturity[3]
Furrow, 24 oz	466	536	87	11	77	10	2	1.092	19	93	3.5
Control (No Respond)	456	540	84	12	76	8	4	1.093	21	96	3.5
Foliar, 24 oz	453	531	85	13	77	8	2	1.093	19	93	3.5
Foliar, 12 oz	451	536	84	13	71	13	3	1.094	20	90	3.5
Furrow, 12 oz	446	527	85	12	71	14	3	1.091	21	93	3.5

[1]Average of 5 replications. The U.S. #1 yield not significantly different between treatments. In this experiment, a difference of at least 35 cwt/A was required for treatments to become statistically significant.

[2]Specific gravity determined by weight in air/water method.

[3]Maturity, 1 = early; 5 = very late.

Foliar treatments applied at hook stage.

CV = 7.8%

EVALUATION OF CULTIVARS FOR FROZEN PROCESSING

R.W. Chase, G.H. Silva, and R.B. Kitchen
Department of Crop and Soil Sciences
In Cooperation with Jim Fuller, Ore-Ida Foods, Inc.

Advanced potato seedlings from USDA-Aberdeen potato breeding program were evaluated at early and late harvests in collaboration with Ore-Ida Foods, Inc.

All trials were planted on May 6. Eight selections were planted in the early harvest trial and harvested on August 28. Ten selections were planted in the late harvest trial and harvested on September 24. In addition, eight selections from the 1985 8-hill screening test were planted in a preliminary adaptation trial. For the 1986 8-hill screening trial, 65 new selections were introduced and tested.

The early and late harvest trials were conducted in a randomized complete block design with four replications. The preliminary adaptation trial had two replications. For the screening test, the 65 selections were tested in 8-hill, single plots. The management practices applied to these trials were similar to those used for the dates-of-harvest trial.

RESULTS

EARLY TRIAL

Table 1 summarizes the performances of varieties tested in the early harvest trial. A description of the variety characteristics is given below:

A76147-2 - Showed early emergence with good vine growth and vigor. Maturity is considered to be late. Produced the highest U.S. #1 and total yield in the trial. Solids are a little lower than desired for frozen processing. Has potential for count pack market.

Onaway - Used as a reference variety, particularly for yield. It is not considered a processing potato.

A79239-8 - Showed early emergence with good vine growth and early vigor. Maturity is considered late and similar to Russet Burbank. Produced above average yields with high solids. Produced smooth tubers with excellent appearance. Has excellent potential.

A78242-5 - Good early growth and vigor. Maturity is considered to be mid-season and produced average yields with high gravity. It is susceptible to hollow heart.

A79357-17 - Good early growth and vigor. Maturity is very late. Produced average yields with high gravity. It is also susceptible to hollow heart.

Shepody - Slow emergence and less vigorous in the early stages of growth. Maturity is medium-late but reaches maturity about two weeks before Russet Burbank. Produced average yields with high gravity. Excellent potential for frozen processing.

ND534-4 - Slow emergence and less vigorous in the early stages of growth. Maturity is early to mid-season and produced below average yields with low solids. Tubers are smooth with excellent general appearance. Specific gravity is too low for frozen processing but has potential for count pack fresh market. Sizing was not adequate in this trial.

Russet Burbank - Used as a reference variety. Very poor sizing and type in 1986. High % solids content is good for frozen processing.

LATE TRIAL

The performances of varieties tested in the late harvest trial is summarized in Table 2. A description of the variety characteristics are given below:

A79239-8 - Produced the highest U.S. #1 and total tuber yield in the trial. Vine and tuber characteristics are similar to those described for early trial. Excellent potential for frozen processing.

A79357-17 - Good early growth and vigor. Late maturity but produced high yields with high solids. As in the early trial, hollow heart was a problem.

A78242-5 - Good early growth and vigor. Late maturity with above average yields. Solids are sufficient for frozen processing.

Pentland Dell - A major variety used for frozen processing in Europe. Vigorous early growth and very late maturity. Produced average yields with high gravity. Percent U.S. #1 was low because of poor sizing.

Krantz - Good early growth and mid-season to late maturity. Produced average yields with good type but the specific gravity is somewhat less than desired for frozen processing. Has potential for a count pack.

Russet Burbank - Used as a reference variety. Produced below average yields because of poor sizing and type.

A80222-2 - Slow emergence and less vigorous growth at the early phase of growth. Very late maturity and has a tendency to produce a higher % of oversize tubers. Tubers had alligator's skin in 1986. Has limited potential in Michigan.

ND534-4 - Slow emergence and less vigorous growth at the early stage. Vine and tuber characteristics are similar to those described in the early trial. Solids content is too low for frozen processing.

A77101-18 - Slow emergence and less vigorous growth at the early stage. Produced below average yields because of higher % of U.S. #2 oversized tubers. Tubers are susceptible to hollow heart.

Norking Russet - Slow emergence and less vigorous growth at the early stage. Mid-season maturity with very low yields because of poor sizing. Potential for frozen processing is limited because of poor sizing, based on this trial.

PRELIMINARY TRIAL

The performances of varieties tested in the preliminary trial are summarized in Table 3. A description of the variety characteristics is given below:

A79341-3 - Produced the highest U.S. #1 and total yields in the trial. Very late maturing and has high solids. Has a tendency to produce a high % of oversized tubers. Tubers are susceptible to hollow heart.

A81556-1 - Good early season growth with mid-season maturity. Produced above average yields but the solids are too low for frozen processing.

A79340-8 - Good early season growth and mid-season maturity. Produced above average yields with high solids. Tubers were not susceptible to hollow heart but showed a high frequency of bud end necrosis.

A80621-8 - Slow early season growth and mid-season maturity. Produced above average yields but the gravity is too low for frozen processing.

Russet Burbank - Used as a reference variety. Produced a low % of U.S. #1 tubers because of poor sizing and type.

A7869-44 - Slow emergence and vigor at the early stage. Late maturing and produced below average yields with high gravity.

A81394-9 - Slow emergence and growth at the early stage of growth. Late maturing and produced below average yields due to poor plant stand. Tubers were of poor type owing to a higher % of U.S. #2 tubers. Solids insufficient for frozen processing. Tubers are susceptible to hollow heart.

A81389-4 - Lowest yield due to poor plant stand establishment. Late maturing and low gravity. Tubers are susceptible to hollow heart.

Table 1. Ore-Ida early trial, 1986.

	Yield cwt/A		Percent Size Distribution								Internal Defects[1]			
			U.S. #1					U.S. #2						
Variety	U.S. #1	Total	#1	<4	4-6	6-10	>10 oz	<10 oz	>10 oz	% Solids	HH	IN	Mat[2]	EB[3]
A76147-2	478	605	79	14	22	37	20	4	3	19.6	2	2	3.5	2.0
Onaway	420	590	71	18	17	42	12	8	3	17.7	0	0	2.5	2.5
A79239-8	390	506	77	13	18	35	24	5	5	21.0	4	0	4.5	2.0
A78242-5	369	513	72	15	17	39	16	7	6	20.4	11	0	3.0	2.0
A79357-17	362	595	61	14	12	23	26	12	13	20.5	9	1	4.5	1.5
Shepody	342	447	76	16	21	42	13	5	3	21.2	5	0	4.0	2.0
ND534-4	264	377	70	23	25	29	16	3	4	18.4	1	0	3.0	2.0
Russet Burbank	206	418	50	35	21	25	4	13	2	21.4	1	1	4.5	1.5
Average	354	506								20.0				

[1]Internal defects evaluated by cutting 40 tubers of size >10 oz.

[2]Mat: 1 = early; 5 = very late maturity.

[3]EB: 1 = Early Blight resistant; 5 = susceptible.

CV (U.S. #1) = 13.1%

Table 2. Ore-Ida late trial, 1986.

Variety	Yield (cwt/A) U.S. #1	Yield (cwt/A) Total	Percent Size Distrubtion U.S. # 1 #1	<4	4-6	6-10	>10 oz	U.S. #2 <10 oz	U.S. #2 >10 oz	% Solids	Internal Defects[1] HH	Internal Defects[1] IN	Mat[2]	EB[3]
A79239-8	488	606	80	14	16	37	27	4	2	21.5	4	0	4.0	2.0
A79357-17	468	662	71	12	13	33	16	6	2	20.7	10	0	4.0	1.5
A78242-5	363	526	69	23	20	33	16	6	2	19.7	2	2	4.5	2.0
Pentland Dell	355	611	58	36	32	24	2	6	0	21.3	2	2	4.5	1.5
Krantz	329	454	72	20	24	31	17	4	4	18.5	0	1	3.5	2.0
Russet Burbank	286	489	59	28	23	30	6	11	2	21.3	7	1	5.0	1.0
A80222-2	282	363	78	16	19	34	25	3	3	19.3	6	0	5.0	1.0
ND534-4	247	383	64	28	22	30	12	6	2	17.7	0	0	3.0	2.0
A77101-18	195	366	54	8	7	18	29	10	28	19.5	11	0	4.0	1.5
Norking Russet	160	306	53	44	28	24	1	3	0	19.5	0	1	3.0	2.0
Average	317	477								19.9				

[1]Internal defects evaluated by cutting 40 tubers of size >10 oz.

[2]Mat: 1 = early; 5 = very late maturity.

[3]EB: 1 = Early Blight resistant; 5 = susceptible.

CV (U.S. #1) = 12.6%

Table 3. Ore-Ida preliminary trial, 1986.

Variety	Yield (cwt/A) U.S. #1	Yield (cwt/A) Total	Percent Size Distribution U.S. #1 #1	U.S. #1 <4	U.S. #1 4-6	U.S. #1 6-10	U.S. #1 >10 oz	U.S. #2 <10 oz	U.S. #2 >10 oz	% Solids	Internal Defects[1] HH	Internal Defects[1] IN	Mat[2]	EB[3]
A79341-3	481	613	78	8	9	24	45	3	11	21.0	13	1	4.5	2.0
A81556-1	362	608	60	15	15	28	17	12	13	11.9	9	1	3.0	2.0
A79340-8	352	566	62	19	16	29	17	12	7	20.4	0	7	3.5	1.5
A80621-8	346	501	69	13	22	21	26	11	7	18.1	5	1	3.5	1.0
Russet Burbank	289	585	49	31	24	21	4	12	8	21.4	2	0	5.0	1.0
A7869-44	284	387	74	13	14	35	25	6	7	21.2	5	0	4.5	1.5
A81394-9	177	306	58	21	13	24	21	8	13	17.1	9	0	5.0	1.0
A81389-4	139	195	71	21	17	32	22	8	0	17.9	12	0	5.0	1.0
Average	304	470								19.4				

[1]Internal defects evaluated by cutting 40 tubers of size >10 oz.

[2]Mat: 1 = early; 5 = very late maturity.

[3]EB: 1 = Early Blight resistant; 5 = susceptible.

CV (U.S. #1) = 20.1%

SUSTAINABLE AGRICULTURE — POTATOES

Robert Lucas and Richard Bay
Department of Crop and Soil Sciences
Michigan State University

A project was carried out at the Kellogg Biological Station (KBS) in Kalamazoo County which compared four different management systems which could be practical for small scale market gardeners. The soil type is classified as a Kalamazoo loam with less than two percent slope. The site had been well manured and fertilized for many years. In 1983 the soil tested: pH - 6.9, phosphorus - 235, potassium - 460, calcium - 2000 and magnesium - 383 pounds per acre (2 million pounds of soil).

The management systems compared were:

1) High Energy (H. Eng.). This description was given in 1983 when fossil fuel resources were more of an input. The management system might better be called a preventive program where liberal amounts of commercial fertilizers and pesticides are used.

2) Integrated Crop Management (ICM). This system is similar to H. Eng. but uses chemicals only when a need is apparent. This system requires scouting for nutrient and pest problems. Risks are greater but total production costs are lower than the H. Eng. inputs system.

3) Bioagriculture (Bio). This system is called "organic" by some. It uses no chemical products except those designated as bioproducts. When needed, ground rock phosphate, bone meal, green sand, granite dust or similar materials are used as sources of phosphorus and potassium.

4) Bioagriculture with Farm Manure (Bio-M). This system uses similar chemicals as used for the Bio system. In addition, 12 tons of farm manure from the KBS dairy loose bedding barn was used as the manure source.

Site

In addition to potatoes, snap beans, cucumbers and sweet corn were grown. Each vegetable crop followed either an alfalfa or some other vegetable crop. Irrigation water was available when needed.

Potatoes

In 1985, Yankee Chipper was planted April 26 and harvested August 19 and in 1986, Yankee Supreme was planted April 22 and harvested August 12. The rows were spaced three feet apart and the seed spaced 10 inches apart in the row. Temik (aldicarb) was applied on top of the row after planting in April and then covered lightly with soil. Before applying, the Temik was mixed with some soil in a bucket to help obtain a more even application.

The N-P-K fertilizer for the two chemical systems was applied in each row before planting the seed. Some of the nitrogen was sidedressed in June.

The data in Table 1 shows the crop yields. Of the seven vegetables under study, potatoes were the most responsive to the H. Eng. and ICM management systems because of serious potato leaf-hopper burn. Of these two systems, yields show no significant differences in 1985 but the H. Eng. yields were significantly better in 1986.

The data in Table 2 shows the grade size and specific gravity values. Table 3 reports the various inputs for the four systems.

Table 1. Yield of potatoes grown under four different management systems.

Management System	1985 After Beans	1985 After Alfalfa	1986 After Beans	1986 After Alfalfa
	cwt/A			
High Energy	370	305	342	338
Integrated Crop Management	370	321	292	280
Bioagriculture	216	217	164	200
Bio and Manure	229	245	212	212
LSD (5%)	36		54	

Table 2. Yield and specific gravity of potatoes (Yankee Chipper) grown in 1985.

Management System	A Size	A and B Size	A Size Specific Gravity
	cwt/A		
High Energy			
After vegetables	231	370	1.075
After alfalfa	256	305	1.074
ICM			
After vegetables	288	370	1.082
After alfalfa	277	321	1.077
Bio			
After vegetables	119	216	1.082
After alfalfa	122	217	1.078
Bio-M			
After vegetables	124	229	1.077
After alfalfa	140	245	1.076
Average			
After vegetables	191	321	1.079
After alfalfa	199	322	1.076
LSD (5%)	37		N.S.

Table 3. Inputs for potatoes growing under four management systems.

Inputs[1]	1985 H. Eng.	1985 ICM	1985 Bio	1985 Bio-M	1986 H. Eng.	1986 ICM	1986 Bio	1986 Bio-M
Primary Tillage	------Plow and Drag-------				------Plow and Drag-------			
<u>Nutrients</u>								
Manure - Ton/A	-	-	-	12	-	-	-	12
Rock Phosphate - lb/A	-	-	2000	-	-	-	-	-
Green Sand - lb/A	-	-	2000	-	-	-	-	-
Fertilizer N - lb/A	100-70[2]	95-55	-	-	100-50	100-50	-	-
Fertilizer P_2O_5 - lb/A	100	50	-	-	60	30	-	-
Fertilizer K_2O - lb/A	180	180	-	-	120	60	-	-
<u>Herbicide</u>[3]								
Lexone	1x[4]	1x	-	-	1x	1x	-	-
<u>Insecticide</u>								
Temik[5]	1x	1x	-	-	1x	1x	-	-
Sevin	2x	2x	-	-	-	-	-	-
Rotenone	-	-	2x	2x	-	-	3x	3x
<u>Fungicide</u>								
Dithane M-45	4x	2x	-	-	2x	1x	-	-
Tri. B. Copper	-	-	2x	2x	-	-	1x	1x
Cultivation	2x	2x	4x	4x	4x	4x	4x	4x
Irrigation	4x	4x	4x	4x	-	-	-	-
Hand Weeding Hours/A	6	6	20	20	5	5	34	34

[1]All "after vegetable" plots were plowed, dragged and planted to rye in late September. Alfalfa was seeded in late August, left in sod the following year and then plowed down in April just prior to planting to potatoes.

[2]The first value designates the nitrogen applied after vegetables and the second value for the N applied after alfalfa.

[3]All pesticides are applied at rates recommended in Michigan State University Extension Bulletins E-312 and E-433.

[4]"1x" indicates one application.

[5]Temik-15 G applied at planting time in row at the rate of 15 lb per A.

Funding: Federal Grant

Annual Report

Improved Production and Utilization Technology for Michigan Potatoes

USDA Project ORD. NO. 38543 and 40818

Sub Report: Tillage Management Systems

F. J. Pierce, R. W. Chase and K. A. Renner
Crop and Soil Sciences Department

Introduction

Quality improvement of potatoes represents the major objective of potato growers in Michigan. A major factor affecting potato quality is the physical condition of the soil in the zone of rooting and tuber development. Wind and water erosion are serious problems on the sandy and organic soils which dominate potato acreage in Michigan. Conventional practices for potato production in Michigan use cover crops for overwinter protection of soil and limit plowing to spring primary followed directly by planting to avoid excessive tillage and soil structure degradation. Michigan farmers, therefore, are well aware of the potential limitations of poor soil physical conditions and soil erosion. However, the potential for serious problems related to poor soil physical condition and erosion remain. Excessive traffic, often with heavy axle loads repeated over several years, has created compact soil conditions below the depth of normal tillage and degraded soil structure in the tillage zone. Soil erosion potential in Michigan from wind and water is highest during the period from tillage and planting to hilling or canopy closure when the soil is bare and unprotected.

The objective of this research is to develop and evaluate aternatives to existing tillage systems on sandy soils in Michigan that reduce potential for soil erosion and improve tuber quality and yield of potatoes. This is the second year of the study and results for both years are discussed.

Experimental Methods and Results:

1985

Tillage tools designed to subsoil in the row were evaluated in replicated experiments with conventional potato production methods. The intention was to restrict tillage in these systems to the zone in the potato row (zone tillage) and leave the interrow area untilled with a cover of standing rye as protection against wind and water erosion. The tillage treatments evaluated were as follows:

1. Conventional tillage - light disking, moldboard plowing followed immediately by planting

2. Conventional tillage preceded by subsoiling in the row with a Kelly subsoil unit

3. Bush Hog Ro-till - one pass (this is an in-the-row subsoiler equiped with surface tillage tools)

4. Bush Hog Ro-till - two passes

5. Paraplow in-the-row (a subsoiler that fractures the soil with minimal surface disturbance).

Results for 1985 were reported in the research report for the Montcalm Station for 1985. While not significant at the 5 percent level, showed trends for yields and tuber quality of Russet Burbank potatoes to increase with the use of zone tillage, with the paraplow showing the highest average yields (385 cwt/ac) and conventional tillage with in-the-row subsoiling the lowest yields (348 cwt./acre). A check of > 10 oz No. 1 potatoes showed an increased incidence of hollow heart. tissue analysis of potato petioles showed a significant increase in uptake of Zn and Mn in the Bush Hog Ro-till treatments. Measurements of population densities of root lesion nematodes (Paratylenchus penetrans) showed no effect of tillage treatments.

1986

Three experiments were initiated in fall of 1985 and spring of 1986 to further develop and evaluate these "zone tillage" systems for potato production.

Tillage Management

Tillage treatments were expanded from those used in 1985 to include the timing of zone tillage (spring vs fall), the use of surface rotary cultivation in-the-row after passage of the paraplow, and the use of a ridge cultivator for use in hilling potatoes. Treatments were as follows:

1. Paraplow fall in-the row.

2. Paraplow spring in-the row.

3. Paraplow spring with surface rotary cultivation both in-the row.

4. Bush Hog Ro-till in-the-row fall.

5. Bush Hog Ro-till in-the-row spring.

6. Bush Hog Ro-till in-the-row spring, hilling with ridge cultivator.

7. Conventional tillage - spring, light disking, moldboard plow.

Yields were higher in 1986 than in 1985. As was the case in 1985, yield of Russet Burbanks were improved with the use of zone tillage systems. Yields in the Paraplow (#1) and the Bush Hog (#4) spring treatments were highest, 424 and 413 cwt./ac respectively, and yields in the conventional tillage treatments were lowest, 346 cwt./ac. Conventional tillage was significantly lower at the 5 percent level than all other treatments. These data are summarized in Table 1.

Tuber quality was reduced over that recorded for 1985. Percent No 1's ranged from 55 % for the spring Bush Hog treatment (#5) to 49 % for conventional tillage compared to 70 and 63 %, respectively, for 1985. Tillage affected the distribution of tuber sizes. Conventional tillage produced smaller potatoes although the percentage of No 1 potatoes was not significantly different from other tillage systems. The trends in the data, while not significant, showed a tendency for fall zone tillage to produce higher total yields but spring zone tillage produced higher yields of No 1 potatoes.

Seeding Rate Study

The results from the 1985 tillage experiment suggested that seeding rate may be important when soil is prepared with zone tillage. Therefore, two seeding rates, 10 inch and 14 inch spacings, were evaluated in a split-plot design field experiment with tillage as the main plots. Tillage included conventional, Bush Hog Ro-till, and Paraplow treatments with all tillage done in the spring. Yields (Table 2) in this study showed no statistical difference between tillage treatments but Bush Hog and conventional treatments were higher than the paraplow, 507, 524, and 468 cwt./ac, respectively. There were no yield differences due to seeding rate, 504 and 496 cwt/ac for the 10 and 14 inch spacings, repsectively. Yields were higher in this experiment than the tillage management study where potatoes have been grown more frequently and more recently in the rotation cycle at the Moncalm farm.

Tuber quality was affected by both tillage and seeding rate as shown in Table 3. Seeding rate tended to alter the size distribution of tubers with the 10 " seeding rate producing more tubers in the smaller size ranges and less in the No. 1 > 10 oz size. Conventional tillage methods produced a significantly higher percentage of No 2 > 10 oz potatoes. Quality of potatoes was higher in this experiment than the tillage experiment where yield of No. 1 potatoes averaged 62 percent.

Rye-Kill Experiment

It was apparent from the 1985 experiment that the condition of the rye cover crop in terms of growth and degree of kill affected the performance of the tillage machinery. Therefore, in 1986 an experiment was set out to evaluate the timing and method of killing the rye. Zone tillage was performed with the Bush Hog Ro-till. Treatments included two rates of Roundup herbicide (3/8 and 3/4 pint) applied either 14 days preplant or immediately after planting and one rate of Paraquat applied either 2 days preplant or immediately after planting.

Visual rye injury and percent moisture evaluations were taken at planting and at hilling. Results are summarized in Table 4. Glyphosate applications fourteen days before planting gave the most visual rye injury and greatest rye moisture reduction. Paraquat application two days before planting gave 73% visual injury. Glyphosate and paraquat applications immediately after planting did not give complete control or the rye cover crop.

Visual observations were made of machinery performance confirmed observations made in 1985 that partial killing of the rye just prior to planting hindered performance of the tillage equipment. Where rye was killed with Roundup 14 days prior to planting, rye was completely killed and experienced little growth. Therefore, machinery was not affected by the rye. Where rye was killed after planting, machinery performed well with the exception of plots in low areas where soil moisture was high. It was our opinion that early killing of the rye was best for machinery performance but was both expensive and did not allow for sufficienct rye growth to insure erosion control. In all methods, all rye was gone after the hilling operation.

There were no significant effects of rye kill on potato yield as summarized in Table 5. Significant differences were evident and due to wet conditions in the lower areas of the field. The fourth rep of the experiment was not harvested due to excessive wet conditions and rotting of the potatoes in this area of the field.

Table 1. Yield of Russet Burbank as affected by tillage system in 1986.

Component	PPF\1	PPS	RTF	RTS	PPSRC	CONV	RTSDR
	CWT/ACRE						
< 4 oz	52.1	56.3	54.5	57.8	54.1	58.0	53.9
4 - 6 oz	56.3	63.8	54.5	64.0	58.9	61.8	60.5
6 - 10 oz	56.0a	53.1a	57.0a	63.1a	52.0a	40.6 b	53.8a
> 10 oz	27.1a	25.3a	26.5a	19.4a	18.5a	9.1 b	22.1a
No2 <10 oz	43.4ab	42.6ab	44.8ab	40.3ab	49.8a	39.8ab	37.1 b
No2 >10 oz	40.9a	26.4 bc	31.9ab	22.6 bc	25.3 bc	19.3 c	28.3 bc
Total yield	424a	411a	413a	410a	397a	346 b	393a
Yield No 1	214.0a	218.3a	212.0a	225.0a	198.9a	171.3 b	209.5a
% No 1	50.5	53.2	51.2	54.7	50.0	49.2	53.5

\1 See treatment descriptions in text under tillage management study for 1986. Numbers with the same letter within a row are not significantly different at the 5 % level using LSD criterion.

Table 2. Yield of Russet Burbank as affected by tillage and seeding rate in 1986.

Component	Tillage					
	Conv.		Bush Hog		Paraplow	
	cwt/ac					
< 4 oz	74.0a	60.1b	98.8a	75.1b	90.7a	68.4b
4 - 6 oz	107.8	98.8	117.2	111.8	112.2	95.9
6 - 10 oz	129.9	124.3	137.4	138.2	116.7	120.7
> 10 oz	75.1a	97.2b	66.7a	86.3b	49.8a	73.0b
No2 <10 oz	50.2	55.5	56.3	49.2	54.6	55.7
No2 >10 oz	67.2a	74.0a	55.3b	55.2b	52.1c	47.9c
Total yield cwt/ac	504	510	532	515	476	461
No 1 %	61.2	62.3	65.2	64.8	58.6	62.7

Numbers with the same letter within a row are not significantly different at the 5 % level using LSD criterion.

Table 3. Yield of Russet Burbank as affected by seed spacing in 1986.

Component	Plant Spacing	
	10 inch	14 inch
	%	
< 4 oz	17.6a	13.9b
4 - 6 oz	22.3	20.6
6 - 10 oz	25.3	25.7
> 10 oz	12.4a	17.0b
No2 <10 oz	10.8	11.0
No2 >10 oz	11.6	11.9
No 1	61.7	63.3
Total yield cwt/ac	504	496

Numbers with the same letter within a row are not significantly different at the 5 % level using LSD criterion.

TABLE 4.

CONTROL OF RYE-COVER CROP IN TILL-PLANTED POTATOES.

			4-25-86		6-16-86		9-18-86
HERBICIDE	RATE (LB AI/A)	APPL. TIME	VISUAL* RYE INJURY	% MOISTURE RYE	VISUAL RYE INJURY	% MOISTURE RYE	YIELD** (CWT/A)
GLYPHOSATE	0.38	14 DBP	90 A	36 C	100 A	42	390
X-77	1/2%	14 DBP					
GLYPHOSATE	0.75	14 DBP	90 A	40 C	100 A	44	425
X-77	1/2%	14 DBP					
GLYPHOSATE	0.38	AP	0 C	67 A	38 C	56	433
X-77	1/2%	AP					
GLYPHOSATE	0.75	AP	0 C	67 A	63 B	55	453
X-77	1/2%	AP					
PARAQUAT	0.50	2 DBP	73 B	58 B	93 A	44	451
X-77	1/4%	2 DBP					
PARAQUAT	0.50	AP	0 C	67 A	33 C	58	463
X-77	1/4%	AP					

*% MOISTURE OF ALL RYE PRESENT IN 2 SQ FT AREA.

**AVERAGE OF 3 REPS. ONLY.

STATISTICAL COMPARISONS ARE NOT VALID BETWEEN COLUMNS.

Table 5. Yield of Russet Burbank as affected by method and timing of rye kill in a zone tillage system in 1986.

Treatments:

1. R3/8Pr Roundup + X-77 at 3/8 # + 1/2 % 14 days preplant
2. R3/8Pr Roundup + X-77 at 3/4 # + 1/2 % 14 days preplant
3. R3/8Pr Roundup + X-77 at 3/8 # + 1/2 % post plant
4. R3/8Pr Roundup + X-77 at 3/4 # + 1/2 % post plant
5. P3/4P Paraquat + X-77 at 1/2 # + 1/4 % 2 days preplant
6. P3/4Po Paraquat + X-77 at 1/2 # + 1/4 % post plant

	Herbicide Treatment					
Component	R3/8Pr	R3/4Pr	R3/8Po	R3/4Po	P3/4P	P3/4Po
	CWT/ACRE					
< 4 oz	99.9	90.5	86.3	89.7	99.7	112.7
4 - 10 oz	180.1	219.6	217.0	226.3	228.0	226.3
> 10 oz	27.9	42.0	41.8	53.3	32.3	25.6
No. 2	82.0	72.8	87.6	84.0	90.7	98.4
Total yield	390	425	433	453	451	463
	%					
< 4oz	26.1	21.4	19.7	19.8	22.4	24.3
4 - 10 oz	46.5	51.6	50.0	49.9	50.2	48.8
> 10 oz	6.7	9.6	9.7	11.7	7.0	5.5
No. 2	20.7	17.3	20.6	18.5	20.4	21.3
No. 1	53.2	61.2	59.7	61.7	57.2	54.4

Funding: MPIC

Weed Control on Muck Soils and Variety Response to Herbicide Application and Time of Hilling

1986 Report to the Michigan Potato Industry Commission

K. A. Renner and R. W. Chase, Dept. of Crop and Soil Sciences

Preliminary Report (Year 1 of 2 year study)

Research in 1986 was conducted to:

1. Establish herbicide efficacy on muck soils
2. Evaluate swamp smartweed suppression in potatoes
3. Evaluate the interactions between hilling, potato variety response, and time of herbicide application on mineral soils.

Summary of Results:

1. Cinch (2.0 lb ai/A), Command (1.0 lb ai/A), and CGA-180937 (3.0 lb ai/A) provided acceptable season long grass control when applied preemergence (PRE) (at planting) or delayed preemergence (DPRE) (at potato cracking) (Table 1). Command injured the Frito Lay variety at the Allegan Co. location, but no injury occurred where the Atlantic variety was planted in Clinton Co (Table 2). Yields were not taken in Allegan Co. because of flooded conditions resulting in rotting of initial tubers and new tuber set. Sencor (Lexone) provided better redroot pigweed and barnyardgrass control than Lorox when these herbicides were applied PRE or DPRE (Table 3). Optimum Sencor (Lexone) timing appeared to be either a single DPRE application, or a split application of Sencor, with the grass herbicide tank-mixed with the DPRE application of Sencor (Table 4). Another year of research is needed for verification of these weed control results, and to determine tolerance of potatoes to Command herbicide.

2. Sencor (Lexone) when soil applied at 1.0 lb ai/A gave the best suppression of swamp smartweed (Table 5). Roundup and Banvel applied at various rates, timings, and combinations will be evaluated for swamp smartweed regrowth in the spring of 1987. Planned September applications were not made due to saturated soil conditions.

3. Early hilling on mineral soils followed by DPRE or postemergence herbicide applications gave excellent control of barnyardgrass, redroot pigweed, common lambsquarters, and Pennsylvania smartweed (Tables 6, 7, 8, and 9). On July 11, nine weeks after planting, there was no interaction between the time of hilling and the herbicide treatments for weed control evaluations. However a significant interaction between the time of hilling and herbicide treatments occurred for weed control evaluations taken in August and September. Barnyardgrass and common lambsquarters control was poor in August and September where Eptam (3.0 lb ai/A) was incorporated prior to planting followed by early hilling (EH) (at potato emergence) and then a delayed preemergence (DPRE) application of Lorox (1.0 lb ai/A) or Cobra (0.25 lb ai/A). When Sencor (Lexone) (0.5 lb ai/A) was applied DPRE after Eptam, weed control did not decrease when the treatment was early hilled. Sencor (Lexone) provided better barnyardgrass and common lambsquarters

control than Lorox or Cobra when the Eptam activity on these weeds had declined. A preemergence application of Dual + Lorox (2.0 + 1.0 lb ai/A) gave 37% control when early hilled, and 77% control when late hilled (40 days after planting, conventional practice). When this same treatment was applied DPRE (just prior to potato emergence) control of common lambsquarters was excellent throughout the season. All herbicide treatments provided excellent redroot pigweed control throughout the growing season except where Dual + Lorox was applied preemergence and early hilled (Table 8). Sencor (Lexone) was superior to Lorox or Cobra for Pennsylvania smartweed control when applied either DPRE or postemergence with Poast + COC (Table 9). When potatoes were EH a DPRE or postemergence treatment was necessary for maintaining broadspectrum weed control throughout the growing season. However the reduced weed control that began to occur with some treatments by late July was not reflected in potato yield.

Early visual injury on potatoes was noted for all Eptam treatments on the 'Atlantic' variety, especially when the Eptam was followed by Cobra (Table 10). This injury was not reflected in potato yield. There was no significant difference between yields of the 'Atlantic' variety in the seven herbicide treatments, but all herbicide treated plots yielded significantly greater than the untreated check. 'Russet Burbank' yields were significantly greater when herbicides were applied compared to the yield of the hilled-only check. However the yield of the 'Russet Burbank' in the Eptam plus Cobra treatments was significantly lower than the other herbicide treated plots. Double application rates of Dual + Sencor (Lexone) did not injure either potato variety in 1986. There was not a significant interaction between the time of hilling and herbicide treatment when potato yields were evaluated (Table 11). The increased weed growth evident in some of the herbicide treatments that were early hilled did not significantly reduce potato yield. It appeared that if weeds were controlled for the first 8 to 10 weeks after potato planting and then allowed to infest the potatoes, yields were not reduced. Further research in 1987 is necessary to determine if in fact weeds that emerge after mid July have no significant competitive effect on potatoes that is reflected in yield, and to determine if hilling time interactions with herbicice applications will repeat in 1987.

TABLE 1:

HERBICIDE EFFICACY AND POTATO YIELD ON ORGANIC SOILS.

HERBICIDE TREATMENT*	RATE (LB AI/A)	6-11 ANGR	9-9 ANGR	6-11 RRPW	9-9 RRPW	YIELD (CWT/A)
		------------(% CONTROL)------				
DUAL + SEN/LEX	2.5 + 1.0	97 AB	77 ABC	100 A	93 A	269 A-F
COMMAND + SEN/LEX	1.0 + 1.0	90 AB	80 AB	100 A	87 A	254 A-H
CINCH + SEN/LEX	1.0 + 1.0	93 AB	77 ABC	100 A	93 A	209 F-I
CINCH + SEN/LEX	2.0 + 1.0	93 AB	70 ABC	100 A	100 A	267 A-F
CGA-180937 + SEN/LEX	3.0 + 1.0	90 ABC	83 AB	100 A	100 A	318 AB
SAN-582 + SEN/LEX	1.5 + 1.0	83 BC	63 BC	100 A	90 A	283 A-E
SEN/LEX + (POAST + COC)	1.0 + (0.2 + 1 QT)	97 AB	90 AB	100 A	100 A	290 A-E
SEN/LEX + (SEN/LEX + POAST + COC)	0.5 + (0.5 + 0.2 + 1 QT)	90 ABC	87 AB	100 A	93 A	247 C-H
CHECK	-	0 E	27 DE	0 C	0 D	75 I

*ALL HERBICIDES APPLIED PRE. ( ) DENOTES POST APPLICATION.

STATISTICAL COMPARISONS ARE NOT VALID BETWEEN COLUMNS.

TABLE 2:

POTATO TOLERANCE TO NEW GRASS HERBICIDES.

HERBICIDE*	APPL. RATE (LB AI/A)	APPL. TIME	6-11-86 ALLEGAN CO.	6-11-86 CLINTON CO.
			------% VISUAL INJURY----	
DUAL	2.5	PRE	0 D	0 D
		DPRE	0 D	3 CD
CINCH	1.0	PRE	0 D	10 BC
		DPRE	0 D	0 D
CINCH	2.0	PRE	0 D	3 CD
		DPRE	0 D	0 D
COMMAND	1.0	PRE	17 B	0 D
		DPRE	30 A	7 CD
CGA 180937	3.0	PRE	0 D	0 D
SAN-582	1.5	PRE	0 D	2 D

*1.0 LB AI/A OF SENCOR (LEXONE) WAS APPLIED WITH ALL HERBICIDE TREATMENTS.

STATISTICAL COMPARISONS BETWEEN COLUMNS ARE VALID.

TABLE 3:

HERBICIDE EFFICACY AND POTATO YIELD ON ORGANIC SOILS.

HERBICIDE	RATE (LB AI/A)	APPL. TIME	6-11 ANGR	9-9 ANGR	6-11 RRPW	9-9 RRPW	YIELD (CWT/A)
			------------(%)-----------				
SEN/LEX	1.0	PRE	77 C	47 CD	93 A	90 A	198 G-I
LOROX	1.5	PRE	50 D	23 DC	77 B	63 C	193 HI
SEN/LEX	1.0	DPRE	100 A	83 AB	100 A	97 A	246 C-H
LOROX	1.5	DPRE	93 AB	62 BC	100 A	93 A	228 D-I
CHECK	-	-	0 E	27 DE	0 C	0 D	75 I

STATISTICAL COMPARISONS ARE NOT VALID BETWEEN COLUMN.

TABLE 4:

SENCOR (LEXONE) TIMING ON ORGANIC SOILS.

APPL. RATE (LB AI/A)	APPL. TIME	6-11-86 ANGR	6-11-86 RRPW	9-9-86 ANGR	9-9-86 RRPW	9-18-86 YIELD (CWT/A)
		----------% CONTROL-------				
1.0	PRE	93 B	97 B	76 B	93 A	250 A
1.0	DPRE	100 A	100 A	93 A	98 A	286 A
*G + 0.5 + (0.5)	PRE + DPRE	99 A	100 A	83 AB	82 B	268 A
0.5 + (G + 0.5)	PRE + DPRE	100 A	100 A	86 B	93 A	265 A

*G = GRASS HERBICIDE.

STATISTICAL COMPARISONS BETWEEN COLUMNS ARE NOT VALID.

Table 5:

Suppression of swamp smartweed on fallow ground.

*TREAT-NUMBER	PESTICIDE NAME	RATE LB/A	APPLICATION TIMING	7/23/86 SWSM	8/11/86 SWSM	9/25/86 SWSM
01	Lorox DF	1.50	May	0.0	4.0	3.3
02	Lexone DF	1.00	May	3.3	7.0	6.7
03	Command	1.00	May	0.0	3.0	1.7
04	Cinch	2.00	May	0.0	0.7	0.8
05	Roundup	3 QT	June	6.8	9.5	8.5
06	Roundup	4 QT	June	8.1	9.7	9.0
07	Roundup	2 QT	June	8.0	9.7	8.8
08	Banvel II	1 QT	June	10.0	9.5	8.7
*09	Roundup	1 QT	June	9.3	9.7	9.7
09	Banvel	1 QT	June			
09	X-77	1/2%	June			
*10	Roundup	2 QT	June	10.0	9.7	9.2
10	Banvel	1 QT	June			
10	X-77	1/2%	June			
11	Roundup	3 QT	August	-	-	8.8
12	Roundup	4 QT	August	-	-	9.3
13	Roundup	2 QT	August	-	-	7.8
13	Roundup	2 QT	September			
14	Banvel	1 QT	August	-	-	10.0
*15	Roundup	1 QT	August	-	-	10.0
15	Banvel	1 QT	August			
15	X-77	1/2%	August			
*16	Roundup	2 QT	August	-	-	9.8
16	Banvel	1 QT	August			
16	X-77	1/2%	August			
17	No Treatment	-	-	0.0	0.0	0.0

*Treatment 1-8, 11-14 - 23 gpa, 30 psi.
Treatment 9-10, 15-16 - 11.5 gpa, 30 psi.

Table 6:

Barnyardgrass Control During the Growing Season

Herbicide	Rate (lb ai/a)	Appl Time	% Control 7-11-86 EHLH	8-14-86 EH	8-14-86 LH	9-9-86 EH	9-9-86 LH
Eptam + (Sen/Lex)	3.0 + (0.5)	PPI + (DPRE)	97 a	98 a	97 a	85 ab	92 a
Eptam + (Lorox)	3.0 + (1.0)	PPI + (DPRE)	93 a	73 b	95 a	62 b	93 a
Eptam + (Cobra)	3.0 + (0.25)	PPI + (DPRE)	90 a	47 c	87 ab	20 cd	78 ab
Dual + Sen/Lex +	2.0 + 0.5 +	PRE +					
(Dual + Sen/Lex)	(2.0 + 0.5)	(DPRE)	100 a	100 a	100 a	100 a	100 a
Dual + Lorox	2.0 + 0.5	PRE	100 a	87 ab	97 a	87 a	90 a
[Poast + Sen/Lex +	[0.2 + 0.5 +						
COC*]	1 pt]	[POST]	100 a	93 a	95 a	92 a	75 ab
(Dual + Lorox)	(2.0 + 1.0)	(DPRE)	97 a	93 a	100 a	95 a	99 a
Hill only	-	-	12 b	17 d	33 cd	0 d	27 c

*COC = Crop Oil Concentrate.

Statistical comparisons are valid only between columns 2 and 3, and columns 4 and 5.

TABLE 7:

REDROOT PIGWEED CONTROL DURING THE GROWING SEASON.

HERBICIDE	RATE (LB AI/A)	APPL TIME	% CONTROL 7-11-86 EHLH	8-14-86 EH	8-14-86 LH	9-9-86 EHLH
EPTAM + (SEN/LEX)	3.0 + (0.5)	PPI + (DPRE)	100 A	100 A	100 A	93 A
EPTAM + (LOROX)	3.0 + (1.0)	PPI + (DPRE)	100 A	95 A	100 A	86 A
EPTAM + (COBRA)	3.0 + (0.25)	PPI + (DPRE)	100 A	97 A	100 A	96 A
DUAL + SEN/LEX + (DUAL + SEN/LEX)	2.0 + 0.5 + (2.0 + 0.5)	PRE + (DPRE)	100 A	100 A	100 A	98 A
DUAL + LOROX	2.0 + 0.5	PRE	93 A	50 B	87 A	68 B
[POAST + SEN/LEX + COC*]	[0.2 + 0.5 + 1 PT]	[POST]	100 A	100 A	100 A	94 A
(DUAL + LOROX)	(2.0 + 1.0)	(DPRE)	100 A	97 A	100 A	92 A
HILL ONLY	-	-	23 B	17 D	33 C	13 C

*COC = CROP OIL CONCENTRATE.

STATISTICAL COMPARISON ARE VALID ONLY BETWEEN COLUMNS 2 AND 3.

TABLE 8:

COMMON LAMBSQUARTERS CONTROL DURING THE GROWING SEASON.

			% CONTROL				
	RATE	APPL	7-11-86	8-14-86		9-9-86	
HERBICIDE	(LB AI/A)	TIME	EHLH	EH	LH	EH	LH
EPTAM + (SEN/LEX)	3.0 + (0.5)	PPI + (DPRE)	100 A	100 A	100 A	100 A	98 A
EPTAM + (LOROX)	3.0 + (1.0)	PPI + (DPRE)	100 A	100 A	100 A	100 A	100 A
EPTAM + (COBRA)	3.0 + (0.25)	PPI + (DPRE)	100 A	57 BC	100 A	60 BC	98 A
DUAL + SEN/LEX + (DUAL + SEN/LEX)	2.0 + 0.5 + (2.0 + 0.5)	PRE + (DPRE)	100 A	100 A	97 A	100 A	100 A
DUAL + LOROX	2.0 + 0.5	PRE	87 B	37 CD	77 AB	43 CD	78 AB
[POAST + SEN/LEX + COC*]	[0.2 + 0.5 + 1 PT]	[POST]	100 A	100 A	100 A	100 A	98 A
(DUAL + LOROX)	(2.0 + 1.0)	(DPRE)	100 A	100 A	100 A	100 A	99 A
HILL ONLY	-	-	11 C	17 D	33 D	0 E	27 D

*COC = CROP OIL CONCENTRATE.

STATISTICAL COMPARISONS ARE VALID ONLY BETWEEN COLUMNS 2 AND 3, AND COLUMNS 4 AND 5.

TABLE 9:

PENNSYLVANIA SMARTWEED CONTROL DURING THE GROWING SEASON.

HERBICIDE	RATE (LB AI/A)	APPL TIME	% CONTROL 7-11-86 EHLH	8-14-86 EH	8-14-86 LH	9-9-86 EH	9-9-86 LH
EPTAM + (SEN/LEX)	3.0 + (0.5)	PPI + (DPRE)	100 A	100 A	100 A	98 A	98 A
EPTAM + (LOROX)	3.0 + (1.0)	PPI + (DPRE)	97 A	70 B	98 A	57 CD	78 ABC
EPTAM + (COBRA)	3.0 + (0.25)	PPI + (DPRE)	93 A	23 CD	80 B	7 FG	65 BCD
DUAL + SEN/LEX + (DUAL + SEN/LEX)	2.0 + 0.5 + (2.0 + 0.5)	PRE + (DPRE)	100 A	100 A	100 A	100 A	100 A
DUAL + LOROX	2.0 + 0.5	PRE	97 A	37 C	40 C	43 DE	33 E
[POAST + SEN/LEX + COC*]	[0.2 + 0.5 + 1 PT]	[POST]	100 A	100 A	100 A	100 A	93 A
(DUAL + LOROX)	(2.0 + 1.0)	(DPRE)	100 A	83 AB	100 A	78 ABC	88 AB
HILL ONLY	-	-	28 B	17 D	33 CD	0 G	27 EF

*COC = CROP OIL CONCENTRATE.

STATISTICAL COMPARISONS ARE VALID ONLY BETWEEN COLUMNS 2 AND 3, AND COLUMNS 4 AND 5.

TABLE 10:

INJURY EVALUATION AND POTATO YIELD.

HERBICIDE	RATE (LB AI/A)	APPL. TIME	% VISUAL INJURY 6-2-86		YIELD (CWT/A) 10-3-86	
			ATL	RB	ATL	RB
EPTAM + (SEN/LEX)	3.0 + (0.5)	PPI + (DPRE)	10 B	0 C	515 AB	523 AB
EPTAM + (LOROX)	3.0 + (1.0)	PPI + (DPRE)	12 B	0 C	513 AB	505 AB
EPTAM + (COBRA)	3.0 + (0.25)	PPI + (DPRE)	20 A	2 C	527 A	453 CD
DUAL + SEN/LEX + (DUAL + SEN/LEX)	2.0 + 0.5 + (2.0 + 0.5)	PRE + (DPRE)	3 C	3 C	494 ABC	496 ABC
DUAL + LOROX	2.0 + 1.0	PRE	0 C	0 C	495 ABC	474 BCD
[POAST + SEN/LEX + COC*]	[0.2 + 0.5 + 1 PT]	[POST]	8 C	0 C	513 AB	528 A
(DUAL + LOROX)	(2.0 + 1.0)	(DPRE)	0 C	0 C	525 AB	487 ABCD
HILL ONLY	-	-	0 C	0 C	444 D	339 E

*COC = CROP OIL CONCENTRATE.

STATISTICAL COMPARISONS ARE VALID BETWEEN COLUMNS 1 AND 2, AND BETWEEN COLUMNS 3 AND 4.

Table 11:

Timing of hilling had no significant effect on potato yield.

Herbicide	(lb ai/A)	Appl. Time	Yield (cwt/A) Atlantic EH	Atlantic LH	Russet B EH	Russet B LH
Eptam + (Sen/Lex)	3.0 + (0.5)	PPI + (DPRE)	501	528	501	544
Eptam + (Lorox)	3.0 + (1.0)	PPI + (DPRE)	494	532	512	497
Eptam + (Cobra)	3.0 + (0.25)	PPI + (DPRE)	495	559	435	472
Dual + Sen/Lex + (Dual + Sen/Lex)	2 + 0.5 + (2.0 + 0.5)	PRE + (DPRE)	487	502	493	498
Dual + Lorox	2.0 + 1.0	PRE	474	516	469	478
[Poast + Sen/Lex + COC*]	[0.2 + 0.5 + 1 pt]	[POST]	542	483	525	532
(Dual + Lorox)	(2.0 + 1.0)	(DPRE)	521	529	487	488
Hill Only	-	-	433	456	307	372

*COC = Crop oil concentrate.

Statistical comparisons are valid between columns 1 and 2, and between columns 3 and 4.

Funding: MPIC

NITROGEN STUDIES ON RUSSET BURBANK POTATOES IN THE UPPER PENINSULA

R.H. Leep and D.L. Pellegrini
Michigan State University

The objective of this study is to determine the effect of nitrogen rates on Russet Burbank potatoes grown in the Upper Peninsula. The end result of this study will determine the most efficient rate of applied nitrogen upon Russet Burbank potatoes grown in rotations following either alfalfa or clover plowdown. Variables which are being analyzed include tuber yield, size distribution, specific gravity, nitrogen concentration, foliage growth and quality.

The study was established on the Valare VanDamme farm in Delta County on an Onaway loam. The previous plowdown crop was a mixture of alfalfa and clover. The nitrogen carrier used was ammonium nitrate and was applied on June 10 at first cultivation shortly after emergence. No preplant nitrogen was applied, however, 1,500 pounds/acre of 0-20-20 was applied to this field. Specific treatments are given in Tables 1 and 2. Each treatment was replicated four times. Plot size was four rows by 50 feet.

Tissue sampling of young mature leaves was done on July 21 and August 18 and analyzed for nitrate-N content. The nitrate-N content of the tissue was not significantly affected by nitrogen treatments in the first sampling, however, it was significantly affected in the second sampling. Since the normal rate of nitrogen losses due to leaching was the same for all treatments the data would suggest that more nitrogen is available later in the growing season from the higher nitrogen rates.

Increasing nitrogen rates above 50 pounds N/acre did not significantly increase total yield. Specific gravity decreased with increasing nitrogen rates. These data indicate that increasing nitrogen rates above 50 pounds N/acre did not increase yields significantly at the general yield levels of 300 cwt/acre. However, plant stands in this field were not optimum with several "skips" occurring which resulted in overall lowered yields. Poor stands resulted from extreme dry soil conditions in the area where this study was conducted.

In summary, potato yields were not affected by increasing nitrogen rates above 50 pounds N/acre immediately following a legume mixture of alfalfa-clover. Specific gravity decreased significantly only with the 400 lb nitrogen rate. Nitrate concentration in leaves increased with increasing rates of applied nitrogen. Because of poor stands overall yields were lower than expected.

Table 1. Influence of nitrogen fertilizer rates on nitrate-N concentration in petioles-leaves of potatoes grown in the Upper Peninsula[a].

Nitrogen Rate[b] lb. N/A	Nitrate N in Leaves and Petioles Mg NO_3-N/Kg Dry Tissue	
50	6575	1755
100	7865	2867
200	7517	3627
400	8275	4125
LSD (.05)	n.s.	358

[a]The youngest mature leaves were collected on July 21 and August 18, respectively.

[b]All nitrogen was applied sidedressed as ammonium nitrate on June 10 just as potatoes had emerged.

Table 2. Influence of nitrogen fertilizer rates upon the yield, size distribution and specific gravity upon Russet Burbank potatoes in the Upper Peninsula.

	Yields cwt/A		Percent Size Distribution					
Nitrogen Rate[a] lb. N/A	Total	No. 1	No. 1	Under 2"	2" to 3¼"	Over 3¼"	Pick Outs	Specific Gravity
50	297	220	73	6	44	29	21	1.080
100	312	244	77	7	51	26	16	1.076
200	292	209	71	7	39	33	21	1.073
400	316	219	68	6	43	25	26	1.071
LSD (.05)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	9	.008

[a]All nitrogen was applied sidedressed as ammonium nitrate on June 10 just as potatoes had emerged.

Funding: MPIC

NITROGEN USE EFFICIENCY STUDY WITH RUSSET BURBANK

M.L. Vitosh, D.A. Hyde, B.P. Darling, and J. Thorburn

Introduction

Nitrate contamination of groundwater is a very critical issue facing the Michigan potato growers. Before legislation is enacted to limit the amount of nitrogen fertilizer used on potatoes, there is a need to demonstrate alternatives methods of supplying nitrogen to the potato crop to improve nitrogen use efficiency and decrease potential leaching of nitrates to groundwater.

Current research data is needed to show that certain strategies of nitrogen fertilization will result in minimal contamination of groundwater. Potatoes are a shallow rooted crop fertilized with relatively high rates of nitrogen fertilizer. This problem is of great concern to the potato growers as well as each of their neighbors.

The primary objective of the study are to develop alternative strategies for meeting the nitrogen requirements of the potato crop.

Procedure

A long term study was initiated in 1986 at the Montcalm Research farm to evaluate different strategies for nitrogen management. A rotation sequence of potatoes-corn-small grain will be established. The potato part of the rotation was established in 1986. There were 6 nitrogen treatments (2 nitrogen rates and 4 splits). The split applications were; May 8, June 13, July 14, and August 13. In 1987 corn will be grown in the same area without additional nitrogen fertilizer and without irrigation to pick up any residual N that might be left from the 1986 potato crop.

Soil samples were taken to a depth of 3 feet prior to the experiment and after the experiment. They were analyzed for ammonium and nitrate to determine residual N levels in the soil prior to planting and to determine how much N fertilizer was left at the end of the season.

1986 Results

The potato yield data is shown in Table 1. Very little response was shown to N fertilizer additions over the first 120 lb rate. Through statistical analysis it was determined that only off-type tuber yield was affected by nitrogen. At the 240 lb rate, the August 15 application of N fertilizer appeared to cause an increase in off-type tubers. No differences due to the late application on August 15 were observed at the 180 lb N rate.

There was a great deal of variability in large size tubers (over 10 oz.) and in the 4-10 oz. class. The coefficients of variation for large size tubers was 38 percent, making it impossible for us to predict significant differences. Some of this variability may be explained by a relatively thin stand as indicated by the stand counts on June 20. These data are shown in Table 2. Although the stands appear to be relatively uniform this count per 100 feet represents a 15 inch spacing. Due to wet, cool conditions soon after planting some seed pieces were lost due to decay.

Table 2 also contains information about petiole nitrate contents on August 13 just prior to the last application of N fertilizer. The differences detected by our statistical analysis can not be easily explained. Treatments 1 and 3 as well as 2 and 4 had identical treatments at the time of sampling but yet they show significantly different levels of nitrates in the petioles. The July 15 application showed an increase in nitrate concentration for only 1 of the 3 treatments.

Tuber nitrate was very low and unaffected by rate or timing of nitrogen fertilizer. Specific gravity of tubers was unaffected by the treatments.

Table 3 shows soil nitrate and ammonium data for both the spring and fall samplings. Relatively small amounts of nitrate and ammonium were found in the 3 foot profile prior to any additions of nitrogen fertilizer. On the average, 1.4 ppm of NO_3-N and 1.1 ppm NH_4-N was found in the experimental area to a depth of 3 feet. This represents 17 lbs of NO_3-N and 13 lbs of NH_4 or a total of 30 lbs of residual N per acre. Most of this nitrogen was found at the 0-12 inch level, which would have been readily available to the 1986 potato crop. This may help to explain why no response was obtained to N additions above the 120 lb rate.

The fall samplings were taken on October 1 after nearly 16 inches of rain in September. Yet, the data shows even greater amounts of nitrate in the 3 foot profile. On the average the experimental site gained 15 ppm of NO_3-N or 18 lbs of N leaving 35 lbs (17 + 18) of NO_3-N in the profile after harvest. These plots will be sampled again in the spring to see how much of the 35 lbs of N remains. The amount of NH_4-N decreased and it will be interesting to see if it will build back up by spring of 1987.

In conclusion, significant responses to N fertilizer were not obtained in this study even though relatively low levels of residual N were left in the profile from the previous year. The advantages or disadvantages of the various split application will need further study.

Table 1. The effect of nitrogen rate and time of application on yield a quality of Russet Burbank potaotes.

Time of Nitrogen Application1					Size Distribution					
5-15	6-15	7-15	8-15	Total	Off2/ Type	Under 4 Oz.	4-10 Oz.	Over 10 Oz	U. S. No. 1	Total Yield
lb N/acre					cwt/acre					
60	60	-	-	120	47	116	208	28	235	398
60	60	60	-	180	53	126	189	19	208	386
60	60	-	60	180	41	120	205	24	229	390
60	60	60	60	240	61	112	211	30	240	414
120	60	60	-	240	40	129	198	31	229	399
120	60	-	60	240	72	96	199	40	239	407

1/ All treatments received 60 lb of N/acre through the planter at planting time all other amounts of N fertilizer were topdressed as ammonium nitrate over the row.

2/ Means followed by the same letter are not significatly different as determined by the Duncans Multiple Range test (p=.05).

Table 2. The effect of nitrogen rate and time of application on plant stand, tuber and petiole nitrate content and specific gravity of Russet Burbank potatoes.

Time of Nitrogen Application 1/					Plant 2/ Stand	Petiole3/ Nitrate	Tuber Nitrate	Tuber Specific Gravity
5-15	6-15	7-15	8-15	Total				
lb N/acre					plt/100'	-ppm-	-ppm-	g/cc
60	60	-	-	120	78	15325	8.25	1.077
60	60	60	-	180	79	15225	9.75	1.075
60	60	-	60	180	78	11350	6.25	1.077
60	60	60	60	240	79	17775	6.50	1.076
120	60	60	-	240	80	12275	6.75	1.077
120	60	-	60	240	77	19075	9.00	1.075

1/ All treatments received 60 lb of N/acre through the planter at planting time all other amounts of N fertilizer were topdressed as ammonium nitrate over the row.

2/ Plant stand was taken on June 20, 1986.

3/ Means followed by the same letter are not significantly different as determined by the Duncans Multiple Range test (p=.05).

Table 3. Spring and fall soil nitrate and ammonium levels as influenced by rates and time of nitrogen fertilizer applications to potatoes.

Dates of application						Spring 1/		Fall 2/		Difference 3/	
5/8	6/13	6/14	8/13	Total N	Soil Depth	NO3-N	NH4-N	NO3-N	NH4-N	NO3-N	NH4-N
--------lb/acre---------											
60	60	60		120	0-12	2.21	2.05	3.80	0.38	1.59	-1.66
					12-24	0.97	0.61	2.20	0.28	1.23	-0.34
					24-36	0.81	0.35	1.53	0.39	0.72	0.04
					Average	1.33	1.00	2.51	0.35	1.18	-0.65
60	60	60	60	180	0-12	2.48	1.52	5.50	0.27	3.02	-1.25
					12-24	1.53	0.68	3.76	0.27	2.23	-0.41
					24-36	1.49	0.34	3.55	0.31	2.06	-0.02
					Average	1.83	0.85	4.27	0.28	2.43	-0.56
120	60	0	0	180	0-12	2.56	1.83	3.86	0.34	1.30	-1.50
					12-24	1.10	0.80	2.28	0.34	1.18	-0.46
					24-36	1.00	0.37	1.39	0.42	0.39	0.06
					Average	1.55	1.00	2.51	0.37	0.96	-0.63
120	60	60	60	240	0-12	2.32	1.91	3.58	0.38	1.27	-1.53
					12-24	1.20	0.62	2.64	0.19	1.43	-0.42
					24-36	1.27	0.37	1.99	0.56	0.72	0.19
					Average	1.60	0.97	2.74	0.38	1.14	-0.59
60	120	0	0	180	0-12	2.67	1.74	4.14	0.32	1.47	-1.42
					12-24	1.32	0.71	2.34	0.23	1.02	-0.48
					24-36	1.16	0.36	1.13	0.29	-0.03	-0.07
					Average	1.72	0.94	2.54	0.28	0.82	-0.66
60	120	60	0	240	0-12	2.53	2.27	4.25	0.53	1.72	-1.74
					12-24	0.96	0.64	2.79	0.26	1.83	-0.37
					24-36	0.70	0.32	1.77	0.39	1.07	0.07
					Average	1.40	1.08	2.94	0.39	1.54	-0.68

1/ Sampled April 14, 1986.
2/ Sampled October 1, 1986.
3/ Gain or loss of soil N between the spring and fall sampling dates.

Funding: MPIC

THE INFLUENCE OF METHAM CHEMIGATION AND NITROGEN ON YIELD AND QUALITY OF RUSSET BURBANK POTATOES

M. L. Vitosh and G. W. Bird
Department of Crop and Soil Sciences and Entomology

The objectives of this study were: 1. to determine the nitrogen fertilizer requirements of Russet Burbank potatoes treated with metham by chemigation and 2. to study the interaction effects of nitrogen and metham on tuber size and quality.

Two farm cooperater's were selected who had applied metham in the fall of 1985 by chemigation. Both sites were located in Montcalm County on irrigated sandy soils. Rye was the previous crop at both locations. Vapam was applied at 50 gallons per acre to one half or more of the pivot area. Plots were established on both treated and untreated areas shortly after plant emergence. Plots were selected with uniform stands. one row was selected for each replication so that all nitrogen treatments were randomized within each row or replication. A large area between chemigated and unchemigated plots was not used to make sure there was no mixing of treated and untreated areas. The experiment was analyzed as a split plot design, where the fumigant treatments were considered as whole plots and nitrogen treatments were the sub-plots.

At experimental site # 1, 1000 lb 6-24-24 fertilizer per acre was applied at planting with Thimet as the systemic insecticide. At site # 2, 150 lb N per acre was applied at planting with Thimet as the systemic insecticide. The entire experimental area was staked and no additional N was applied to the area by the grower. All sidedress N was applied just prior to hilling. All plots received sidedress N as ammonium nitrate except one which received calcium nitrate. This treatment supplied 300 or 188 lb calcium per acre for sites 1 and 2, respectively. The last N treatment received an equivalent amount of calcium from Gypsum.

Plant petiole samples were taken for nitrate analysis on July 14. Tubers were sampled on August 4 and analyzed for nitrates using the nitrate paper test. Yields were hand harvested on October 8-10 and sized. Specific gravity and nitrate analysis were determined later in the laboratory.

RESULTS AND DISCUSSION

TUBER YIELD AND SIZE

Tuber yield and size distribution data for the two studies are shown in Tables 1 and 2.

EXPERIMENT SITE # 1 (Table 1.)

Metham had a very significant affect on plant growth which was evident shortly after plant emergence. The increased plant growth also resulted in an increase in large tubers over 10 oz., 4-10 oz. size tubers , U.S. # 1 tubers and total yield. Metham increased the U. S. No. 1 yield by 127 cwt per acre. Nitrogen response was considerable less, giving only a significant increase in large size tubers and U. S. No. 1 tubers. Most of the increase in size was observed with the 60 and 120 lb N rates. Small size tubers (less than 4 oz.) were greatest with no sidedress N.

EXPERIMENT SITE # 2 (Table 2.)

Metham had a similar effect at this site, significantly increasing large size tubers, U. S. No. 1 tubers, 4-10 oz. tubers and total yield. U. S. No. 1 yield was increased with metham by 78 cwt per acre. The yield of small tubers was significantly decreased with metham. Significant Nitrogen responses were again limited. The zero N rate and the calcium nitrate treatment had the smallest yield of larger sizer tubers. Significant interactions between N and metham were detected for off-type and large size tubers. Increasing the N rate significantly increased off-type tubers without metham but not when metham was applied. Gypsum significantly increased large size tubers when metham was present but not when it was absent.

NITRATE CONTENT AND SPECIFIC GRAVITY

Tables 3 and 4 contain data for, nitrate content of potato petioles during mid-season, nitrate content of tubers at harvest time and specific gravity of tubers at harvest.

EXPERIMENTAL SITE # 1 (Table 3.)

Petiole nitrate content was significantly increased by 180 and 240 lb N over the three lower N rates. Metham did not significantly affect petiole or tuber nitrate content. Calcium nitrate significantly increased the nitrate content of potato tubers, but all nitrate levels are considered to be very low. Specific gravity was not affected by the N treatments, but metham increased the specific gravity greatly (.005 g/cc increase).

EXPERIMENTAL SITE # 2 (Table 4.)

The nitrate content of potato petioles was considerably higher at this site, probably due to the higher rate of N at planting time. Petiole nitrate content of the zero sidedress N rate was significantly lower than the other N rates. Petiole nitrate content was not affected by chemigation of metham. Specific gravity was again significantly increased by metham (.005 g/cc increase). Tuber nitrate was very low and unaffected by any of the treatments.

ECONOMIC ANALYSIS

Tabes 5 and 6 contain economic information on these two experiment. Net income represents total income minus the cost of the treatments applied in the study. Treatment costs were calculated using $.20 /lb for N from ammonium nitrate and $.30 /lb for N from Calcium nitrate, $10.00 per acre for Gypsum and $200 per acre for Vapam. The prices used for potatoes were $8.00 /cwt for tuber over 10 oz., $5.50 /cwt for 4-10 oz. tubers, $3.00 /cwt for off-type tubers and $1.50 /cwt for tuber less the 4 oz. No adjustment was made for specific gravity.

EXPERIMENTAL SITE # 1 (Table 5.)

Even though the cost of the chemigation treatment appears to be very costly, it proved to be very profitable on this farm. When averaged of all N treatments a profit of $631 per acre was realized. Maximum profit was obtained with metham and 240 lb N from either ammonium nitrate or calcium nitrate. This represents a net return of more than $1000 for an investment of $248 for metham and ammonium nitrate

EXPERIMENTAL SITE # 2 (Table 6.)

Because of the lower yields, the net income for this study was considerably less ($458 to $1008 less) than the previous study. Nevertheless, metham was profitable in this study. When averaged over all N treatments, a profit of $254 was obtained. The calcium nitrate in this study appeared to be the least profitable treatment due to it's higher cost and lack of yield improvement over the other N treatments. The Gypsum treatment with metham gave the maximum profit but none of values are statistically significant at the 95% probability level.

SOFT ROT EVALUATION

Tubers from the highest N rate treatments were injected with a small amount of the soft rot organism, E. caratovora and incubated in a plastic bag for 96 hours. The diameter of decay was then measure. A combined analysis of variance was made on the data for the two experiments. The data are shown in Table 7.

Tubers from experimental site # 1 had significantly more decay. Soil calcium levels ranged from 640 and 960 lb Ca/acre for site # 1 and from 800 to 1360 lb Ca/acre for site #2. Wisconsin has reported significant improvement in resistance to infection due to calcium additions to the soils testing less than 700 lb Ca/acre. Calcium from either calcium nitrate fertilizer or Gypsum decreased the amount of decay. Metham did not significantly affect the amount of decay. Addition research on the influence of calcium for reducing the infection of soft rot is needed to determine how significant these findings are.

SUMMARY

1. Metham significantly increased tuber size, specific gravity and yield at both locations. Nitrogen requirements for potatoes treated with or without metham were similar.

2. Although the cost of chemigation with metham is expensive, net income was more than enough to pay for the cost of the material in these two studies.

3. The response to nitrogen in both of these studies was small compared to the response from metham. The greatest response to nitrogen was obtained when metham was used. Nitrogen had it's greatest affect on increasing tuber size.

4. Calcium from calcium nitrate fertilizer or Gypsum did not significantly affect tuber size or yield at either location. Calcium additions did increase the resistance to decay by soft rot.

5. Tuber nitrate was unaffected by any of the treatments used in these experiments.

6. The first increment of sidedress N fertilizer increased the petiole nitrate level. Additional N did not increase the petiole nitrate

7. Specific gravity of tubers was unaffected by any of the N treatments.

Table 1. The effect of metham and sidedress nitrogen on yield and quality of Russet Burbank potaotes. Experimental site # 1.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Off Type	Under 4 Oz.	4-10 Oz.	Over 10 Oz.	U. S. No. 1	Total Yield
lb N/acre			cwt/acre					
0	Without	A. N.	4.7	125	252	2	255	384
60	"	A. N.	15.2	88	265	12	277	381
120	"	A. N.	18.0	104	278	20	299	421
180	"	A. N.	22.7	74	270	45	315	412
240	"	A. N.	43.3	71	241	38	278	392
240	"	C. N.	16.6	85	285	44	328	430
240	"	A. N.+Gypsum	27.2	92	301	30	330	450
0	With	A. N.	6.4	135	325	38	362	505
60	"	A. N.	29.3	92	354	56	410	531
120	"	A. N.	15.5	96	361	79	439	551
180	"	A. N.	8.6	97	344	95	439	544
240	"	A. N.	4.1	84	360	107	467	555
240	"	C. N.	21.1	83	327	127	454	558
240	"	A. N.+Gypsum	12.0	98	315	89	404	514
				Treatment Means 4/				
	Without Metham		21.1	91	270 a	27 b	298 b	410 b
	With Metham		13.9	98	341 b	84 a	425 a	537 a
0	-	A. N.	5.5	130 a	289	20 d	309 b	444
60	-	A. N.	22.2	90 b	310	34 cd	344 ab	456
120	-	A. N.	16.7	100 b	320	49 bc	369 a	486
180	-	A. N.	15.6	86 b	307	70 ab	377 a	478
240	-	A. N.	23.7	77 b	301	72 ab	373 a	473
240	-	C. N.	18.8	84 b	306	85 a	391 a	494
240	-	A. N.+Gypsum	19.6	95 b	308	59 ab	368 a	482

1/ 60 lbs of N/acre was applied at planting time.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 300 lb Ca/acre.
4/ Means followed by different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Table 2. The effect of metham and sidedress nitrogen on yield and quality of Russet Burbank potaotes. Experimental site # 2.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Off Type		Under 4 Oz	4-10 Oz		Over 10 Oz		U. S. No. 1		Total Yield	
lb N/acre						cwt/acre							
0	Without	A. N.	11.1	bcd	87	165		18	bc	183		281	
50	"	A. N.	13.3	bcd	74	162		15	bc	177		264	
100	"	A. N.	11.5	bcd	70	182		29	bc	211		293	
150	"	A. N.	15.6	bc	68	163		22	bc	185		268	
150	"	C. N.	22.6	ab	75	171		14	c	185		282	
150	"	A. N.+Gypsum	32.2	a	83	162		9	c	171		286	
0	With	A. N.	0.4	d	125	241		13	c	253		379	
50	"	A. N.	4.3	cd	103	233		37	b	270		377	
100	"	A. N.	10.9	bcd	102	228		25	bc	253		366	
150	"	A. N.	6.2	cd	79	244		29	bc	273		358	
150	"	C. N.	5.1	cd	105	212		12	c	223		333	
150	"	A. N.+Gypsum	3.9	cd	85	243		61	a	304		392	
				Treatment Means 4/									
	Without metham		17.7	a	76	167	b	18	b	185	b	279	b
	With metham		5.1	b	100	233	a	29	a	263	a	367	a
0	-	A. N.	5.7		106	203		15	b	218		330	
50	-	A. N.	8.8		88	197		26	ab	223		320	
100	-	A. N.	11.1		86	205		27	ab	232		329	
150	-	A. N.	10.9		74	203		25	ab	229		313	
150	-	C. N.	13.9		90	191		13	b	204		307	
150	-	A. N.+Gypsum	18.1		84	202		35	a	238		339	

1/ 150 lbs of N/acre was applied at planting time.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 188 lb Ca/acre.
4/ Means followed by different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Table 3. The effect of metham and sidedress nitrogen on petiole and tuber nitrate content and specific gravity of Russet Burbank potatoes. Experimental site # 1.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Petiole Nitrate	Tuber Nitrate	Specific Gravity
lb N/acre			---- ppm	----	-g/cc-
0	Without	A. N.	14,750	6.9	1.079
60	"	A. N.	15,100	7.8	1.078
120	"	A. N.	15,750	7.6	1.078
180	"	A. N.	22,750	8.9	1.076
240	"	A. N.	21,600	8.8	1.077
240	"	C. N.	-	15.5	1.077
240	"	A. N.+Gypsum	-	9.6	1.079
0	With	A. N.	14,750	7.3	1.083
60	"	A. N.	13,400	7.2	1.082
120	"	A. N.	15,050	7.5	1.084
180	"	A. N.	17,900	7.7	1.084
240	"	A. N.	18,850	7.9	1.083
240	"	C. N.	-	9.0	1.081
240	"	A. N.+Gypsum	-	8.5	1.081
			Treatment Means 4/		
	Without Metham		17,990	9.3	1.078 b
	With Metham		15,990	7.9	1.083 a
0	-	A. N.	14,750 b	7.1 b	1.081
60	-	A. N.	14,250 b	7.5 b	1.800
120	-	A. N.	15,400 b	7.6 b	1.081
180	-	A. N.	20,325 a	8.3 b	1.080
240	-	A. N.	20,225 a	8.4 b	1.080
240	-	C. N.	-	12.3 a	1.079
240	-	A. N.+Gypsum	-	9.1 b	1.080

1/ 60 lbs of N/acre was applied at planting time.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 300 lb Ca/acre.
4/ Means followed by different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Table 4. The effect of metham and sidedress nitrogen on petiole and tuber nitrate content and specific gravity of Russet Burbank potatoes. Experimental site # 2.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Petiole Nitrate	Tuber Nitrate	Specific Gravity
lb N/acre			---- ppm ----		-g/cc-
0	Without	A. N.	18,000	10.4	1.080
50	"	A. N.	27,150	11.0	1.080
100	"	A. N.	27,000	11.6	1.081
150	"	A. N.	27,000	11.6	1.079
150	"	C. N.	--	10.4	1.080
150	"	A. N.+Gypsum	--	14.8	1.080
0	With	A. N.	18,050	10.4	1.085
50	"	A. N.	27,500	10.8	1.085
100	"	A. N.	29,900	11.2	1.085
150	"	A. N.	30,600	9.4	1.085
150	"	C. N.	--	13.0	1.084
150	"	A. N.+Gypsum	--	10.4	1.084
			Treatment Means 4/		
	Without Metham		24,788	11.6	1.080 b
	With Metham		26,513	10.9	1.085 a
0	-	A. N.	18,025 b	10.4	1.083
50	-	A. N.	27,325 a	10.9	1.083
100	-	A. N.	28,450 a	11.4	1.083
150	-	A. N.	28,800 a	10.5	1.082
150	-	C. N.	--	11.7	1.082
150	-	A. N.+Gypsum	--	12.6	1.082

1/ 150 lbs of N/acre was applied at planting time.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 188 lb Ca/acre.
4/ Means followed by different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Table 5. The effect of metham and sidedress nitrogen on net income and income over the check treatment. Experimental site # 1.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Net Income 4/	Net Income Over Check 5/
lb N/acre			- $/acre -	
0	Without	A. N.	$1,608	$0
60	"	A. N.	$1,723	$115
120	"	A. N.	$1,881	$273
180	"	A. N.	$1,993	$385
240	"	A. N.	$1,815	$207
240	"	C. N.	$2,020	$412
240	"	A. N.+Gypsum	$2,056	$448
0	With	A. N.	$2,111	$503
60	"	A. N.	$2,410	$802
120	"	A. N.	$2,579	$971
180	"	A. N.	$2,588	$980
240	"	A. N.	$2,727	$1,119
240	"	C. N.	$2,730	$1,122
240	"	A. N.+Gypsum	$2,371	$763
			Treatment Means 6/	
	Without Metham		$1,871 b	$0 b
	With Metham		$2,502 a	$631 a
0	-	A. N.	$1,860 b	$0 b
60	-	A. N.	$2,067 ab	$207 ab
120	-	A. N.	$2,230 a	$370 a
180	-	A. N.	$2,290 a	$430 a
240	-	A. N.	$2,271 a	$411 a
240	-	C. N.	$2,375 a	$515 a
240	-	A. N.+Gypsum	$2,214 a	$354 a

1/ 60 lbs of N/acre was applied at planting time.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 300 lb Ca/acre.
4/ Net income after treatment expenses: N from A. N. @ $.20/acre and from C. N. @ $.30/acre, Gypsum @ $10.00/acre, Vapam @ $200.00/acre Tuber >10 oz @ $8.00, Tubers 4-10 oz @ $ 5.50, Off-type Tubers @ $3.00, Tuber <4 oz @ $ 1.50.
5/ Check = No sidedress nitrogen and no Vapam.
6/ Means followed by different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Table 6. The effect of metham and sidedress nitrogen on net income and income over the check treatment. Experimental site # 2.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Net Income 4/	Net Income Over Check 5/
lb N/acre			- $/acre -	
0	Without	A. N.	$1,214	$0
50	"	A. N.	$1,150	($64)
100	"	A. N.	$1,352	$138
150	"	A. N.	$1,189	($25)
150	"	C. N.	$1,184	($30)
150	"	A. N.+Gypsum	$1,143	($71)
0	With	A. N.	$1,414	$200
50	"	A. N.	$1,533	$319
100	"	A. N.	$1,419	$205
150	"	A. N.	$1,480	$266
150	"	C. N.	$1,184	($30)
150	"	A. N.+Gypsum	$1,722	$508
			Treatment Means 6/	
	Without Metham		$1,205 b	$0 b
	With Metham		$1,459 a	$254 a
0	-	A. N.	$1,314	$0
50	-	A. N.	$1,341	$27
100	-	A. N.	$1,385	$71
150	-	A. N.	$1,334	$20
150	-	C. N.	$1,184	($130)
150	-	A. N.+Gypsum	$1,432	$118

1/ 150 lbs of N/acre was applied at planting time.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 188 lb Ca/acre.
4/ Net income after treatment expenses: N from A. N. @ $.20/acre and from C. N. @ $.30/acre, Gypsum @ $10.00/acre, Vapam @ $200.00/acre Tuber >10 oz @ $8.00, Tubers 4-10 oz @ $ 5.50, Off-type Tubers @ $3.00, Tuber <4 oz @ $ 1.50.
5/ Check = No sidedress nitrogen and no Vapam.
6/ Means followed by different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Table 7. The effect of metham and sidedress nitrogen on soft rot infection of Russet Burbank potaotes. Combined analysis for. two experiments.

Sidedress N 1/	Metham 2/	Nitrogen Source 3/	Soft Rot Infection Diameter 4/		
lb N/acre		Experimental Site No.	#1	#2	Mean
				cm	
240 or 150	Without	A. N.	0.72	0.51	0.62
240 or 150	"	C. N.	0.57	0.44	0.50
240 or 150	"	A. N.+ Gypsum	0.59	0.39	0.49
240 or 150	With	A. N.	0.72	0.49	0.61
240 or 150	"	C. N.	0.57	0.46	0.52
240 or 150	"	A. N.+ Gypsum	0.61	0.36	0.48

	Treatment Means 5/
Experimental site No. 1.	0.63 a
Experimental site No. 2.	0.44 b
Without Metham	0.54
With Metham	0.54
240 or 150 - A. N.	0.61 a
240 or 150 - C. N.	0.51 b
240 or 150 - A. N.+ Gypsum	0.49 b

1/ 60 lb N/acre and 150 lbs of N/acre was applied at planting time to experimental site's 1 and 2, respectively.
2/ Metham in this experiment was applied as Vapam at 50 gals./acre.
3/ Nitrogen sources were A. N.(Ammonium Nitrate) and C. N.(Calcium Nitrate). Gypsum and Calcium Nitrate supplied 300 lb Ca/acre.
4/ Diameter of decay after injection and incubation for 96 hours.
5/ Means followed by the different letters are significantly different as determined by the Duncan's Multiple Range Test (p = .05).

Funding: MPIC

CONTROL OF SCAB AND RHIZOCTONIA DISEASES

R. Hammerschmidt and M.L. Vitosh
Department of Botany and Plant Pathology
Department of Crop and Soil Sciences

INTRODUCTION

Scab and Rhizoctonia diseases continue to be a problem in potato production. Research was carried out this year to further evaluate possible control measures and to begin to understand the survival and population dynamics of the scab pathogen.

Irrigation and N form:

Last years research indicated that a combination of acid forming fertilizer and maintaining soil wetter than 50 cb of tension gave very good control of scab. In this experiment we further evaluated the control benefits of ammonium sulfate and irrigation.

The research was carried out at the MSU soils farm. N was applied to the plots in four different forms and these treatments were superimposed on high vs. low irrigation regimes. The N treatments were urea/urea, ammonium sulfate/ammonium sulfate, urea/ammonium sulfate, calcium nitrate/calcium nitrate, and urea+gypsum/urea+gypsum as the starter/topdress, respectively (Table 1).
One set of N treatments was maintained by irrigation (when needed) at 50 cb of tension or less. The other set of plots received irrigation only every other time the other plot was irrigated (i.e. this plot was often drier than 50 cb). Tensiometers were installed at the time of tuber initiation (i.e. when stolon tips were swelled to ca. twice the diameter of the rest of the stolon).

Results:

Higher than average amounts of precipitation resulted in less scab than would be expected in drier years. This year, the first irrigation to lower the tension below 50 cb occurred about six weeks after tuber intitiation as compared to only about two weeks in the previous year. However, the effect of maintaining the higher water level in controlling scab was evident (although not as great a difference as last year)(Table 2). Ammonium sulfate at both irrigation levels gave the best control of scab, while plots given only urea as the N form exhibited the most scab (Table 2).

There were some effects on the N form with regard to total yield. Ammonium sulfate as the N form resulted in the best yields (at both irrigation levels) while Calcium Nitrate produced the poorest yields (Table 3). There were no effects on specific gravity (Table 4).

Population of Streptomyces in the soil:

Little is known about how many propagules of S. scabies are required to cause a significant amount of disease. Experiments were carried out in which the populations of total Streptomycetes were determined at the time of planting and at the time of tuber initiation and then compared to the amount of disease observed in the plots. Soil samples were collected at three locations at each of the ammonium sulfate and urea treated plots at the times indicated in table 5. After air drying the samples, one gram samples
were extracted with sterile water and appropriate dilutions made onto water agar. Total Streptomycetes were counted 14 days after plating.

Results:

Populations of streptomycetes in each of the plots at the two sampling times are given in Table 5. A decrease in the total population was observed in the Ammonium sulfate plots while a slight increase in total population was observed in the urea treated plots. Amount of disease in the two N form plots is listed next to the Streptomyces population. Less disease was found where the populations were lowered by ammonium sulfate treatments. No good correlation was found between initial population and final amount of disease observed.

Infection of alternate crops and colonization of crop residue by Streptomyces species:

The survival mechanism used by Streptomyces species in the soil must be understood in order to develop long-term control strategies for this disease. In these experiments seedlings of plants were grown in the presence of a putative pathogenic Streptomyces strain and then evaluated for infection of root tissue. In addition, partly decomposed crop residue samples were assayed for presence of Streptomycetes. This was carried out to assess the possible role that this type of organic matter may serve as a nutrient base for streptomycetes in the absence of the potato.

To evaluate the infection of roots of other plants, a pathogenic strain of Streptomyces was mixed with warm, melted soil extract agar and then poured into sterile beakers. Germinated seeds of corn, wheat, soybean, and radish were placed onto the surface of the agar. The plants were allowed to grow for two weeks and the roots were then examined for evidence of infection.

Partly decomposed corn stalk and potato vine and root residue was collected from a field that had a history of scab problems. Some of the residue, after surface sterilization, was homogenized in sterile water and plated out onto water agar to check for the presence of Streptomycetes. The rest of the residue was chopped into small pieces and placed around seed pieces of potato (var. Yukon Gold) that were planted in steamed soil. After 10 weeks of growth, the tubers were harvested and examined for scab.

Streptomycetes were also tested for their ability to utilize pectin and polygalacturonic acid (polysaccharides that are found in plant tissues) by growing the organism in liquid culture with the polysaccharides as the only carbon source.

Results

Roots of soybean, wheat and radish exhibited browning of their tissues when grown in the presence of the pathogenic strain of Streptomyces. The development of these symptoms took about ten days to develop. The non-pathogenic strain did not cause these symptoms. Corn roots did not exhibit any signs of infection in these tests.

Plating out the crop residue onto water agar demonstrated that some streptomycetes were present along with several other bacteria and fungi. Microscopic observation of the plates showed that many of the streptomycetes copuld be seen growing directly out of the pieces of plant residue, thus suggesting that these organisms were growing inside of the tissue.

Growing Yukon Gold potato in the presence of the crop residues resulted in the development of a slight amount of scab in the potatoes grown in the presence of corn residue and slightly more in the presence of the potato crop residue. This suggests that it is possible that the scab pathogen may survive from potato crop to potato crop by living as a saprophyte in crop residue as do non-pathogenic Streptomycetes.

Several Streptomyces isolated from the residue were tested for their ability to grow on complex polysaccharides such as those found in crop residue. The islates were able to utilize pectin and polygalacturonic acid as the sole carbon source (although at a much slower rate than on a more standard carbon source such as glucose). This suggests that the organisms have the enzymes necessary to decompose residue. These types of enzymes may also be important in the establishment of infection by the pathogen in growing tuber tissue.

Seed piece treatment studies:

Several formulations of seed piece treatments were evaluated on Russet Burbank. The experiment was carried out at the Montcalm Station and planting was on May 14. Treatments were applied to the cut seed pieces immediately after cutting. Treated tubers were planted on the same day of treatment. Plants were evaluated for per cent emergence and vigor. no yield data or Rhizoctonia evaluations could be made on the tubers due to loss of plots from the excessive rains in September.

Results:

Treatment of seed with the CGA formulation resulted in a decrease in stand which was related to phytotoxicity of the material under the wet soil conditions during and after planting. this type of result has been observed in other trials conducted by Ciba-Geigy (personal communication with company). Stand and vigor was good with the other treatments as compared to the untreated control (Table 6).

TABLE 1. SOIL TESTS AND NUTRIENTS USED

Soil Test		FERTILIZER TREATMENTS	
pH	6.9	UREA/UREA	225-100-100
P	128	AMSO4/AMSO4	225-100-100+114 S
K	267	UREA/AMSO4	225-100-100+57 S
Ca	1840	CaNO3/CaNO3	225-100-100+129 Ca
Mg	336	UREA+GYP/UREA+GYP	225+100+100+129 Ca + 98
Type	Spinks Loam Sand		

TABLE 2. SCAB CONTROL

TREATMENTS	%<5% SCAB	% SCAB FREE
IRRIGATION		
High	92.3A	76.8
Low	86.9B	75.0
N FORM		
U/U	86.6B	64.9C
AS/AS	97.6A	87.4A
U/AS	86.9B	74.7BC
CaN/CaN	90.3AB	72.7BC
U+Gyp/U+Gyp	86.9B	79.8AB
N FORM X IRRIG.		
HIGH IRRIG.		
U/U	92.6ABC	67.8BC
AS/AS	100.0A	87.2A
U/AS	87.8BCD	73.8ABC
CaN/CaN	93.2ABC	73.9ABC
U+Gyp/U+Gyp	87.9BCD	81.1AB
Low Irrig.		
U/U	80.6D	61.9C
AS/AS	95.2AB	87.7A
U/AS	85.9BCD	75.6ABC
CaN/CaN	87.3BCD	71.5BC
U+Gyp/U+Gyp	85.9BCD	78.5AB

*High irrig=soil depleted no more than 50 cb. U=urea, AS=ammonium sulfate, CaN=calcium nitrate, Gyp=gypsum.

TABLE 3.YIELD

TREATMENT*	TOTAL YIELD**	%No.1
IRRIGATION		
High	410.6	87.8
Low	375.6	87.7
N FORM		
U/U	404.9AB	88.8
AS/AS	442.7A	87.9
U/AS	389.5AB	86.1
CaN/CaN	334.6B	86.9
U+Gyp/U+Gyp	395.8AB	89.1
N FORM X IRRIG.		
High Irrig.		
U/U	435.4AB	90.1
AS/AS	470.5A	88.7
U/AS	404.0ABC	84.9
CaN/CaN	351.6CD	87.9
U+Gyp/U+Gyp	395.6ABC	87.5
Low Irrig.		
U/U	374.5BCD	87.4
AS/AS	414.9ABC	87.2
U/AS	374.9BCD	87.2
CaN/CaN	317.6D	85.9
U+Gyp/U+Gyp	395.9ABC	90.6

*Same as Table 2.
**CWT/A.

TABLE 4. SPECIFIC GRAVITY

TREATMENT*	SPECIFIC GRAVITY
IRRIGATION	
High	1.088
Low	1.088
N FORM	
U/U	1.088
AS/AS	1.090
U/AS	1.089
CaN/CaN	1.087
U+Gyp/U+Gyp	1.088
N FORM X IRRIG.	
HIGH IRRIG.	
U/U	1.087
AS/AS	1.090
U/AS	1.088
CaN/CaN	1.086
U+Gyp/U+Gyp	1.088
Low Irrig.	
U/U	1.088
AS/AS	1.089
U/AS	1.090
CaN/CaN	1.087
U+Gyp/U+Gyp	1.088

*See Table 2.

TABLE 5. STREPTOMYCES SOIL POPULATIONS

N FORM TREATMENT	STREPTOMYCES POPULATIONS*	
	May 7	June4
U/U High Irrig.	404,000	401,000
U/U Low Irrig.	352,500	465,800
AS/AS High Irrig.	366,000	204,000
AS/AS Low Irrig.	374,200	238,000
	LSD=73,000	

*per gram of dry soil.

TABLE 6. SEED PIECE TREATMENTS

TREATMENT[a]	RATE (lb/cwt)	% STAND	VIGOR[b]
CGA 449 + Fir Bark	0.5	61.9 ± 6.9	poor
CGA 449 + Fir Bark	1.0	50.3 ± 9.5	poor
CGA 449 + Fir Bark	2.0	54.8 ± 3.4	poor
CGA 449	0.5	84.3 ± 4.3	good
CGA 449	1.0	75.3 ± 6.8	fair
CGA 449	2.0	57.0 ± 6.7	poor
Tops 2.5	1.0	93.3 ± 3.7	good
Tops 1.5 + Rovrall 1.0	1.0	93.3 ± 1.9	good
Tops 1.5 + Rovrall 2.0	1.0	88.8 ± 2.0	good
Tops 1.5 + Rizolex 1.0	1.0	97.8 ± 1.9	good
Tops 1.5 + Vitavax 1.0	1.0	93.3 ± 3.7	good
Check	---	84.3 ± 5.8	good

[a]Four replications per treatment.

[b]Vigor: poor = plants less than 4" tall on average
fair = plants 4 to 8" tall
good = plants over 8" tall

Funding: MPIC

MANAGEMENT OF COLORADO POTATO BEETLE

E. Grafius, L. Connington, and D. Herrington
Department of Entomology
Michigan State University

Summary

Evaluation of the relative costs and benefits of treatment at planting with Temik or Thimet in comparison with weekly foliar treatment or scouting and treatment as needed was conducted at the Montcalm Potato Research Farm. Temik treatment resulted in slightly increased yields over other treatments, even though insect populations and damage were similar. "As-needed" treatment produced lowest marginal return because of low levels of control when treatment was applied, demonstrating the need for resistance monitoring and careful selection of insecticide.

Field insecticide trials indicated that Temik and Thimet applied at planting or side-dressed (Temik 2 lb ai/A) gave season-long control in Superior variety potatoes at this location. Di-Syston was ineffective and Furadan gave larval control up to July 7. Early-season adult numbers were relatively low due to the change in plot location between 1985 and 1986 and most materials would be less effective against adults. Furadan 4F was the only standard foliar material that gave reliable control. Experimental materials tested included combinations of soil treatments for insect+nematode control, exotoxin from *Bacillus thuringiensis* (BT), a new pyrethroid (Baythroid), and 2 materials from FMC (F 5951 and f 4922). The new FMC materials seem especially promising, providing excellent control of potato beetle adults and larvae for up to 2 weeks after treatment and reported to have little or no cross resistance problems with other materials.

Studies of insecticide resistance in the Colorado potato beetle (not reported here) are continuing, with funding from a USDA pest management grant.

1. Economics of Soil Insecticide Use for Control of Colorado Potato Beetle

The objective of this study was to compare the economics of soil insecticide use (Temik and Thimet) with foliar treatments weekly or as-needed (based on scouting). The data will be useful in evaluation of the importance of Temik registration and as preliminary information on alternatives, if Temik is removed from the market.

Methods

Russet Burbank potatoes were planted at the Montcalm Potato Research Farm on May 8. Treatments were arranged in a randomized complete block design with 4 replications per treatment. Plots were 4 rows wide and 40 ft long, with the western row left untreated as a consistent source of infestation for each plot. Plots were separated from adjacent plots by 3 ft on each end and 6 ft (one blank row) on each side. Weekly insect counts were made on 2 randomly-selected plants from each plot and damage ratings were made on July 17 and 29.

"Weekly foliar" plots were sprayed weekly from June 25 through August 12, alternating between Imidan 50 WP (1 lb ai/A = 2 lb/A) and Furadan 4F (1 lb ai/A = 2 pt/A). Treatment decisions in the "as-needed" plots were made based on the observed insect counts and treatment were applied within 2 days after sampling, if needed. Treatments were applied when numbers exceeded 2 adults and/or large larvae per plant. Imidan was applied on June 25 and July 31 and Furadan 4F on July 2, at the above rates. All plots were treated with Cygon for control of potato leafhoppers on July 10.

Time required to sample the "as-needed" plots was recorded weekly and used to estimate scouting costs. Yield data were taken from the center row of the three treated rows. Cost analyses were calculated for the respective treatments and marginal returns estimated. (Marginal return is the increase in profits from a particular treatment minus the costs of the respective treatment - scouting, spraying, etc.).

Results

In untreated plots, potato beetle numbers were extremely high and most plants were defoliated by early August. This is similar to what would occur in many non-rotated fields in Michigan without treatment and is less severe than what occurs in treated fields in the northeastern U.S. Numbers of large larvae reached a peak of 47 per plant on July 1 and numbers of adults reached 16 per plant on July 29 (Figure 1, Tables 1 and 2). Adult numbers would have been higher, except that plants were defoliated by early August and many adults moved to other plots.

Numbers of egg masses per plant did not differ significantly between treatments until August 5, when untreated plants had begun to die. This indicates that no attraction or repellence occurred between plots and that the data from small plots may be valid for large fields, at least up until early August. Numbers of small larvae were extremely high in the foliar sprayed and untreated plots, since egg hatch often occurred between spraying and when scouting was done.

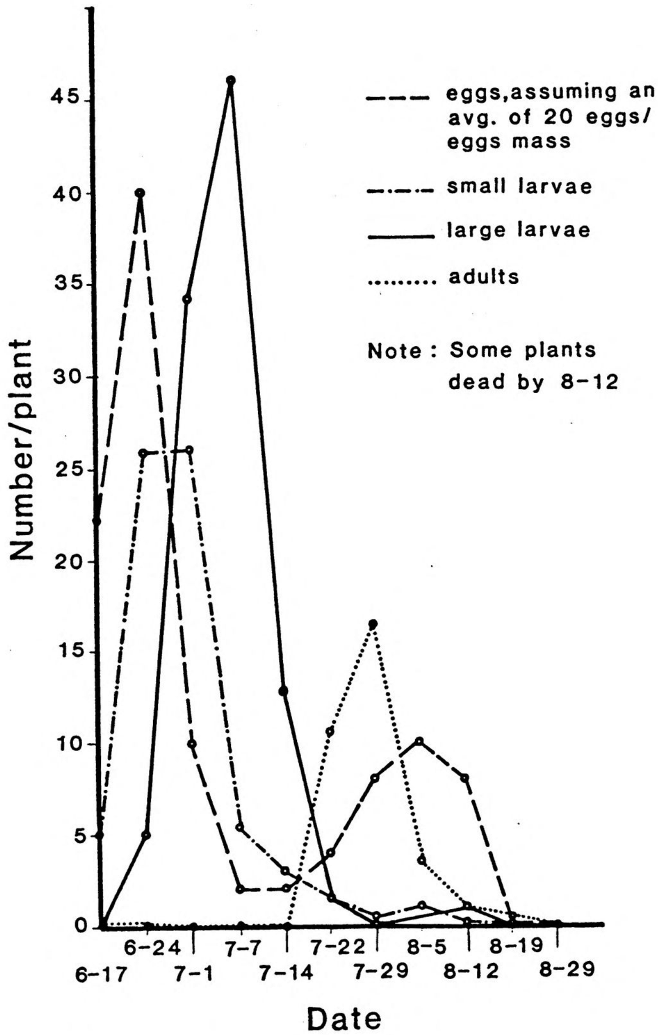


Figure 1. Seasonal dynamics of Colorado potato beetle eggs, larvae, and adults in untreated plot.

Large larvae and adults do nearly all of the feeding and numbers of these stages determine the extent of defoliation and indicate the effectiveness of control. Numbers of large larvae reached very high levels in "weekly foliar" and "as-needed" plots on July 1, as the result of high numbers of small larvae on June 24 and incomplete control with Imidan (Figure 2, Table 1). Imidan was effective in 1985 at this location but not in 1986 (see insecticide trial data, part 2 of this report). Increased Imidan tolerance is the probable reason for this difference, emphasizing the need for routine testing for resistance levels before treatment and immediate field checking after treatment. Adult control with Imidan was also inadequate and adults in the "as-needed" plots reached a level of 13 per plant on July 29 and were still at 9 per plant on August 5, after Imidan treatment (Figure 2, Table 2). Some of the adults present on August 5 had probably emerged from pupation after the July 29 spray and were not affected by the residual levels of Imidan. As the result of these two cases of incomplete control, potato beetle levels were far above the target threshold in the "as-needed" plots on several occasions during the season.

Table 1
Mean Number of Large Larvae/plant*

Treatment	6-17	6-24	7-1	7-7[a]	7-14	7-22	7-29	8-5[a]	8-12[b]	8-19[b]	8-29[b]
Temik 20 lb/A	0.0	0.0	0.0 a	0.0 a	0.5 a	0.2	0.0	0.6	0.0 a	0.1	0.0
Thimet 15 lb/A	0.0	0.0	4.0 a	1.5 b	1.4 a	1.0	0.0	0.0	0.0 a	0.0	0.0
Weekly foliar	0.0	2.8	19.6 ab	1.2 b	0.0a	0.0	0.0	0.0	0.0 a	0.0	0.0
Foliar as needed	0.0	2.1	21.8 ab	0.6 ab	3.9 a	1.6	0.1	3.8	0.0 a	0.0	0.0
Control	0.0 n.s	5.1 n.s.	34.2 b	46.6 c	12.8 b	1.5 n.s.	0.1 n.s.	0.5 n.s.	1.0 b	0.0 n.s.	0.0

*Means followed by the same letter are not significantly different (SNK test, P > 0.05).

a SNK test based on square-root transformed data.
b Some plants dead.

Table 2
Mean Number of Adults/plant*

Treatment	6-17	6-24	7-1	7-7	7-14	7-22[a]	7-29	8-5	8-12[b]	8-19[b]	8-29[b]
Temik 20 lb/A	0.0	0.2	0.1	0.0	0.0	0.4 a	1.8 a	1.9	0.5	0.4	0.0
Thimet 15 lb/A	0.1	0.2	0.1	0.0	0.0	0.6 a	4.2 ab	3.4	0.4	0.5	0.5
Weekly foliar	0.5	0.1	0.0	0.0	0.0	0.1 a	4.1 ab	3.0	0.1	0.4	0.0
Foliar as needed	0.2	0.6	0.5	0.0	0.1	1.1 a	12.6 ab	8.9	0.6	0.9	0.0
Control	0.1 n.s.	0.2 n.s.	0.0 n.s.	0.0 n.s.	0.0 n.s.	10.6 b	16.4 b	3.5 n.s.	1.0 n.s.	0.4 n.s.	0.0 n.s.

*Means followed by the same letter are not significantly different (SNK test, P > 0.05).

aSNK test based on square root transformed data.
bSome plants dead.

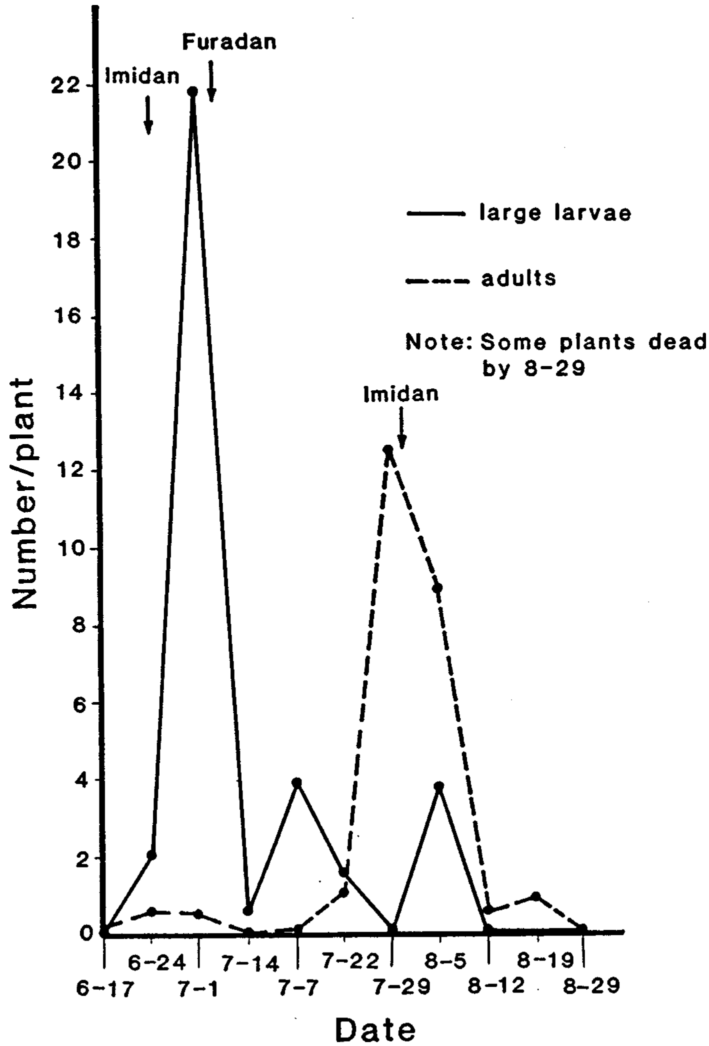


Figure 2. Numbers of large larvae and adult Colorado potato beetles in "weekly foliar' and "as-needed" plots.

Damage ratings made on July 17 and 29, indicated that some defoliation had occurred in all plots and all treated plots showed similar levels of injury (Table 3). Yields were nearly identical for Temik, Thimet, and "weekly foliar" treatments and were slightly reduced in the "as-needed" treatment (not statistically significant, perhaps the result of the control problems discussed above). The slightly increased yield in the Temik treatment may have been the result of decreased nematode or early-dying injury. Yields in the untreated plots were severely reduced.

Economic analysis of grade A's indicates that Temik provides the highest marginal return on investment (Table 4). Treatment "as-needed" provided the lowest marginal return, due to the decreased yield discussed above. Scouting costs were not included in Temik, Thimet, or weekly foliar treatment analyses, but would be a normal part of costs on most farms. Results will differ from farm to farm, depending on pest pressure, treatment and scouting costs, etc.

Table 3
Damage Ratings and Yield Data

Treatment	Mean Damage Rating[a]		Yield[b] (lb/40 ft)				
	7-17	7-29	Grade A	Grade B	Oversize	Knobby	Total
Temik 20 lb/A	1.2	2.0	53.4 a	18.5	0.0	3.1	75.0 a
Thimet 15 lb/A	2.0	2.0	50.6 a	17.5	0.8	2.9	71.8 a
Weekly foliar	2.0	2.0	51.2 a	13.9	0.8	8.1	74.0 a
Foliar as needed	2.0	2.2	45.6 a	16.0	0.3	1.8	63.6 a
Control	3.0	3.8	14.9 b	18.5 n.s.	0.3 n.s.	1.0 n.s.	34.6 b

[a]Damage ratings based on a scale of 1 to 5, where 1 = no damage, 2 = 1-5% defoliation, 3 = 6-25% defoliation, 4 = 26-50% defoliation, 5 = 51-100% defoliation.
[b]Means followed by the same letter are not significantly different (SNK test, P>0.05).

Table 4
Economic Analysis of Treatments

	Costs ($/A)			Yield difference Treatment-Control	Price Difference (@ $4, 6, or 8/cwt)			Marginal Return		
	Scouting[a]	Chem's[b]	Appl.[c]	(cwt/A grade A)	$4	$6	$8	$4	$6	$8
Temik	$0	$52.00	$0	148.0	$592	$888	$1184	$540	$836	$1132
Thimet	0	24.00	0	137.2	549	823	1097	525	799	1073
Weekly foliar	0	48.00	35	139.5	558	837	1116	475	754	1033
Foliar as n'ded	17.31	19.50	15	118.0	472	708	944	438	674	909

[a] For a 20 A field, 50 plants sampled per field @ $10/hr, based on sampling time for "as needed" plots.
[b]Furadan 4 F @ $60/gal, Imidan 50 WP @ $3/lb.
[c]Based on $5/A cost.

2. Field Insecticide Evaluations

Potatoes (cv. Superior) were planted May 7 '86 at the MSU Montcalm Potato Research Farm. Plots were 3 rows wide (34 inch spacing) by 40 ft, with 3 ft of buffer zone before the next plot. Two untreated rows were left between adjacent plots. Treatments were arranged in a randomized complete block design with 4 blocks per treatment. Treatments were applied at planting, as a sidedress with fertilizer at hilling (May 28), or as weekly foliar treatments from June 25 to August 6. Foliar treatments were applied with a sprayer mounted boom at 30 gal/acre, 40 psi with a cluster of 3 nozzles over each of the three rows. One nozzle was pointed down directly over the top, with the other two directed at the sides of the plants.

Weekly insect counts (June 17 to August 5) were made from two randomly selected plants ir the center row of each plot. On July 10, Cygon was sprayed on all plots to control potato leafhoppers. On July 17 and 30 the plots were rated for Colorado potato beetle damage. Yields were taken from center row of each plot on August 26 and 27.

Colorado potato beetle larvae first appeared on June 17 in untreated plots and larval numbers peaked during mid-July (Fig. 3). Summer adults in the untreated plots peaked during the last week of July. Very few second generation larvae were present in the untreated plots due to the extensive defoliation and natural plant senescence that had occurred by the end of July.

A comparison of the effects of soil systemic treatments indicated large differences between treatments (Fig. 4, Tables 5 and 6). Both Temik and Thimet appeared to give nearly season-long control of adults and larvae. Furadan 15G was less effective and larval control apparently had broken down by July 7. DiSyston gave little apparent Colorado potato beetle control, although flea beetles and potato leafhopper numbers were reduced.

Among the foliar treatments, Furadan 4F gave excellent control of larvae and adults. Imidan, the other standard, was not as effective as in previous years. Baythroid, the only pyrethroid evaluated, also gave only moderate control of larvae and no apparent adult control. This result was not surprising, since high levels of pyrethroid resistance are present in the beetle population.

The ABG materials, B.t. exotoxins, gave good to very good control of larvae, although the effects were not rapid enough to affect the number of small larvae. F5951 and F4922 gave extremely effective control of larvae, especially considering that treatments were applied only every 2 weeks. Both materials also gave control of adults and numerous deformed undersized pupae were observed on the soil surface. Seasonal totals of egg masses and small larvae were generally highest in plots treated with materials effective against larvae (therefore reducing defoliation) but not effective against adults.

Defoliation and yield data follow the same general patterns as large larvae and adult numbers. However, there were no significant differences in total yield or yield of grade A potatoes. The maximum difference in yield was 32% (Temik 3 lb ai/A versus untreated). Mucl of the defoliation occurred after tuber bulking was well along ('Superior' is a mid-season variety), limiting yield losses. Peak larval numbers occurred on July 14 and adult numbers peaked on July 22 in the untreated plots.

Overall, data indicate that there are 2 systemic materials and at least 1 foliar material that are registered and remain effective at this location. New types of materials look good to very good, but may be more effective against larvae than adults.

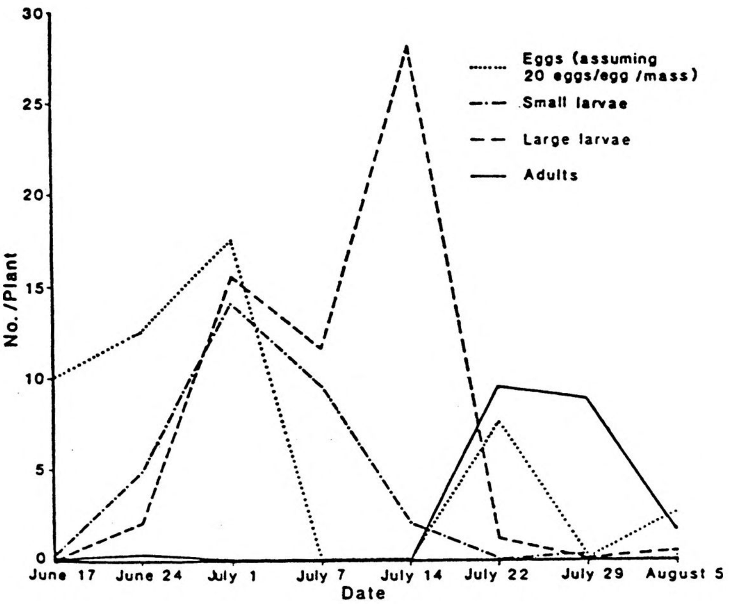
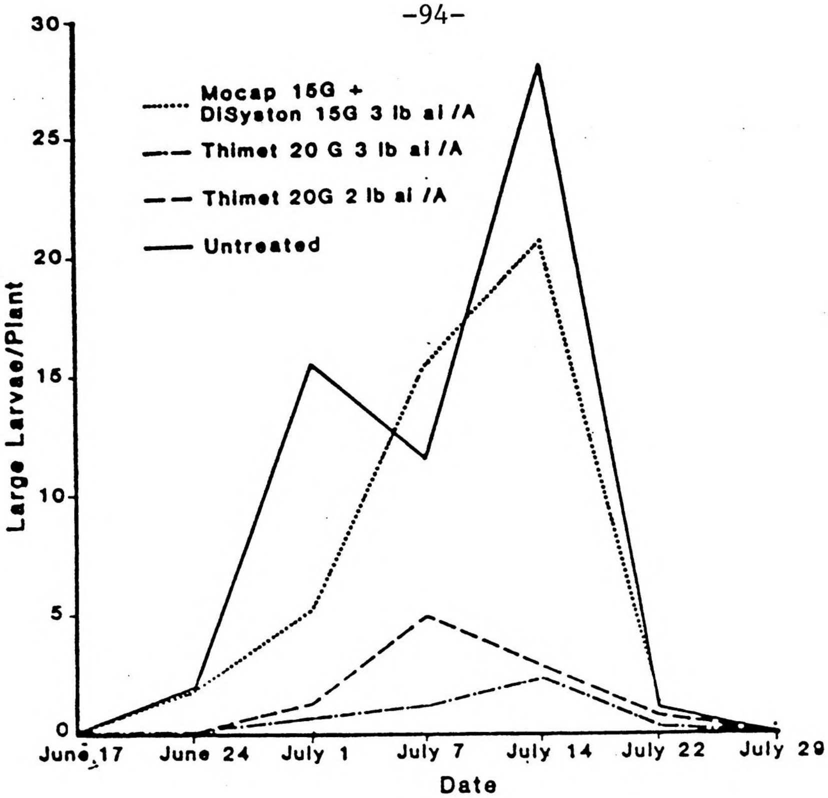


Figure 3. Seasonal dynamics of Colorado potato beetle in untreated plots.



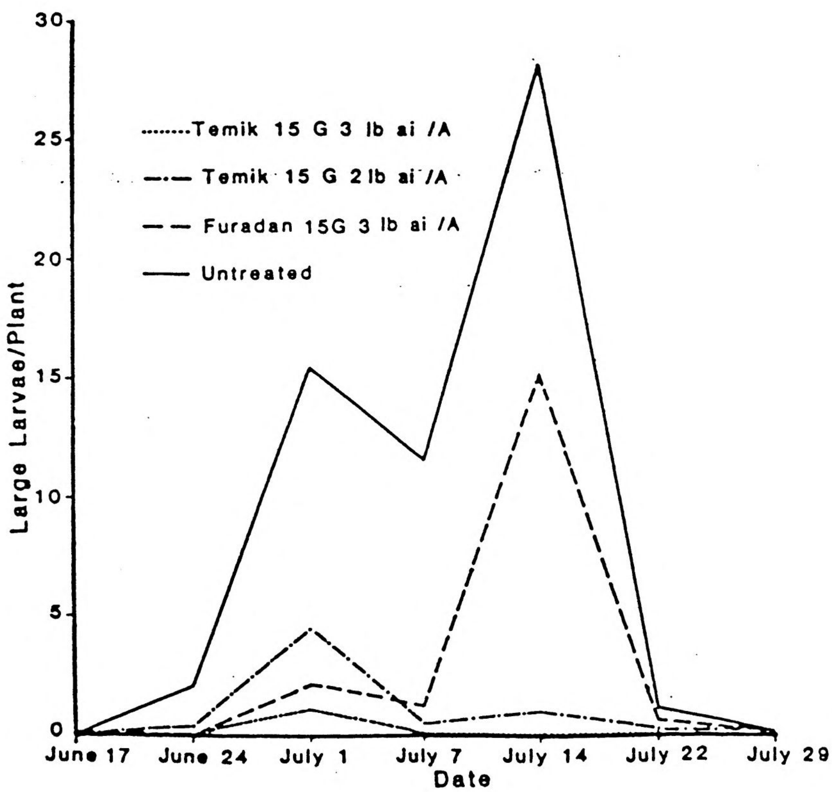


Figure 4. Large larvae numbers in plots treated with soil systemic materials compared to numbers in untreated plots.

Table 5
Seasonal Mean Densities
(number per 2 plants)

	Egg masses[a]	Small larvae[a,b]	Large larvae[a]	Adults[a,c]
Soil Treatments				
Temik 15G, 3 lb ai/A in furrow	0.5 a	0.6 a	0.3 a	0.8
Temik 15G, 2 lb ai/A side-dress at hilling	0.6 a	2.3 b	1.5 a	1.5
Mocap 15G, 3 lb ai/A band pre-plant + DiSyston 15G, 3 lb ai/A band pre-plant	0.8 abc	10.6 b	11.1 ab	2.9
Mocap 15G, 3 lb ai/A band pre-plant + Thimet 20G, 3 lb ai/A band pre-plant	1.0 abc	4.2 b	4.9 ab	2.9
UAP 101, 25 lb form./A band pre-plant	1.4 abc	13.2 b	10.8 ab	2.9
UAP 101, 20.75 lb form./A band pre-plant	1.5 abc	14.8 b	9.5 ab	4.6
Furadan 15G, 3 lb ai/A in furrow	1.1 abc	11.4 b	6.3 ab	2.2
Thimet 20G, 3 lb ai/A in furrow	0.7 ab	3.1 b	1.1 a	1.9
Thimet 20G, 2 lb ai/A in furrow	0.6 a	7.7 b	2.4 a	1.4
Foliar Treatments				
ABG 6162, 40 g form./A	1.4 abc	16.2 b	3.9 a	3.6
ABG 6162, 80 g form./A	1.6 abc	20.3 b	1.9 a	1.9
ABG 6211, 40 g form./A	1.7 abc	20.5 b	4.3 a	3.9
ABG 6211, 80 g form./A (bi-weekly)	0.9 abc	18.4 b	10.3 ab	3.5
Baythroid 4E, 0.5 lb ai/A	1.6 abc	10.5 b	4.9 ab	6.2
F 5951 0.78 EC, 0.05 lb ai/A (bi-weekly)	1.6 abc	13.0 b	2.7 a	3.6
F 5951 0.78 EC, 0.10 lb ai/A (bi-weekly)	0.8 abc	10.1 b	4.1 a	1.9
F 5951 0.78 EC, 0.20 lb ai/A (bi-weekly)	1.6 abc	13.0 b	2.9 a	2.3
F 4922 0.78 EC, 0.05 lb ai/A (bi-weekly)	2.0 c	11.1 b	3.6 a	3.2
F 4922 0.78 EC, 0.10 lb ai/A (bi-weekly)	2.1 c	14.8 b	1.8 a	1.7
F 4922 0.78 EC, 0.20 lb ai/A (bi-weekly)	1.0 abc	4.6 b	1.2 a	1.9
Imidan 50WP, 1.0 lb ai/A	1.9 bc	21.1 b	7.8 ab	4.8
Furadan 4F, 1.0 lb ai/A	1.4 abc	6.3 b	1.2 a	0.6
Untreated	0.6 ab	7.7 b	14.6 b	5.3

[a]Means of samples from 4 replications per treatment, 2 plants per replication, over 8 sample dates. Means followed by the same letter are not significantly different (SNK test, $p>0.05$).

[b]SNK test based on log-transformed data.

[c]Excluding data for 8/5/86. Numerous plants in untreated plots and ineffective treatments were dead and significant adult movement to plots with more foliage had occurred by this date.

Table 6
Damage Ratings and Yield Data

	Damage Rating[a]		Yield (lb/40 ft)[b]				
	7/17	7/30	Grade A	Grade B	Oversize	Knobby	Total
Soil Treatments							
Temik 15G, 3 lb ai/A in furrow	2.0	2.0	79.3	9.5 abc	1.1	0.6 b	90.5
Temik 15G, 2 lb ai/A side-dress at hilling	1.8	2.3	71.6	7.4 bc	2.8	0.9 b	82.6
Mocap 15G, 3 lb ai/A band pre-plant + DiSyston 15G, 3 lb ai/A band pre-plant	3.0	3.0	68.8	6.8 bc	2.3	0.5 b	78.3
Mocap 15G, 3 lb ai/A band pre-plant + Thimet 20G, 3 lb ai/A band pre-plant	2.0	2.5	67.9	8.3 abc	0.9	1.3 b	78.3
UAP 101, 25 lb form./A band pre-plant	2.5	3.5	58.9	9.6 abc	0.5	0.8 b	69.8
UAP 101, 20.75 lb form./A band pre-plant	3.3	3.5	62.1	10.4 ab	0.1	0.5 b	73.1
Furadan 15G, 3 lb ai/A in furrow	2.5	2.8	65.6	11.5 a	1.6	1.3 b	80.0
Thimet 20G, 3 lb ai/A in furrow	2.0	2.3	67.5	9.0 abc	3.8	1.0 b	81.3
Thimet 20G, 2 lb ai/A in furrow	2.0	2.5	64.3	9.6 abc	1.5	0.5 b	75.9
Foliar Treatments							
ABG 6162, 40 g form./A	2.0	2.8	64.3	6.6 bc	1.4	0.4 b	72.6
ABG 6162, 80 g form./A	2.0	2.0	66.0	6.4 bc	0.5	0.6 b	73.5
ABG 6211, 40 g form./A	2.0	3.0	63.3	9.4 abc	1.5	0.8 b	74.9
ABG 6211, 80 g form./A (bi-weekly)	2.5	3.3	56.9	6.9 bc	0.8	0.9 b	65.4
Baythroid 4E, 0.5 lb ai/A	2.0	2.8	66.3	6.3 c	1.9	0.6 b	75.0
F 5951 0.78 EC, 0.05 lb ai/A (bi-weekly)	2.3	2.5	64.6	8.0 abc	0.7	0.9 b	74.1
F 5951 0.78 EC, 0.10 lb ai/A (bi-weekly)	2.0	2.3	67.0	7.5 bc	1.0	1.5 b	77.0
F 5951 0.78 EC, 0.20 lb ai/A (bi-weekly)	2.0	2.3	68.8	7.0 bc	2.6	0.6 b	79.0
F 4922 0.78 EC, 0.05 lb ai/A (bi-weekly)	2.0	2.5	62.4	6.9 bc	3.6	0.9 b	77.3
F 4922 0.78 EC, 0.10 lb ai/A (bi-weekly)	2.0	2.0	70.6	6.0 c	3.0	0.9 b	80.5
F 4922 0.78 EC, 0.20 lb ai/A (bi-weekly)	2.0	2.0	70.6	6.3 bc	2.4	1.3 ab	80.5
Imidan 50WP, 1.0 lb ai/A	2.0	2.8	62.5	6.8 bc	2.4	0.6 b	72.3
Furadan 4F, 1.0 lb ai/A	2.0	2.0	79.3	6.0 c	4.6	2.4 a	92.3
Untreated	3.3	4.0	54.1	6.8 bc	0.1	0.4 b	61.4

[a]Damage ratings based on a scale of 1 to 5, where 1=no damage, 2=0-5% defoliation, 3=5-25% defoliation, 4=25-50% defoliation, and 5=50-100% defoliation.

[b]Means followed by the same letter are not significantly different from each other (SNK, $P>0.05$).

Funding: MPIC

1986 POTATO NEMATODE RESEARCH REPORT

G.W. Bird
Michigan State University

POTATO EARLY-DIE CONTROL

1986 Russet Burbank research data from the Montcalm Potato Farm indicated a significant increase in tuber yield from potato early-die (PED) control with Temik 15G and Vorlex (Figure 1). This management practice resulted in a $675.00 increase in potential net profit per acre (Table 1).

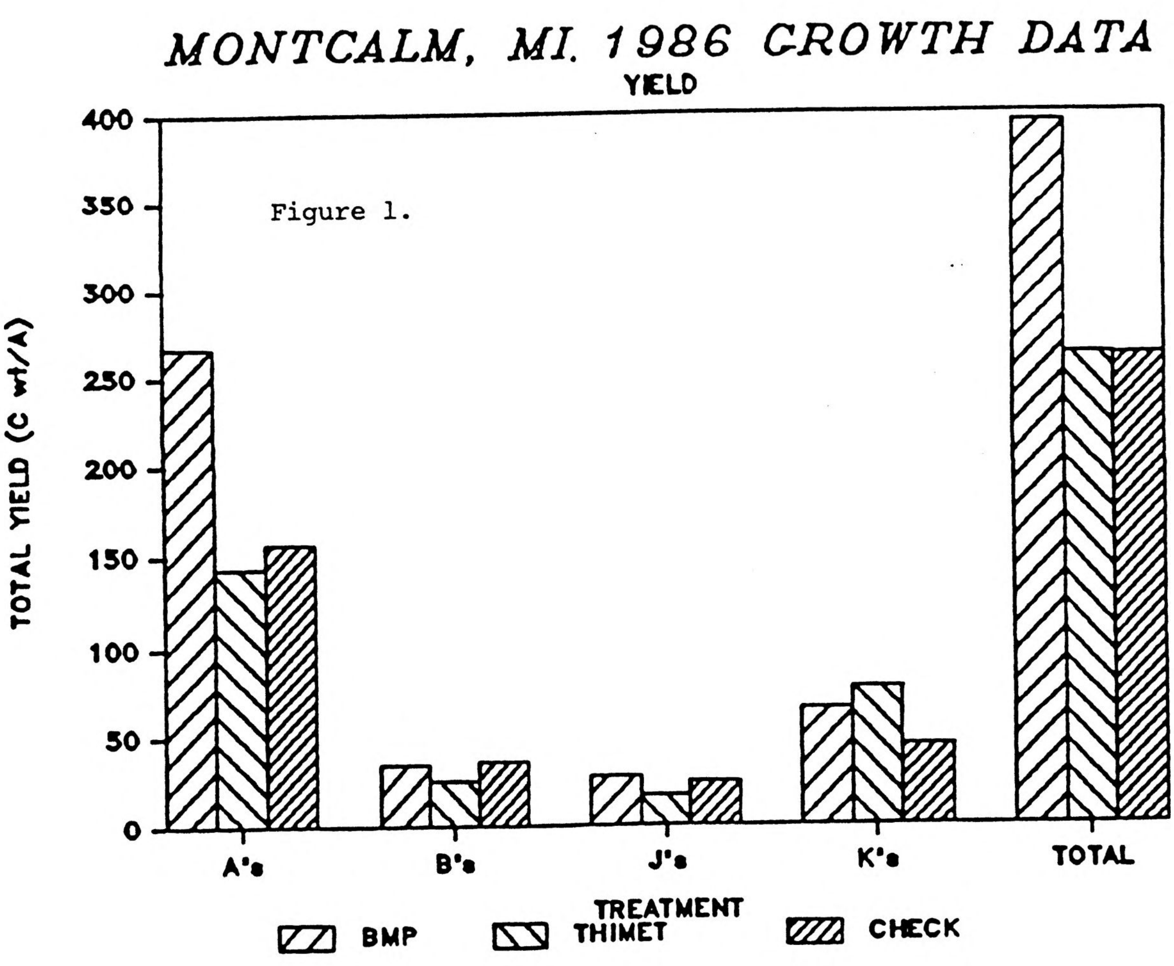


Table 1. Economics of Potato Early-Die Control

Best Management Practice			
>10 oz	39 cwt	$8.00/cwt	$312.00
4-10 oz	278 cwt	6.00/cwt	1,668.00
<4 oz	31 cwt	1.50/cwt	46.50
Ks	63 cwt	3.00/cwt	189.00
Gross/A	411 cwt		$2.215.50
Production Costs			1,150.00
Net/A			$1,065.50
No PED Control			
>10 oz	30 cwt	$8.00/cwt	$240.00
4-10 oz	158 cwt	6.00/cwt	948.00
<4 oz	33 cwt	1.50/cwt	49.50
Ks	51 cwt	3.00/cwt	153.00
Gross/A	272 cwt		$1,390.50
Production Costs			1,000.00
Net/A			$390.50

A nematicide evaluation trial with Superior at the Montcalm Potato Farm showed continued season-long control of the root-lesion nematode with Temik 15G, and similar nematode population reduction with Mocap 15G or Mocap + (Table 2). SN556 and SN61 provided nematode control similar to Vorlex, with the high rate of SN61 possibly being superior. This site had not been used for potato production for about 8 years, and the incidence of PED was very low.

No yield benefits were observed in a nematicide trial in Rogers City (Table 3). Although the root-lesion nematode was present, no Verticillium dahliae was detected at planting, and the population density was very low during the growing season. PED symptoms were not observed.

Table 2. 1986 Montcalm Potato Nematicide Trial.

Treatment	Yield (cwt/A)	Pratylenchus penetrans/100 cm³ soil & 1.0 g root tissue					
		4/28	5/13	6/23	7/28	8/28	9/8
DiSyston	449	58a	38ab	42ab	182a	124b	126a
Temik	493	41a	32ab	7a	17b	3a	4a
Vorlex & DiSyston	473	33a	2a	13a	24b	72ab	29a
SN556 & DiSyston (10)	468	68a	1a	8a	42b	62ab	28a
SN556 & DiSyston (15)	472	76a	3a	14a	38b	22a	38a
SN61 & DiSyston (10)	494	59a	6a	10a	26b	48a	36a
SN61 & DiSyston (15)	455	72a	1a	2a	5b	11a	3a
Mocap & DiSyston (6)	498	66a	52b	7a	13b	4a	58a
Mocap & DiSyston (12)	456	55a	55b	4a	0b	0a	5a
Mocap + (6)	506	46a	27ab	5a	5b	2a	63a
Mocap + (12)	477	40a	37ab	2a	2b	1a	71a

Table 3. Rogers City 1986 Potato Nematicide Trial.

Treatment	Yield (cwt/A)	Pratylenchus penetrans/100cm³ soil & 1.0 g root				
		5/21	5/30	7/2	8/21	9/10
Temik	404	16	23	5	10	26
Temik & Telone II	350	23	3	3	3	3
Temik & Vorlex	397	13	6	2	6	5
Thimet	380	16	23	22	96	21
Thimet & Telone II	403	23	3	8	31	20
Thimet & Vorlex	456	13	6	2	7	7

Verticillium dahliae colonies/1.0 g soil = 0.04 (0.00-0.40, n = 10).

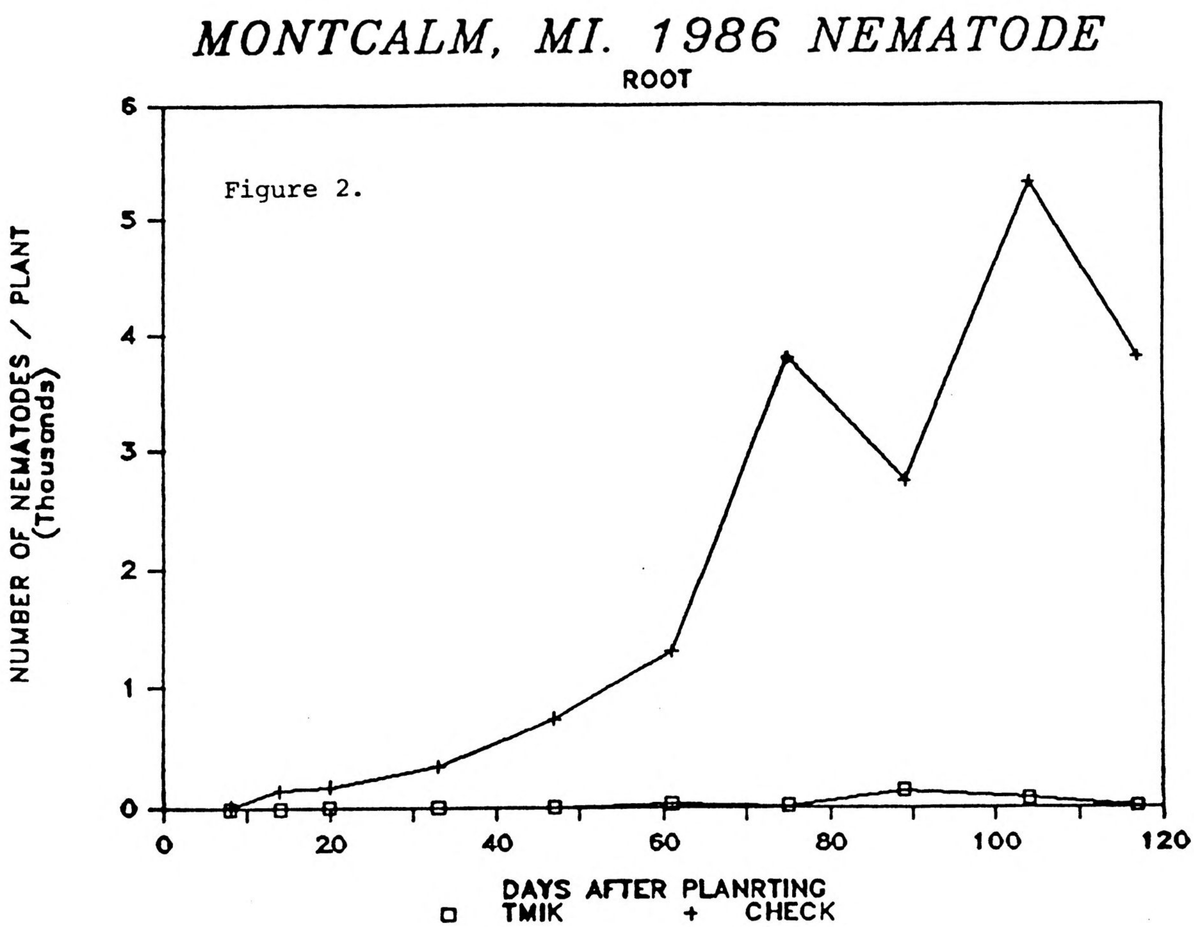
POTATO EARLY-DIE DISEASE COMPLEX OBSERVATIONS

Root-lesion nematodes penetrated potato feeder roots as soon as they were produced (Figure 2). High root population densities of this nematode were recovered as early as 14 days after planting. Root-lesion nematode population densities increased throughout the growing season, reaching a maximum of about 55,000 per plant.

In a microplot experiment, root-lesion nematodes were recovered from potato feeder roots 15 days after planting (Table 4). V. dahliae was recovered from below ground stems 21 days after planting. The fungus was also recovered from the skin, eyes and center of seed pieces.

Potato plant dry weight had been significantly impacted by PED as early as 33 days after planting (Figure 3). Root-lesion nematodes were recovered from both stolon tissue and tubers (Table 5).

As with the 1985 research data, tuber yields were lower where potatoes were previously grown, compared to first-year potato land (Table 6). There also appeared to be a relationship with root-lesion nematodes.



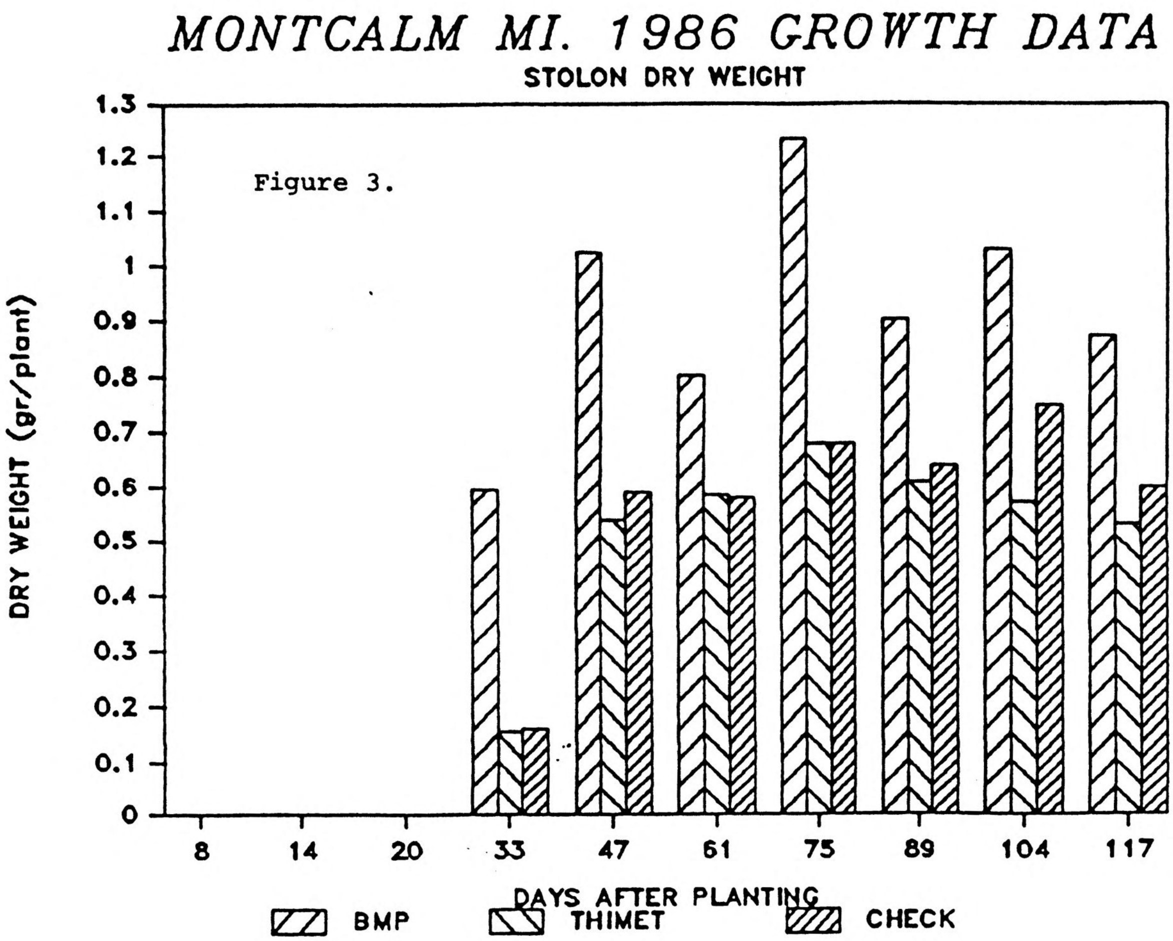


Table 4. 1986 Microtile Experiment.

Root-lesion Nematode
- 15 days after planting (15 P. penetrans)
- 18 days after planting (10 P. penetrans)
- 21 days after planting (38 P. penetrans)

Verticillium dahliae
- 21 days after planting
  - 1 BGS 1st 5 mm
  - 1 BGS 1st 15 mm

Superior seed

Skin	+ V. dahliae
Eyes	+ V. dahliae
Center	+ V. dahliae

Table 5. Root-Lesion Nematodes Recovered from Potato Stolon and Tuber Tissue.

Stolons

August 4, 1986
88 P. penetrans/1.0 g stolon
fresh weight (n = 10 plants)

September 1, 1986
40 P. penetrans/ 1.0 g stolon
fresh weight (n = 6 plants)

Tubers

September 1, 1986
0.5 P. penetrans/ 1.0 g tuber
fresh weight (n = 6plants)

Table 6. 1986 Potato Production Observations.

Antrim County **No Potato Early-Die Control**		
1st year	425 cwt	0 PP/RK
1st year	521 cwt	0 PP/RK
1st year	489 cwt	0 PP/RK
20 Yrs Pasture	421 cwt	5 PP/RK
83 Potatoes	380 cwt	97 PP/RK

CHEMIGATION

In most cases, 40 gal/A of metham was adequate for optimum tuber yields and root-lesion nematode control (Table 7). No differences were observed among Vapam, Busan 1020 and Nemasol. Spring chemigation was satisfactory in 1986. A positive response was obtained from a spring soil spray application of metham followed by discing.

V. dahliae control was not obtained with 27 gal Vapam/A. Control of this fungus with 103 gal of Vapam/A was superior than 53 gal/A of Vapam (Table 8).

Table 7. Influence of Metham on Potato Yield and Nematode Control.

Treatment	Yield	Root-lesion Nematode
0 gal Busan 1020 f	300	0% control
25 gal Busan 1020 f	417	99% control
50 gal Busan 1020 f	490	100% control
100 gal Busan 1020 f	485	100% control
40 gal Vapam f	487	100% control
50 gal Vapam f	488	99% control
50 gal Vapam f	498	100% control
50 gal Vapam s	467	100% control
40 gal Nemasol f	436	100% control
50 gal Nemasol f	488	100% control
50 gal Vapam s	281	(dry corner disc)
0 gal Vapam s	159	(dry corner disc)

Table 8. Verticillium dahliae Colonies/1.0 g Soil

Treatment	5/2	6/27	7/24	9/4	10/4
Antrim County					
0 gal Vapam	3.5	4.7	31.0	27.9	7.8
27 gal Vapam	4.4	4.6	22.4	20.9	5.4
53 gal Vapam	0.4	0.8	11.4	13.7	6.2
103 gal Vapam	0.0	0.0	0.0	0.2	0.1
Montcalm County					
50 gal Vapam	0.4 (0.0-1.2)				
Loam Check	1.3 (0.5-2.4)				
Sand Check	6.6 (10.1-4.2)				

VERTICILLIUM DAHLIAE ASSAY OBSERVATIONS

Population densities of V. dahliae increased throughout the growing season (Table 8). Population densities were variable both within individual potato fields, and between fields and farms (Table 9). The population densities ranged from non-detectable (0.00 colonies per 1.0 g soil) to very high (56.0 colonies per 1.0 g soil). Population densities of V. dahliae were greater in sandy soils than in sandy loams.

Table 9. Verticillium dahliae Colonies/1.0 g Soil

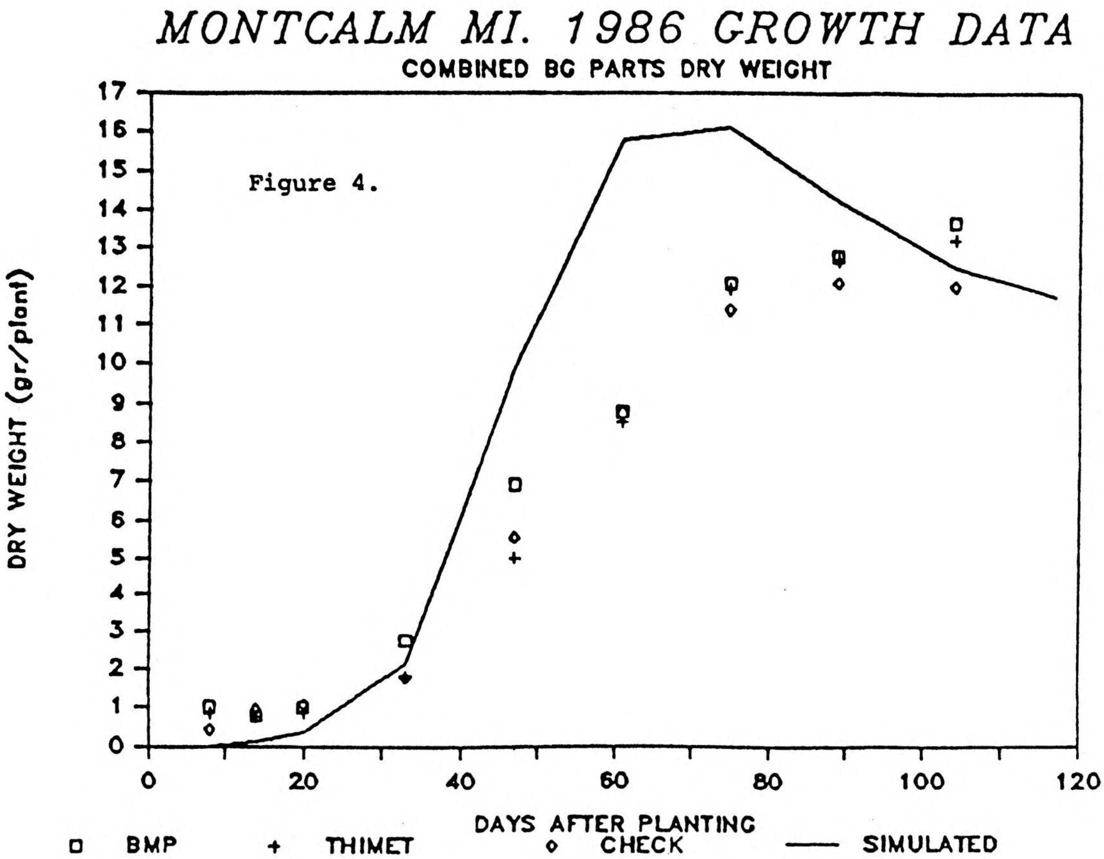
Montcalm County	
Farm No. 1	
Field No. 1	4.9 (0.0-20.4)
Field No. 2	2.0 (0.0-7.2)
Field No. 3	1.8 (0.0-5.2)
Farm No. 2	
Field No. 1	2.8 (0.0-6.0)
Antrim County	
Farm No. 1	
Field No. 1	3.9 (0.0-19.0)
Field No. 2	0.7 (0.0-6.0)
Field No. 3	32.7 (16.8-56.0)

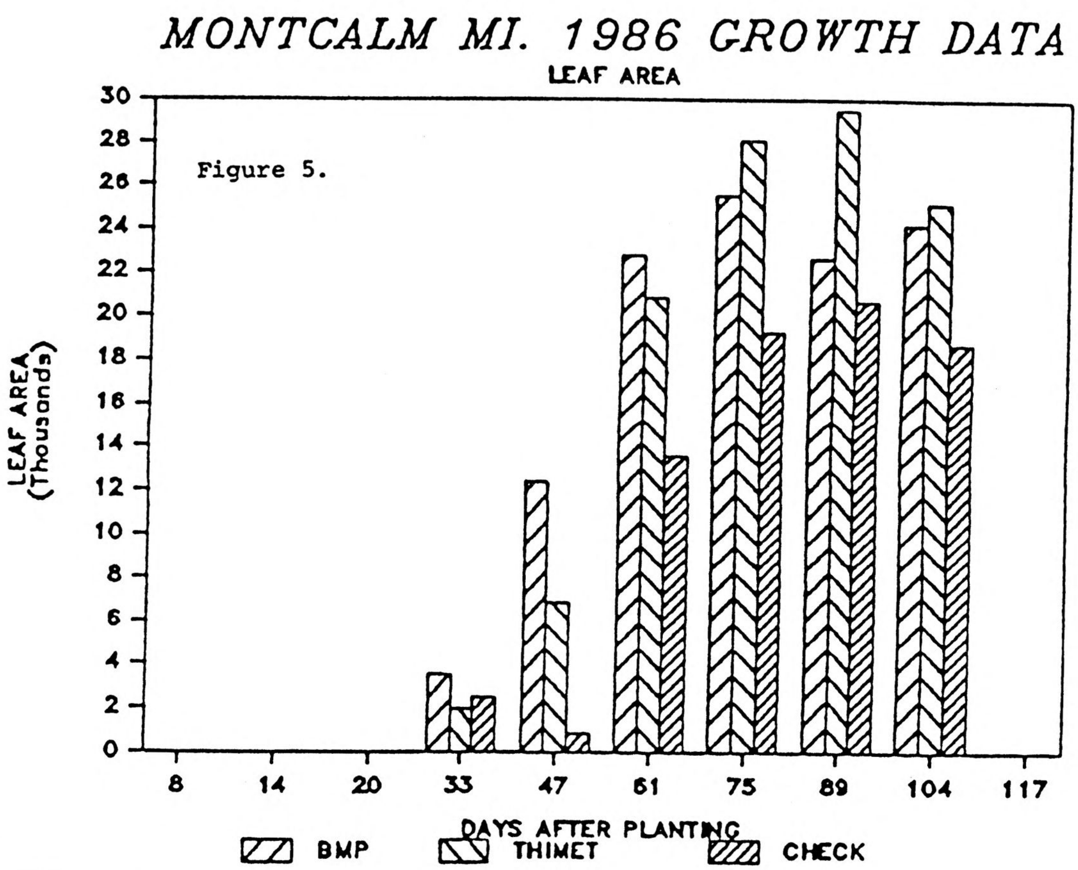
POTATO MODEL VALIDATION

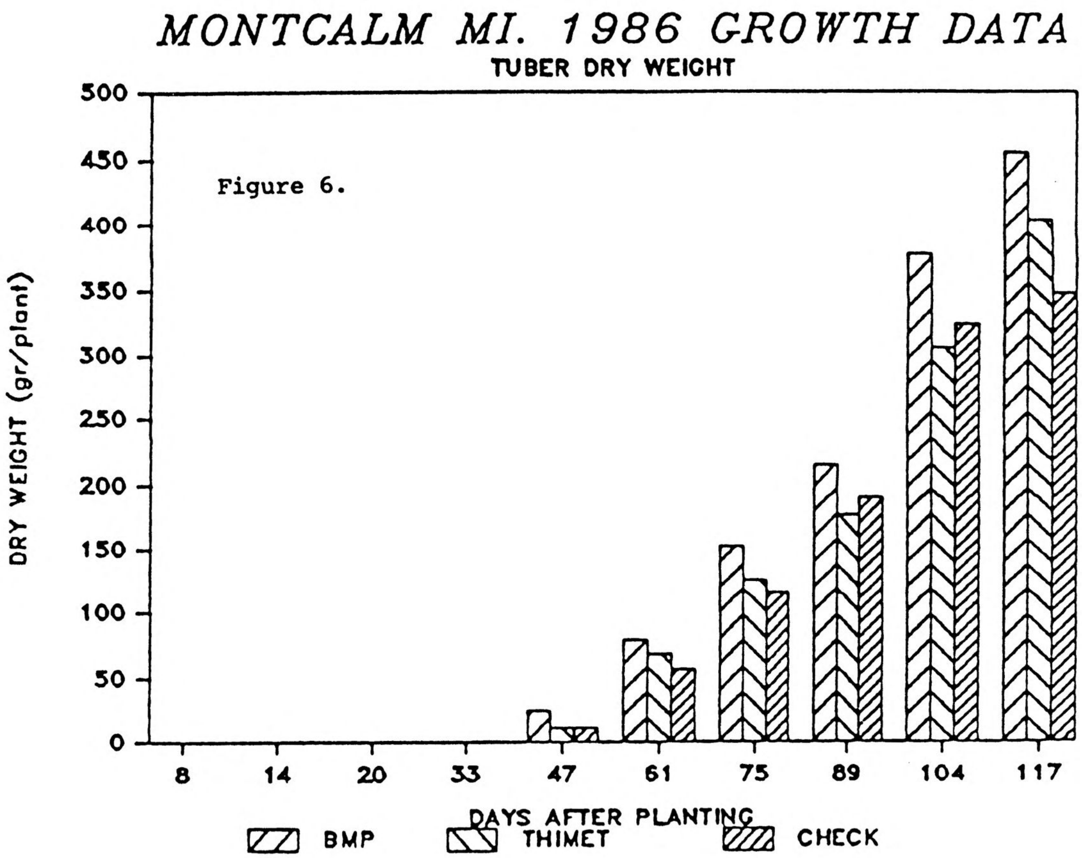
Four computer simulations of potato growth and development and associated pests are being evaluated in a joint integrated pest management research project at Michigan State University, University of Minnesota, North Dakota State University and the University of Wisconsin (Table 10). Figure 4 is an example of a POTATOPEST computer simulation of dry weight of the below ground parts of the potato plant compared to actual Russet Burbank data collected at the Montcalm Potato Farm during 1986. All components of the potato plant are being studied in detail (Figures 5-7).

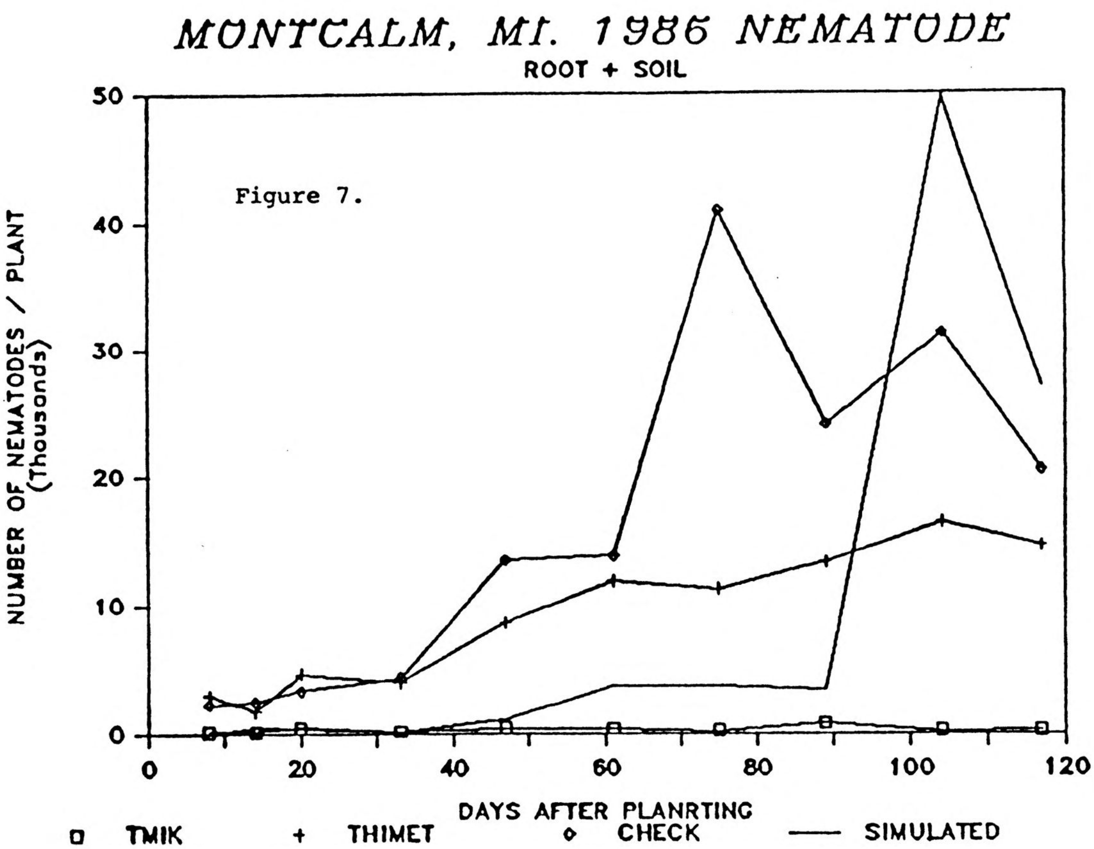
Table 10. Potato Growth Models Used in the MI/MN/ND/WI Potato Model Validation Project.

Model	Date	Authors	Institution
POTATOPEST	1974	G.W. Bird	MSU
POTATO	1982	Loomis/Ng Adams/Rouse	ID/UC-Davis Univ. WI
SPUDGRO	1984	P. Teng	Univ. MN
POTATO CERES	1985	J. Ritchie	MSU


MONTCALM MI. 1986 GROWTH DATA
COMBINED BG PARTS DRY WEIGHT
Figure 4.
DRY WEIGHT (gr/plant)
DAYS AFTER PLANTING
BMP
THIMET
CHECK
SIMULATED


MONTCALM MI. 1986 GROWTH DATA
LEAF AREA
Figure 5.
LEAF AREA (Thousands)
DAYS AFTER PLANTING
BMP
THIMET
CHECK


MONTCALM MI. 1986 GROWTH DATA
TUBER DRY WEIGHT
Figure 6.
DRY WEIGHT (gr/plant)
500
450
400
350
300
250
200
150
100
50
0
8
14
20
33
47
61
75
89
104
117
DAYS AFTER PLANTING
BMP
THIMET
CHECK


MONTCALM, MI. 1986 NEMATODE
ROOT + SOIL
Figure 7.
NUMBER OF NEMATODES / PLANT
(Thousands)
50
40
30
20
10
0
0
20
40
60
80
100
120
DAYS AFTER PLANRTING
TMIK
THIMET
CHECK
SIMULATED

Funding: MPIC

PROGRESS REPORT TO THE MICHIGAN POTATO IMPROVEMENT COMMITTEE

EFFECT OF SPRAY SCHEDULE AND POTATO CULTIVAR ON DEVELOPMENT OF EARLY BLIGHT AND EFFECT OF EARLY BLIGHT ON YIELDS

M. L. LACY
Department of Botany and Plant Pathology
Michigan State University

1986

Objectives: To determine the effect of three fungicide spray schedules (every 7 days, every 14 days, and unsprayed) on development of early blight and on yield in six potato cultivars.

Procedures: Six potato cultivars (Onaway, Atlantic, Superior, Shepody, Russett Burbank, and Rosa) were planted in plots at the MSU Botany and Plant Pathology Farm on May 1. Approximately 800 pounds per acre of 12-12-12 fertilizer was applied prior to planting. No nitrogen side-dress was applied to encourage early blight development. Insects (mostly Colorado potato beetle) were controlled with three applications of Sevin 80W (1.25 lbs per acre) and one application of Imidan 50W (2 lbs per acre). Weeds were controlled with a pre-emergence application of Lorox 50W and one application of Fusilade 4E (6.8 oz. per acre) plus cultivation.

Plots were sprayed with a conventional boom sprayer delivering 50 gallons per acre at 100 PSI. Each row was sprayed with two D2-25 nozzles, one on each side of the row, from a 45 degree angle. Plots were set up on a split plot design with each cultivar replicated 4 times and each fungicide treatment replicated 4 times on each cultivar. Guard rows were inoculated with spores of the early blight fungus on 7/25 and all plots were inoculated on 8/5/86. Dithane M-45 80W (1.8 lbs per acre = 1.45 lbs active) was applied every 7 days, every 14 days, or not at all beginning on July 3 and ending on August 26 (8 applications on the 7 day schedule and 4 applications on the 14 day schedule).

Visual disease ratings estimating % of diseased foliage were made on August 18, vines were killed with paraquat on September 3, and tubers were harvested on October 8 (harvest was delayed due to heavy rains the latter part of September).

Results: Cultivar was clearly an important factor in both disease rating and in yields (Table 1). Shepody had the lowest disease ratings of any cultivar for any given treatment, and it outyielded all other cultivars, regardless of treatment, including the unsprayed. Cultivars could be ranked in order of decreasing yields regardless of fungicide treatment in most cases, in the order Shepody (highest), Atlantic, Rosa, Russett Burbank, Superior, and Onaway. In no case did fungicide treatment significantly increase yields, which was a great surprise to me. However, fungicides did have a significant impact on disease ratings in most cases.

In examining the recent literature, I found that other researchers have had similar experiences. Rowe in Ohio and Stevenson in Wisconsin both found that differences in disease severity due to fungicide application were not reflected in yield differences in some of their experiments. In Washington, Eaton and Nagle found that application of Bravo through center pivot irrigation significantly reduced lesion numbers but did not reduce yields. On the other hand, Teng and Bissonnette at Minnesota found that both spray schedule and cultivar were significant determinants of yield; however, they only used two cultivars, Norland and Russett Burbank.

It appears from this experiment and the experience of others that cultivar is probably the most important determinant of early blight's effect on yield, although not necessarily on development of foliar lesions. This may not be too surprising if we extrapolate from the results of Baker and Wilcox, who examined the effects of removing different amounts of leaf tissue at different times on onion yields. They found that leaf area reduction had the largest effect on yields when it occurred at the time of bulb initiation about 5 weeks prior to harvest. Defoliation prior to or subsequent to this time had decreasing effects on yields as the timing moved further away from this critical period. They also found that it took about 50% defoliation or greater to have a significant effect on yields so it may be that plants have a "safety margin" of leaf tissue that can be lost before yields are materially affected.

It may be that severe early blight developed too late in this experiment to significantly affect yields. We had our only dry period of the summer during July and early August which were probably the critical times for tuber formation, and we inoculated our plots on July 25 and August 5. Early blight did not really become severe until late August. I believe that next year we should inoculate earlier; however, the early period when nitrogen fertilizer levels are still high and potato tissue still vigorous may not be very conducive to disease development.

Table 1. Disease Ratings and Yields of Potato Varieties Infected with Early Blight, Sprayed with Dithane M-45 or Left Unsprayed, 1986.

Variety	Spray Schedule*	Disease Rating**	Yield (CWT/A)	Percent Rot***
Shepody	7 Day	1.0 A	410.77 A	2
Shepody	14 Day	1.5 ABC	407.79 A	0
Shepody	Unsprayed	2.5 DE	377.30 AB	0
Atlantic	14 Day	2.8 DEF	342.82 ABC	10
Atlantic	7 Day	2.3 BCD	320.17 BCD	10
Atlantic	Unsprayed	3.5 FGH	306.95 BCDE	24
Rosa	14 Day	3.0 DEF	298.60 BCDEF	0
Rosa	Unsprayed	3.8 FGH	277.11 CDEF	0
Rosa	7 Day	2.5 CDE	275.66 CDEFG	4
R. Burbank	14 Day	2.8 DEF	261.72 CDEFG	0
R. Burbank	7 Day	2.0 BCD	253.74 CDEFG	2
Superior	Unsprayed	5.0 J	251.70 DEFG	10
Superior	14 Day	4.8 IJ	237.04 DEFG	8
R. Burbank	Unsprayed	3.5 FGH	236.17 DEFG	4
Onaway	7 Day	1.3 AB	226.73 EFG	4
Onaway	Unsprayed	2.8 DE	222.01 EFG	6
Superior	7 Day	4.0 GH	211.77 FG	0
Onaway	14 Day	2.0 BCD	184.40 G	0

*Plots were sprayed with 1.8 lbs. of Dithane M-45 80% WP.
**Based on a visual rating scale of 1 to 5, where 1=0-2%, 2=3-10%, 3=11-25%, and 5=>50% of tissue diseased. Disease ratings were made on 8/18/86.
***Total amount of tuber rot after 11 weeks in storage at 45 F.
Means followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=.05). Harvested 10/8/86.

Table 2. Comparison of Fungicide Sprays on Yields of Six Potato Varieties with Yield Data Pooled, 1986.

Spray Schedule*	Yield (CWT/Acre)
Every 7 Days	288.95 A
Every 14 Days	283.14 A
Unsprayed	278.78 A

*Sprayed with 1.8 lbs per acre Dithane M-45 80% WP.

Means followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=.05)

Table 3. Yields of Six Potato Varieties with Data from Spray Treatments Pooled, 1986.

Variety*	Yield (CWT/Acre)
Shepody	398.57 A
Atlantic	323.07 B
Rosa	283.87 BC
R. Burbank	250.47 CD
Superior	233.77 D
Onaway	211.27 D

*Varieties were sprayed every 7 or 14 days or left unsprayed.

Means followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=.05)

Title: Influence of Environmental Factors on Wound Healing of Potato Tubers in Relation to Storage Disorders

Investigators: R. Hammerschmidt and A. Cameron

Justification:

Wounding of potato tubers commonly occurs during harvesting and handling. It is well established that physical and chemical barriers formed during the early stages (1-2 weeks) of wound healing can reduce subsequent shrinkage (water loss) and pathogen-mediated decay during storage. Additionally, the rate and extent of wound healing is influenced by environmental factors such as temperature, humidity, oxygen and carbon dioxide. However, knowledge of optimal conditions is incomplete, particularly under commercial storage conditions. Research is needed to provide information which then can be used to aid in design of potato storage facilities which will provide conditions that minimize losses due to shrinkage and disease.

Objectives:

A. Develop and refine rapid screening methods for parameters of wound healing most closely linked to resistance to shrinkage and pathogen-mediated decay. Specifically, this includes resistance to water loss, production of lignin and wax, and resistance to pathogen inoculation and tissue maceration.

B. Utilize screening methods to test effects of environmental factors and of extended storage duration. Ultimately, the objective is to establish upper and lower limits for factors such as temperature, humidity, O_2 and CO_2 which can be used for design of potato storage facilities.

C. Screen selected varieties for wound healing using methods developed in Part A. In addition, determine varietal responses to environmental factors.

D. Screen selected varieties for resistance to Fusarium and Erwinia tuber rots.

Procedures:

A. Screening methods.

1. Resistance to water loss: A standard method has been developed utilizing potato discs of 2.1 cm diameter and 1 cm thick. Potato tubers are surface sterilized prior to slicing. Discs are placed at 20°C in chambers through which humidified air (90-95% RH) is passed at a constant flow rate. Generally, discs are sampled for water loss at 0, 2, 4, 6, 8 and 10 days after wounding. Each disc is placed separately on a balance (accurate at 0.1 mg) which measures the rate of weight loss at 5 sec intervals and transfers the data to a computer. A separate computer program was written to analyze and display the data for visual confirmation of the results. The resistance to water loss was calculated using the rate of water loss and the ambient temperature and RH measured within the balance chamber.

2. Lignin production: Lignin is a major structural component of suberin, therefore monitoring production of this polymer can be used as a measure

of suberization. Generally, the top mm of discs (prepared as above) were sampled at intervals after wounding. Each set of slices from the discs are thoroughly extracted with methanol and then chloroform. The insoluble residue is analyzed by the thioglycolic acid procedure for lignin content. Slices were also evaluated for lignin by histochemical techniques. The methanol and chloroform soluble materials are saved for analysis of waxes and wound-induced antibiotic compounds.

3. Resistance to maceration: Both Erwinia and Fusarium attack tuber tissue using enzymes that macerate or degrade the tissue. Solvent extracted slices (see above) are incubated with a preparation of tissue degrading enzymes. Coherency of tissue after 24 h in the enzyme solution is a measure of wound induced resistance to these factors.

4. Wound induced antibiotic substances and waxes: The methanol soluble fraction can be assayed for antibiotic (antifungal and antibacterial) phenols by applying small amounts of the extracts onto filter paper. After drying of the solvent, the filter papers are sprayed with a suspension of the pathogen in a nutrient solution. Antibiotic materials appear as clear zones on a background of fungal growth. Total phenol was determined spectrophotometrically. Wax analyses methods are still under development.

5. Resistance to pathogen inoculation: At intervals (0, 2, 4, 6 days) after wounding, the discs were challenged with a suspension of Fusarium sambucinum macroconidia (the dry rot pathogen). One week later, discs were visually assessed for dry rot infection and rated as infected or not-infected.

B. Environmental factors and storage duration.

1. Storage duration: Russet Burbank tubers were stored at $5^{\circ}C$ ($41^{\circ}F$) and sampled several times during storage up to 8 months.

2. Effect of CO_2: CO_2 was blended into air stream to yield final concentration of 8% during wound healing period. Discs were sampled for resistance to water loss as outlined above.

C. Varietal screening.

1. During fall of 1986, 14 varieties of potato tubers were harvested and tested for development of barriers to water loss and pathogen infection and timing of resistance development. Methods were comparable to those described above.

2. Whole tubers were evaluated for genetically based resistance to Fusarium dry rot and Erwinia soft rot. Whole tubers were injected with 10 ul of F. sanbucinum or 50 ul of E. carotovora. Fusarium inoculated tubers were incubated at $20^{\circ}C$ for 3 weeks prior to disease assessment while Erwinia inoculated tubers were evaluated at 96 h. Amount of disease was determined by measuring lesion size after bisecting the tuber through the lesion.

Results:

A. Screening method.

1. It was found that the resistance to water loss could be consistently calculated using data from 2 minutes of weight loss data. In almost every case, resistance to water loss begins to increase 3 days after wounding with a very large increase on day 4. Resistance to water loss continues to develop but at a slower rate through day 10.

2. Use of the thioglycolic acid method indicated this part of wound healing began between 1 and 2 days after wounding. Largest increases occurred between 2 and 5 days after wounding. Microscopic observations using histochemical techniques confirmed these results.

3. Maceration tests indicated that the coherency of the suberized layer was complete by 3-5 days after wounding.

4. Analysis of the methanol soluble materials revealed that accumulation of wound induced antibiotic materials (mostly phenols) started within 24 h of cutting. These reached apparent antibiotic levels within 2-3 days.

B. Environmental factors and storage duration.

1. Storage duration: There was no significant difference in the rate and pattern of water loss during wound healing noted for tubers sampled through 8 months of storage.

2. Effect of CO_2: Carbon dioxide exposure during wound healing marked decreased rate of water loss barrier formation. The initiation of resistance to water loss did not begin until 6 days after wounding and exposure to 8% CO_2 compared to only 3 days when in air. However, 10 days after wounding, there was little difference between air and carbon dioxide treated discs.

3. Air flow: It was discovered that when discs were held in closed containers rather than in constant air, there was consistently a higher rate of mold development on the cut surfaces. In all cases, molds were associated with lowered resistance to water loss.

C. Varietal screening.

1. Preliminary data indicate that shortly after harvest, all 14 varieties exhibit very similar rates and patterns of development of resistance to water loss during wound healing.

2. Some variation among varieties was noted in the whole tuber susceptibility to Fusarium and Erwinia, wound induced resistance to Fusarium and wound induced phenol and lignin accumulation.

Conclusions:

1. Screening methods for measurement of resistance to water loss and structural and chemical barrier formation during wound healing were developed to yield consistent results.

2. Wounded potato tubers initiate barriers to water loss 3 days after wounding with the greatest increase at 4 days. Structural barriers are initially evident within 2 days and increases greatest between 2 and 5 days. Barriers continue to develop for at least 10 days after wounding.

3. There appears to be no loss in ability to generate barriers to water loss during wound healing for at least 8 months of storage at 5^{o}C (41^{o}F), however, resistance to Fusarium in these tubers did decline.

4. Eight percent CO_2 retards development of barriers by 3 days during a period which is critical for pathogen interactions.

5. Lack of air movement during wound healing is very conducive to mold development which is asociated with loss of ability to resist water loss.

6. No differences were noted in ability to develop water barriers during wound healing for 14 varieties of freshly harvested potato tubers. Some differences (1-2 days) in wound related lignin synthesis, phenol accumulation and resistance to Fusarium were detected. The first 3 days appear critical.

7. No resistance to Fusarium nor Erwinia was detected in whole tubers. However, there was variation in the amount of susceptibility from variety to variety. Double inoculations with both pathogens resulted in more disease than with either separately.

8. Resistance to pathogen attack may be due to a mixture of wound repair and constitutive factors in the tubers.

Funding: Federal Grant

SIMULATED POTATO STORAGE RESEARCH: 1985-1986

INVESTIGATORS: Burt Cargill, Todd Forbush

GOAL AND OBJECTIVES:
The overall goal of the 1985-86 Simulated Potato Storage research was to determine the practicality of an operational potato storage research facility which will accurately simulate the storage environment encountered in a typical commercial bulk potato storage. The specific objectives include:

1. Comparison of the out of storage quality of potatoes from the storage research facility and from a companion commercial bulk storage

2. Evaluation of equipment for monitoring and controlling the environment of a bulk potato storage

JUSTIFICATION:
In the past potato storage research has been conducted at two levels: using commercial potato storage bins (10,000 cwt and larger) and using small samples (25 lb.) stored in environment controlled cubicles. The commercial bins are grower owned and operated, making controlled research difficult. The small samples are good for developing base line data regarding the response of potatoes to different environmental conditions. However they lack the effect of storage conditions encountered in bulk potato storages such as pile depths, bin pressures, and variations in air flow.

There is a need for potato storage research facility that can make the transition from small sample research to commercial bulk potato storage conditions. The research facility must be able to accurately simulate bulk storage conditions, yet be small enough to allow for replications using equivalent potatoes and environments within the same season.

METHODS AND PROCEDURES:
A storage research bin measuring 8'X 8'X 16' (see Fig. 1 and 2) was constructed and placed within a commercially stored potato pile at Sandyland Farms in Howard City, MI. This bin was filled with approximately one acre of potatoes (300 cwt.) identical to those in the pile surrounding it.

The air handling system of the "Simulated Storage" was designed to deliver 3.0 cfm/cwt, twice the current recommendations for bulk potato storage in Michigan. The commercial storage was ventilated at the industry standard of 1.5 cfm/cwt. The intake air of the Simulated Storage was removed from above the commercial storage. Even air distribution within the Simulated Storage was obtained through the use of an under floor plenum (see Fig 1).

The fans used for ventilation of both storages were under the control of a commercially available Paragon time clock set by Michigan State University for the Simulated Storage bin and by Sandyland Farms for the commercial bin. Both fans were run continuously during the period of suberization. Fan times were then decreased at the discretion of the management of the respective storage

Small samples (25 lb of potatoes) were placed at three levels (6,10, and 12 foot above floor level) within both the commercial storage and the Simulated

Storage. Upon removal from storage these samples were evaluated for market quality using the procedure outlined by Cargill, et al. (1985).

Four large samples (80 lb. each) were randomly selected from the Simulated Storage during unloading. Two samples were chosen at the same time from the commercial storage. The samples were taken to the Frito-Lay plant in Allen Park, MI for evaluation of chip color and percent solids.

Throughout the storage season, different types of environmental monitoring systems were installed on the Simulated Storage and evaluated on their performance in monitoring the environment of the storage and on their ability to control the storage environment. Parameters of interest included the temperature and relative humidity of the environment surrounding the potato, as measured from within the potato pile. The instrumentation systems were tested included:

1. A Digi-Strip data logger by Kaye Instruments,
2. A CR21 weather logger by Campbell Scientific,
3. A 21X weather station control by Campbell Scientific

RESULTS:

FAN TIME - The fan time of both the commercial storage and the Simulated Storage were recorded on a weekly basis. The fan time for both storages are presented in Table 1. The total fan time of the Simulated Storage during the 122 day storage season was approximately 531 hours, compared to approximately 1392 hours for the commercial bin. The reduction in the fan time could reduce the energy required for ventilating the potatoes by 24%.

POTATO QUALITY - The market quality of the potatoes as determined from the examination of the individual potatoes is listed in Table 2. A market quality of the potato samples from the Simulated Storage averaged 85.0%, with an observed vertical gradient of 10%. The market quality of the potato samples from the commercial storage averaged 78.7%, with an observed gradient of 25%. The potatoes of higher quality were those stored near the air inlet into the potato pile (the 6 foot level) in both cases while the potatoes furthest from the air inlet (the 12 foot level) were of lower quality.

CHIP COLOR - The results of the chip color analysis carried out by Frito-Lay are presented in Table 3. All potato samples received a number 2 color designation (55-64 Agtron). The samples tested showed no significant difference in chip color.

PERCENT SOLIDS - An evaluation of the large samples for percent solids, performed during the chip color evaluation and presented in Table 3. The evaluation gives some indication of the amount of water lost during the storage season. The value of 12.6% obtained for the Simulated Storage is 1.1% less than the value obtained in the commercial storage. This lower value for percent solids indicates that the potatoes within the Simulated Storage retained more of their original fluid content than did the commercially stored potatoes.

Cargill, BF, et al. 1985. Influence of prestorage chemical treatments on out-of-storage market quality of potatoes. ASAE Paper 85-4028.

WEIGHT LOSS - The weight loss from the small samples in both storages are presented in Table 4. The data indicates that, on the average, the Simulated Storage lost more weight (water) due to ventilation than did the commercial storage. The validity of this data is questionable since different scales were used for determining initial and final weights.

ENVIRONMENTAL CONTROL - The Digi-Strip data logger did not record the data well on impact paper due at the high humidity in the storage. The CR21 by Campbell Scientific performed well in the harsh environment, but was not completely compatible with the temperature sensors (copper-constantan thermocouples).

The best performance was obtained from the 21X weather station controller. The data output was in a desirable form and easily recoverable, using a cassette tape for data storage and a reader for placing data on disk file. The 21X was used to monitor the inlet air temperature and the temperature within the Simulated Storage at the 6 ft and 10 ft levels (see Fig. 3 and 4). A temperature gradient was observed indicating that the fan operation period was not long enough to allow the temperature front to move through the pile. Thus, the temperature gradient within the Simulated Storage, as indicated in Figure 3, increased with time up to 1.0F.

CONCLUSIONS:

The results of this pilot study indicate that the storage research facility can accurately simulate the out of storage quality of stored potatoes when compared to a companion commercial bulk storage. In addition, the data from this years study indicates that there may be some advantages in the use of high volume, low fan time air flow in the extended storage of potatoes. The potatoes subjected to this type of air flow maintained a higher marketable percent solids and a chip color equivalent to potatoes subjected to normal ventilation airflow.

The instrumentation systems tested were successful in recording the temperatures within the potato storage. However, they were deficient in the number of control ports and the conditions of control port activation. Further investigation into the field of instrumentation is required to obtain an environmental controller capable of handling the complex task of controlling a potato storage environment.

TABLE 1
Fan time for MSU Simulated Storage and for companion commercial bulk storage.

Fan Operation Dates	Elapsed Days	Fan Hours per Day[1] MSU	Fan Hours per Day[1] Bulk	Fan Hours Total MSU	Fan Hours Total Bulk
10/02/85 - 10/07/85	6	24	24	144	144
10/08/85 - 10/14/85	7	7	24	49	168
10/15/85 - 10/24/85	10	7	12	70	120
10/25/85 - 11/21/85	28	4	12	112	336
11/22/85 - 12/05/85	14	3	12	42	168
12/06/85 - 01/31/86	57	2	8	114	456
TOTAL	122	--	--	531	1392

[1] Fan time was divided into equal increments within each 12 hour period of the day.

TABLE 2
Market quality (% by number) of potatoes stored in MSU Simulated Storage and companion commercial bulk storage.

Sampling Position (feet above floor)	MSU	Bulk
6	89.6%	92.6%
10	85.6%	76.1%
12	79.8%	67.3%
AVERAGE	85.0%	78.7%

TABLE 3
Chip color and percent solids for MSU Simulated Storage and companion commercial bulk storage.

	Chip Color (Agtron scale) MSU	Chip Color (Agtron scale) Bulk	Percent Solids MSU	Percent Solids Bulk
	61	64	12.8	13.6
	62	60	12.7	13.8
	63	--	12.0	--
	60	--	12.9	--
AVERAGE	61.5	62.0	12.6	13.7

TABLE 4
Weight data for MSU Simulated Storage and companion commercial bulk storage.

Sampling Position (feet above floor)	Weight Loss, %[1] MSU	Bulk
6	6.8	4.3
10	9.7	6.0
12	4.6	6.5
AVERAGE	7.0	5.6

[1] Due to error in weighing techniques and the use of different scales for determining beginning and ending weights, the weight loss data recorded in this table has questionable validity.

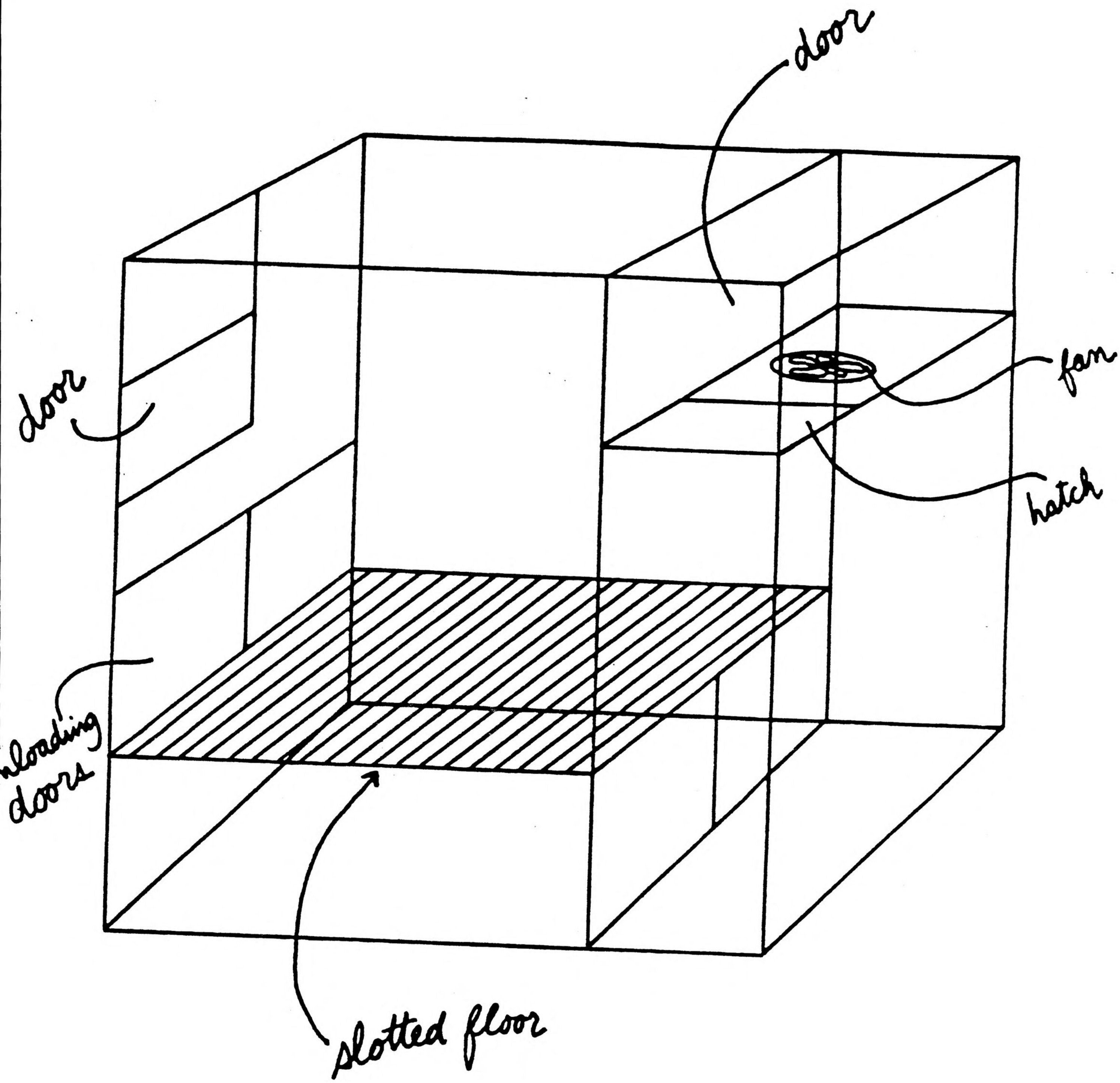


Figure 1. Perspective of Simulated Storage

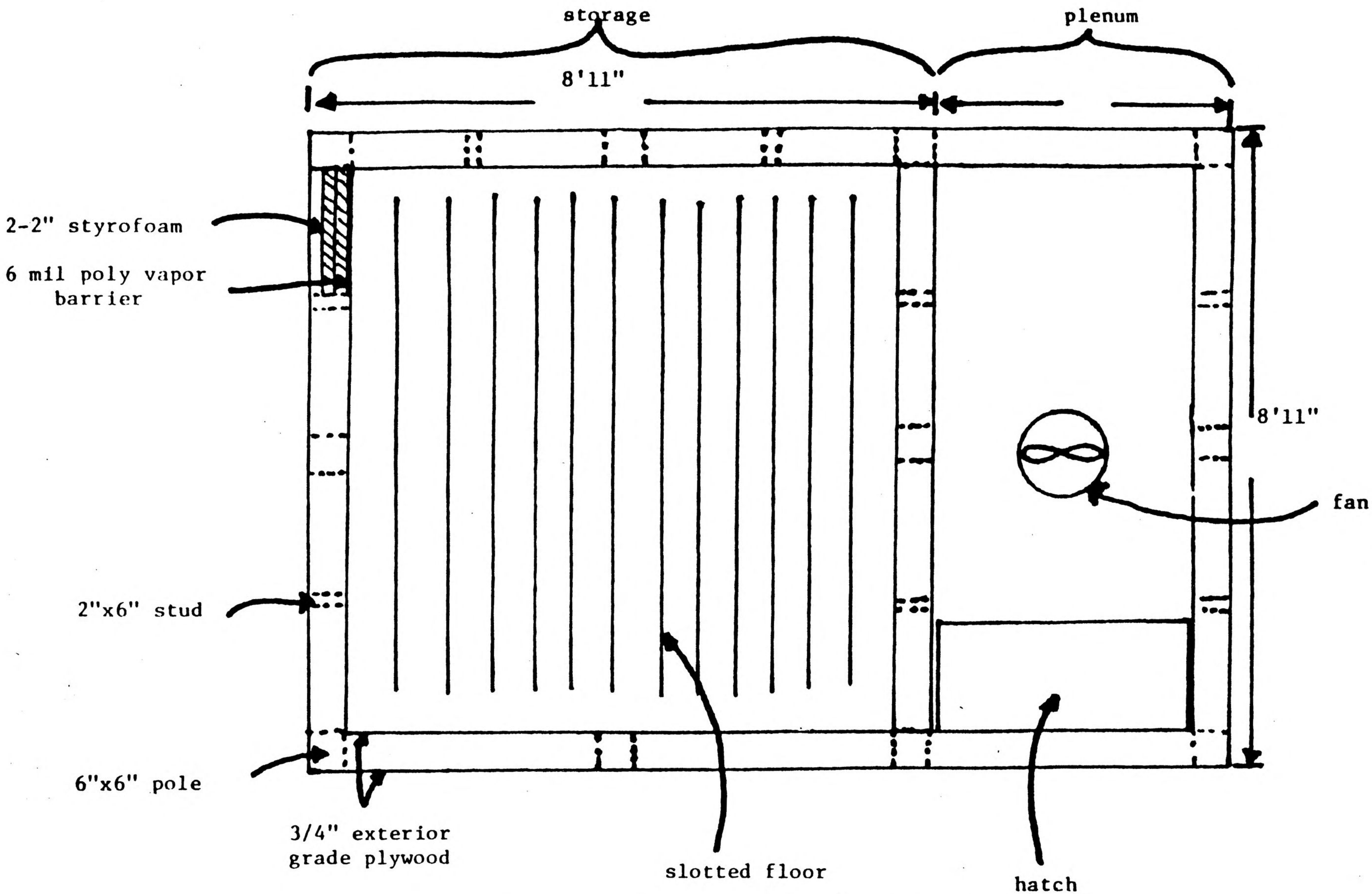


Figure 2. Top View of Simulated Storage

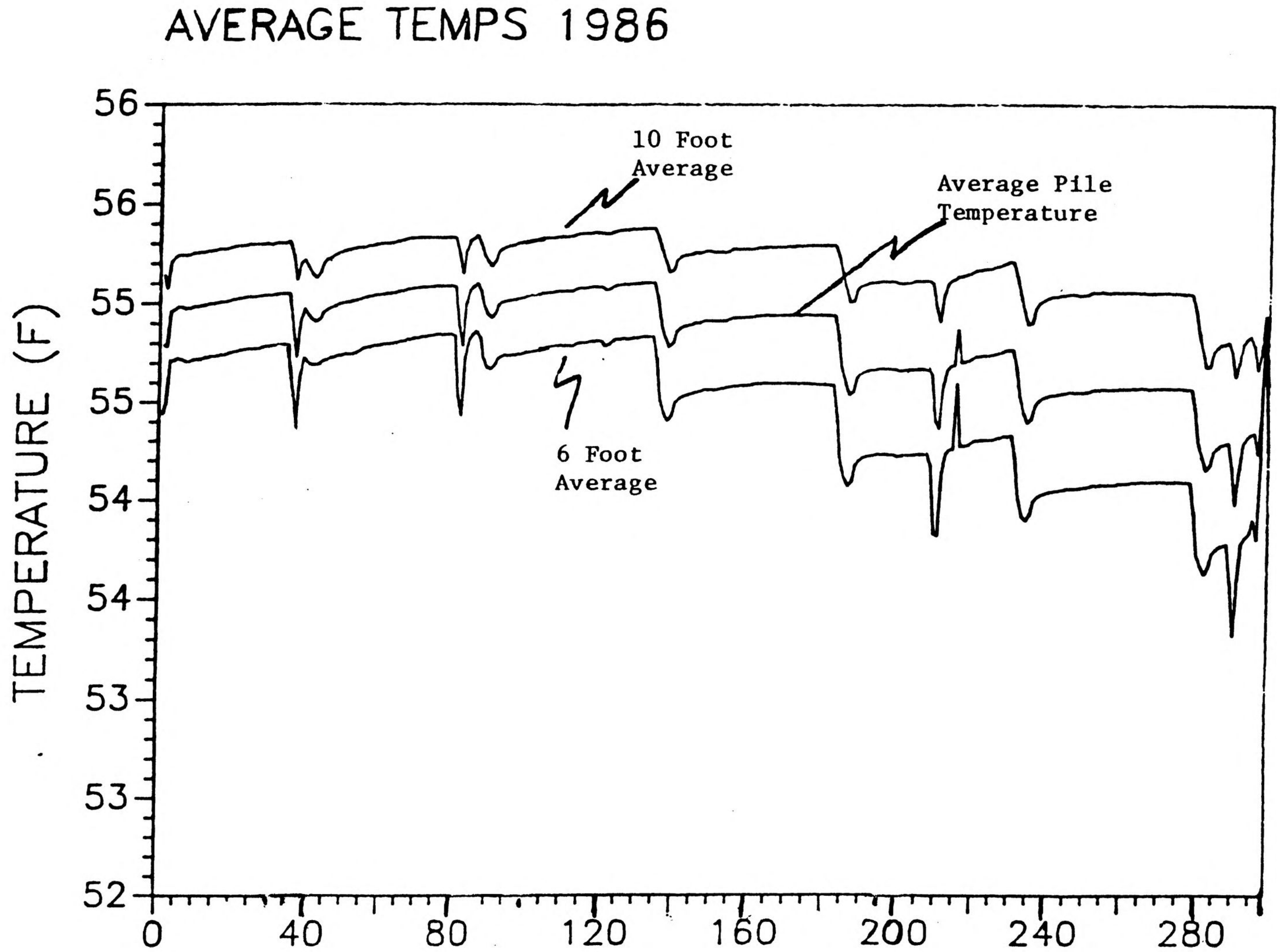


Figure 3. One Increment Equals 75 Minutes

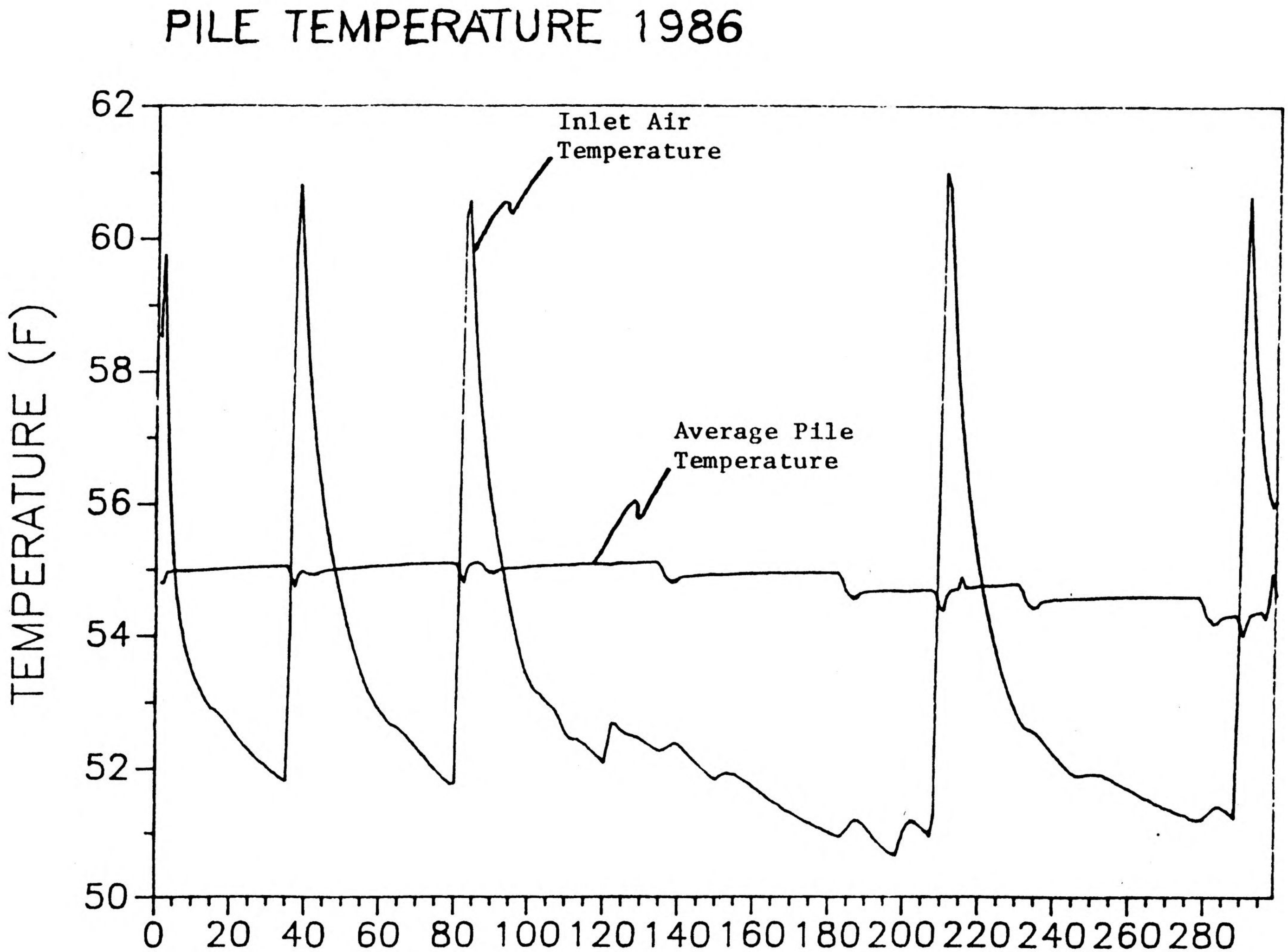


Figure 4. One Increment Equals 75 Minutes

Funding: MPIC

A PILOT STUDY INVESTIGATING SPROUT INHIBITING AND VINE KILLING METHODS 1985-86 SEASON

B.F. Cargill, Agricultural Engineering Department
T.D. Forbush, Agricultural Engineering Department
R.L. Ledebuhr, Agricultural Engineering Department
G.R. VanEe, Agricultural Engineering Department
H.S. Potter, Botany and Plant Pathology

Michigan State University
East Lansing, MI 48824-1323

ABSTRACT

During the 1985 growing season, field trials were conducted on Atlantic variety potatoes to determine the effectiveness of various chemical solutions and application methods for sprout inhibiting and vine killing in potatoes. The studies compared straight stream air assisted rotary atomization (MSU Air Curtain) to conventional nozzles.

In the sprout inhibitor tests, two different active ingredient rates were applied on two spray dates at the MSU Montcalm Research Farm, Entrican, MI. Samples were stored in environmentally controlled cubicles at MSU and in a commercial storage at Sackett Ranch, Stanton, MI. The data from the 1985-1986 sprout inhibitor study indicated that the early spray date, 89 days after planting, was more effective in the limiting of sprout growth in extended storage than was the late spray date, 99 days after planting.

In the vine kill study, four treatments with varying chemical solutions were performed at V&G Farms, Stanton, MI. The data from the 1985-1986 vine kill studies indicates that the use of the Air Curtain sprayer increases the rate of potato vine "kill down" over the conventional hydraulic nozzle equipment.

PROCEDURE

Application Methods

In both the sprout inhibitor and the vine kill tests the spray systems used remained the same. They were:

1. Conventional brush type boom sprayer with hollow cone D4-25 nozzles applying 50 GPA carrier at 50 psi.

2. MSU Air Curtain sprayer with Micronair AU7000 applying 5 GPA carrier.

Chemical Treatments

All chemical treatments included standard herbicide and insecticide materials applied at label rates as needed before and after planting. A commercially available form of MH-30, **Super Sprout Stop**, was the chemical used for the sprout inhibitor study. Active ingredient rates of 1-1/3 GPA (labeled rate) and 2/3 GPA were applied using the application methods listed above. Application dates were July 30 (89 days after planting) and August 9 (99 days after planting). These dates will be referred to as early and late spray dates respectively. The treatments and methods of application are listed in Table 1.

All vine kill treatments were applied September 19, approximately one week prior to harvest. The treatments and methods of application are listed in Table 3.

Experimental Designs

In the sprout inhibitor study, all sprayer plots were 0.0122 acre each, while the check plot was 0.0245 acre. After harvest, the treated potatoes were divided into samples of 20-25 lbs. These samples were then placed in controlled environment cubicle storage on the MSU campus and in the center of a 14,000 cwt balanced air flow storage at the Sackett Ranch, Stanton, MI. The bulk potatoes surrounding the research potatoes in this commercial bin had been treated with MH-30 using conventional application methods. The potatoes in the cubicles were suberized for two weeks, one week at 60F and 95% r.h. and one week at 55F and 95% r.h. After suberization the air temperature in the cubicle was lowered to 50F. The potatoes were held at this temperature for the remainder of the approximately 6 month storage season. Samples stored in the commercial storage were suberized at 55-60F with continuous ventilation for approximately 30 days. The air temperature was then gradually lowered to the storage temperature of 50F.

In the vine kill study, sprayer plots were 0.206 acre. Four sampling areas were chosen within these plots.

Evaluation Method

Evaluation of the sprout inhibitor experiment was performed upon removal of samples from the commercial storage. This evaluation involved removal of the respective bag from storage, emptying the bag and, examining the tuber for the degree of sprouting that had occurred over the approximately 230 day storage season. Tuber sprouting was classified as follows:

A. No sprout
B. Peeper sprout (This included any potato with a button sprout less than 3/8" in length.
C. 3/8 - 3" sprout
D. 3 - 6" sprouts
E. Sprouts over 6"

Categories C - E were divided once more on the basis of sprout vigor. Sprouts less than 3/16" in diameter were classified as "spindly" sprouts, while sprouts with diameters larger than 3/16" were classified as "hardy" sprouts. For example, a potato with a 2.5" sprout 1/4" in diameter would be placed into category C, hardy, indicating a sprout less than 3" in length and over 3/16" diameter.

Data in the vine kill study was compiled by means of subjective panel evaluations. The desiccation index was based on a scale from 1 to 10, 10 being complete vine kill. Evaluations were performed every two days for eight days after spraying. The evaluations represent an average of 10 readings taken in each replication. Complete desiccation by chemical treatments after eight days was the basis for discontinuing evaluation.

RESULTS AND DISCUSSION

Effectiveness of Sprout Inhibitor, MSU Stored Potatoes

Table 2 shows the percent potatoes (by number) that exhibited retarded sprout growth after 230 days of storage at 50F. Retarded sprout growth is defined as potatoes having sprouts less than 3" in length and not larger than 3/16" in diameter. A statistical analysis performed on data showed the following statistically significant differences:

1. A difference of 10% between treatments one and two, labeled rate vs. half labeled rate applied with boom sprayer, at the 99.5% level of significance

2. Differences of 13 to 28% between early and late spray dates at the 90% level of significance

3. Differences of 38 to 77% between the treated samples vs. the check samples at the 99.5% level of significance.

The percent of potatoes that exhibited retarded sprout growth suggests a very significant decrease in the number of potatoes that develop vigorous sprouts when treated with sprout inhibitor. The data also suggests that the early spray date (89 days after planting) demonstrated a greater decrease in the vigor of the sprouts than did the late spray date (99 days after planting). A slight increase in percent of potatoes with retarded sprout growth was demonstrated by the early treatments with the Air Curtain. However, no statistical difference was observed.

Effectiveness of Sprout Inhibitor, Commercially Stored Potatoes

Table 2 shows the percent potatoes (by number) that exhibited retarded sprout growth. A statistical analysis on the data showed the following statistical significant differences:

1. A difference of 2% between the labeled rate and one-half labeled rate applications with the boom sprayer at the 95% level of significance.

2. A difference of 15% between the early and late applications of one-half labeled rate by the boom sprayer at the 99.5% level of significance.

3. A difference of 20% between the early and late applications of labeled rate by the Air Curtain sprayer at the 99.5% level of significance.

4. Differences of 7 to 12% between the labeled boom and Air Curtain applications vs. the check treatment on the early spray date.

Similar to the MSU stored potatoes, the commercially stored samples indicated a reduction in the effectiveness of sprout inhibitor applied at the late spray date, 99 days after planting. A slight increase in the effectiveness of the sprout inhibitor sprayed on the early date with the MSU Air Curtain sprayer vs. the boom sprayer at the labeled application rate was indicated. However, no statistical difference was observed.

The effectiveness of the sprout inhibitor may have been reduced in both studies by the occurrence of rainfall after the application was made. The manufacturer of Super Sprout Stop (Uniroyal Chemical) suggests that for optimum spray effectiveness, there should be no irrigation or rainfall 24 hours before or after application. There was no rain 24 hours before application, but a trace of rain fell on both application dates within 24 hours of application.

Effectiveness of Vine Kill

Table 4 shows the desiccation index for the vine kill studies. Applications by the Air Curtain sprayer consistently increased vine desiccation (0.1 to 1.0) over the conventional boom sprayer. Treatments which included Diquat as part of the spray solution demonstrated more effective vine kill both by the desiccation index and the rate of vine desiccation. Figure 1 shows the data in Table 4 in graphical form. The data also suggests a slight increase in the vine desiccation with the use of drift retardant, as shown in Figures 2 and 3. However, no statistical difference was observed. All treatments effectively eliminated potato vines over the eight-day evaluation period.

CONCLUSIONS

The data from the 1985-1986 sprout inhibitor study indicated that the early spray date, 89 days after planting, was more effective in the limiting of sprout growth in extended storage than was the late spray date, 99 days after planting.

The data from the 1985-1986 vine kill studies indicates that the use of the Air Curtain sprayer increases the rate of potato vine "kill down" over the conventional hydraulic nozzle equipment.

Table 1. Sprout Inhibitor Chemical Treatment

Treatment No.	Spray Date	Chemical Applied
1	July 30, 1985[1]	Boom sprayer, 1-1/3 GPA MH-30
2	July 30, 1985	Boom sprayer, 2/3 GPA MH-30
3	July 30, 1985	Air curtain sprayer, 1-1/3 GPA MH-30
4	July 30, 1985	Air curtain sprayer, 2/3 GPA MH-30
5	August 9, 1985[2]	Boom sprayer, 1-1/3 GPA MH-30
6	August 9, 1985	Boom sprayer, 2/3 GPA MH-30
7	August 9, 1985	Air curtain sprayer, 1-1/3 GPA MH-30
8	August 9, 1985	Air curtain sprayer, 2/3 GPA MH-30
9		Check

[1]89 days after planting
[2]99 days after planting

Table 2. Percent Potatoes (by Number) Exhibiting Retarded Sprout Growth, MSU Stored and Commercially Stored.

Treatment No.[1]	Retarded growth, % MSU Storage	Retarded growth, % Commercial Storage
1 (early)	91	92
2	81	90
3	92	97
4	95	87
5 (early)	78	--[2]
6	53	85
7	65	77
8	76	75
9 (check)	15[3]	85[4]

[1]Treatments listed in Table 1
[2]Data lost
[3]Sample untreated with sprout inhibitor
[4]Sample untreated, but stored with potatoes field treated with MH-30

Table 3. Chemical Treatments in the Vine Kill Study.

Treatment No.[1]	Chemical applied
1	Diquat, 1 pt/a; X-77 spreader, 4 oz/a
2	Diquat, 1 pt/a; X-77 spreader, 4 oz/a; STAYPUT, 0.64 oz/gal solution
3	Diquat, 1 pt/a; X-77 spreader, 4 oz/a; copper sulfate $CuSO_4$ 5 lbs/a
4	Copper sulfate $CuSO_4$, 5 lbs/a; X-77, spreader 4 oz/a
5	Check

[1]All treatments applied with air curtain and boom sprayers, only carrier volume was varied due to CDA nozzles in air curtain

Table 4. Desiccation Index for the Vine Kill Study.

	Desiccation Index			
Treatment No.[1]	2 days	4 days	6 days	8 days
1 (air curt.)	1.9	5.6	8.6	9.6
2	2.7	7.2	9.6	9.9
3	2.3	6.2	8.7	9.5
4	3.0	8.2	9.5	9.8
5 (boom spray)	2.2	5.6	8.5	9.7
6	2.9	7.2	9.3	9.8
7	0.8	2.8	6.4	9.2
8	0.8	4.2	6.8	9.3
9 (check)	0.2	0.4	2.1	2.4[2]

[1]Treatments listed in Table 3
[2]Kill down due mostly to early blight

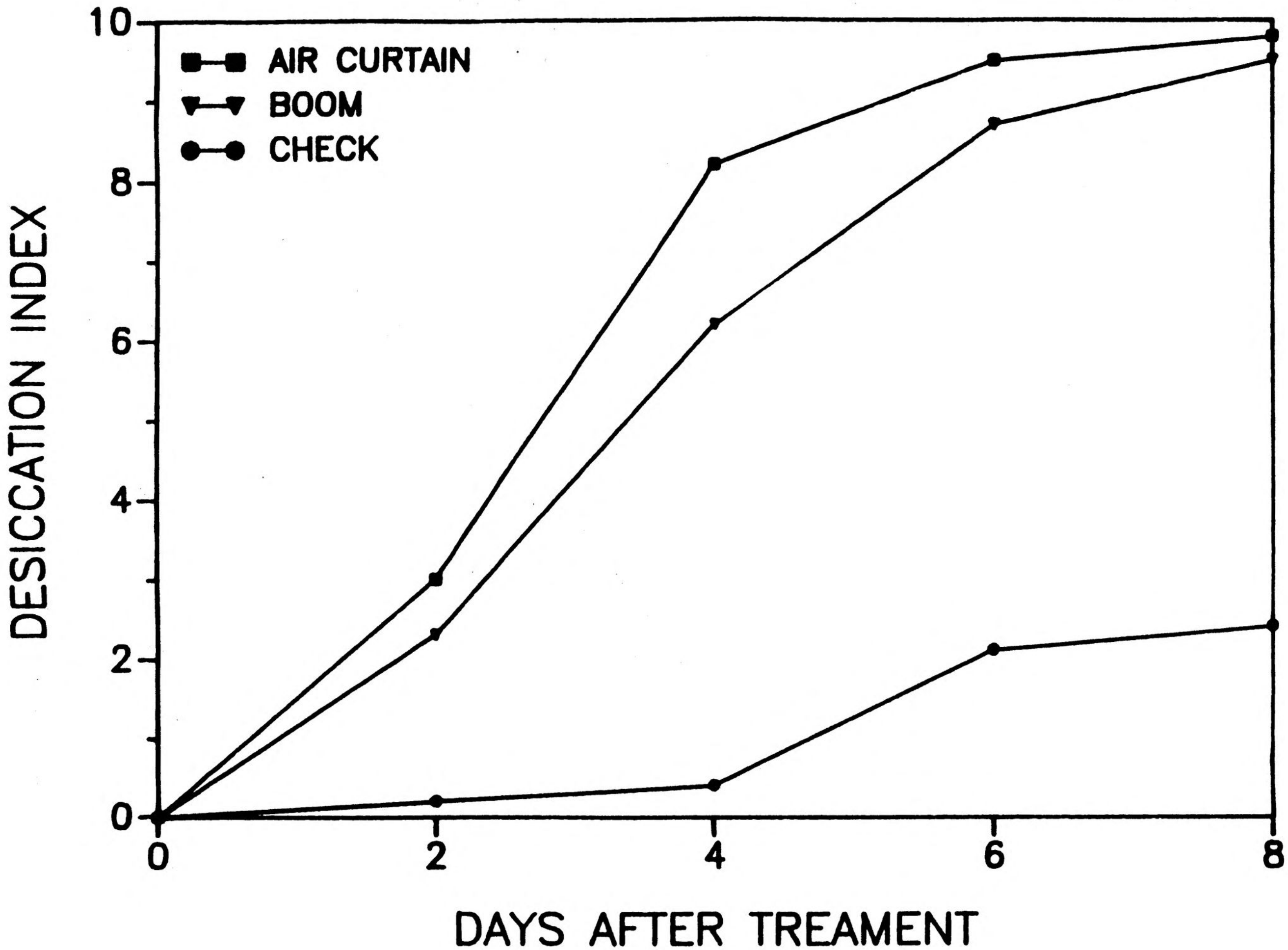


FIG. 1 DESICCATION INDEX

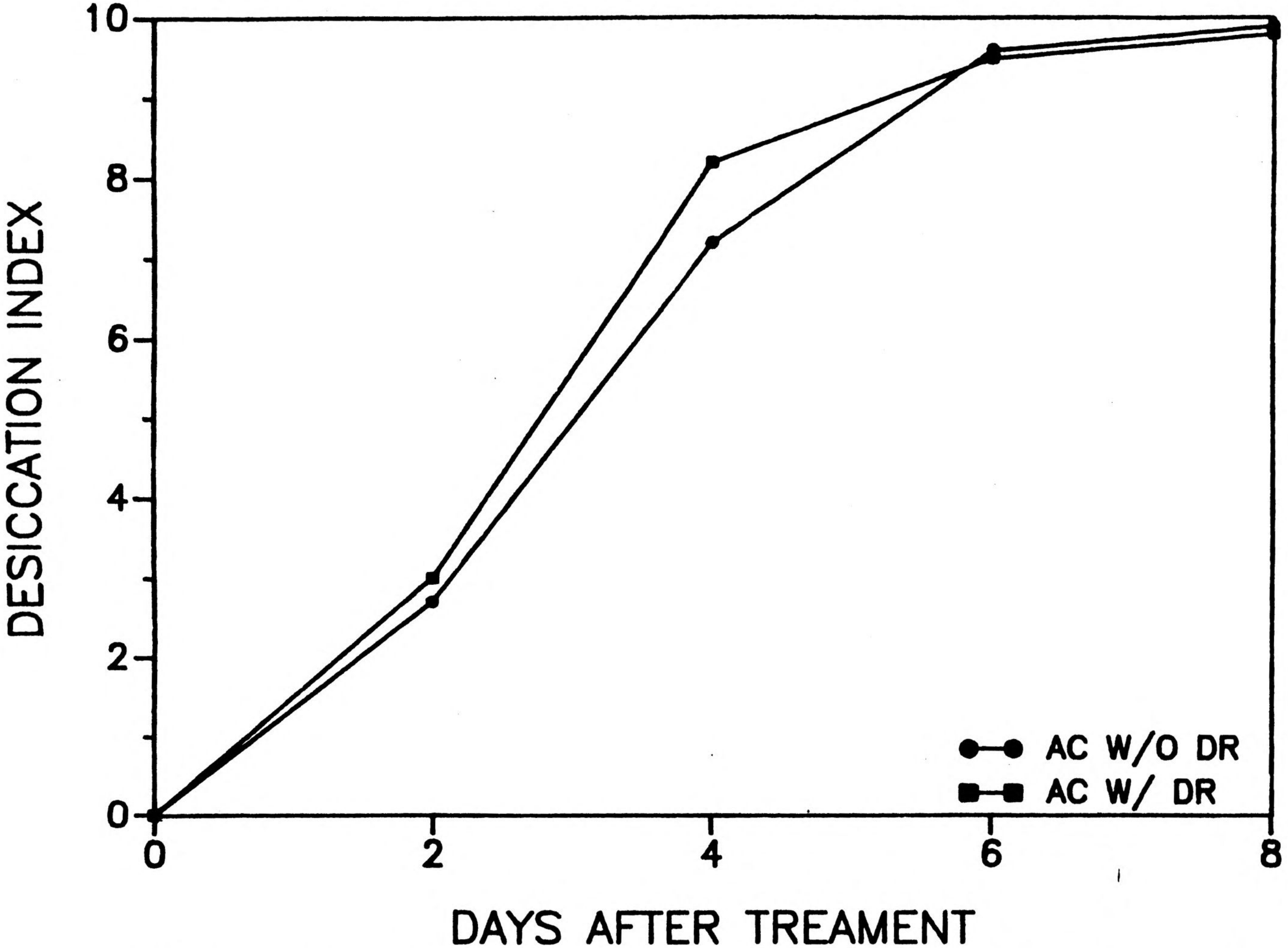


FIG.2 AC WITH AND WITHOUT DRIFT RETARDANT

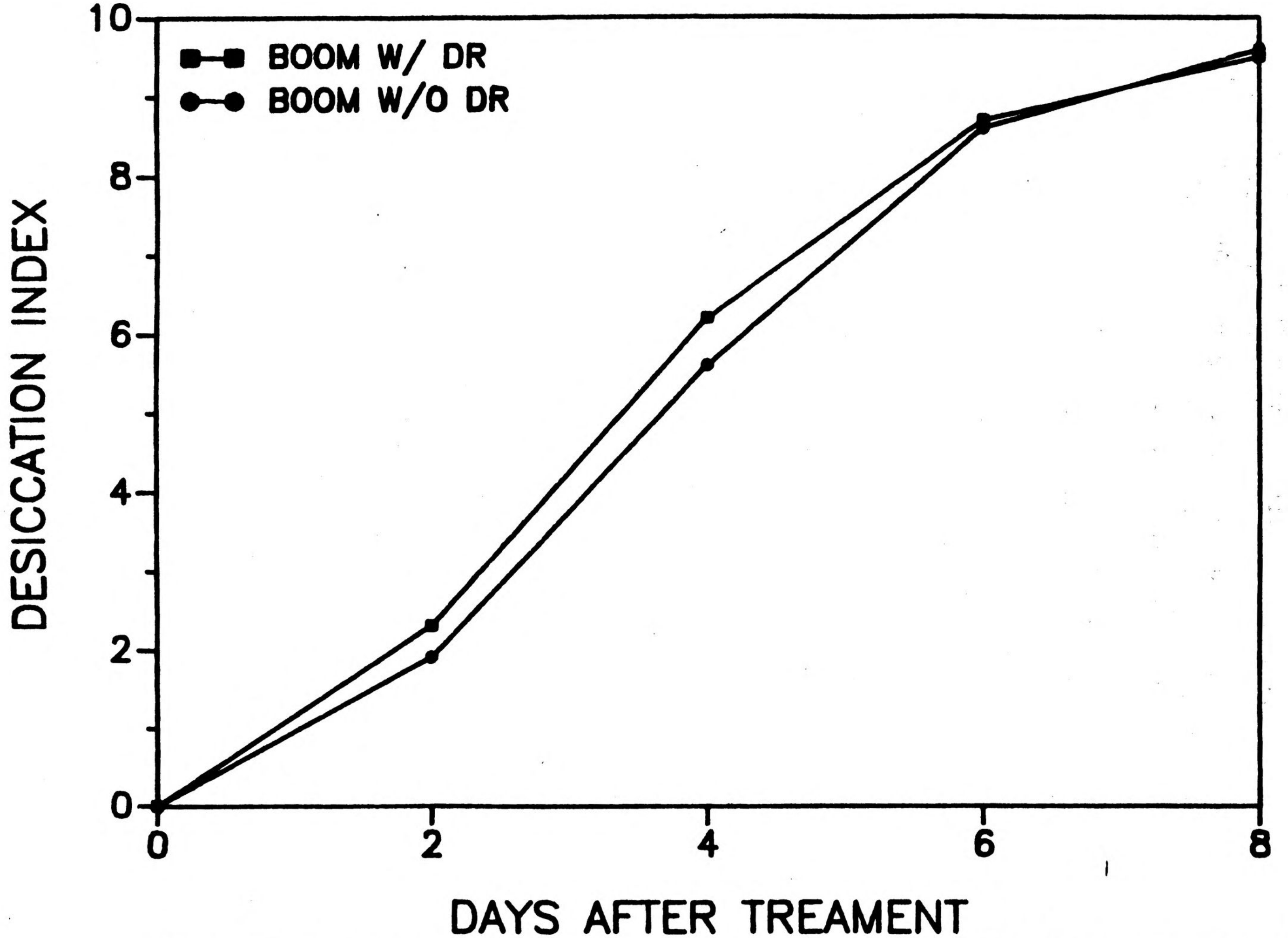


FIG.3 BOOM WITH AND WITHOUT DRIFT RETARDANT

Funding: MPIC

THE EFFECTS OF PRESTORAGE CHEMICAL TREATMENTS ON THE MARKET QUALITY OF 1985 ATLANTIC POTATOES 1985-1986

B.F. Cargill, Agricultural Engineering Department
T.D. Forbush, Agricultural Engineering Department
R.L. Ledebuhr, Agricultural Engineering Department
G.R. VanEe, Agricultural Engineering Department
H.S. Potter, Botany and Plant Pathology

Michigan State University
East Lansing, MI 48824-1323

INTRODUCTION

While the current potato harvesting and handling equipment has greatly reduced the time required for fall harvest, it also has one large disadvantage-- excessive tuber damage. This report is part of continuing research on the influence of prestorage mechanical handling and chemical treatments on the market quality of potatoes out of extended storage.

Various prestorage chemical treatments have demonstrated the ability to increase the out of storage quality of potatoes. The application technology developed in the Agricultural Engineering research facilities at Michigan State University has allowed the full advantage of these chemical treatments to be realized. Through the use of low volume application, the problem of excessive water in the pile that was apparent with previous application systems has been eliminated, while maintaining the increased market quality exhibited by the chemical treatments.

PROCEDURE

Potato Samples

The MSU Atlantic potatoes were grown at the Michigan State University potato research farm at Entrican, MI. These potatoes were harvested using the MSU one-row plot harvester. The potatoes for the commercial phase of this project were grown and harvested by Sandyland Farms, Howard City, MI.

During the 1985-1986 growing season, the nine potato growers collaborated in the market quality research on the effectiveness of prestorage chemical treatment. This phase of the research included several varieties of potatoes.

Chemical Solution/Treatments

All of the potatoes were treated with the MSU developed air curtain sprayer, currently marketed under the trade name CURTEC by BEI, Inc., South Haven, MI., mounted on the bin piler.

The chemical solution used in the MSU Atlantic storage project consisted of a fungicide, a bactericide, and a chemical carrier. In all the chemical treatments, the chemicals used remained constant. They were 0.42 oz/ton of Mertect 340F (Merck & Co., Rahway, NJ), with a carrier solution which contained 4 oz of either water or soybean oil with 5% Rohm Hass food grade emulsifier. Purigene (BIO-CIDE Chemical Co., Inc., Norman, OK) was added to the total solution to provide 200 ppm of chlorine dioxide. The Mertect is used to help control dry rot, while the chlorine dioxide helps reduce the occurrence of bacterial soft rot.

Along with chemical treatments, the effect of various degrees of bruising was also investigated. Non-bruised potatoes were subjected to a slight level of bruising (MSU plot harvester and piler only) while bruised samples were artificially bruised using a one-row potato windrower after the potatoes had been harvested. A complete list of treatments is presented in Table 1.

Storage Environment

Immediately after treatment, 25 lb samples were bagged and placed in controlled environment cubicle storage on the MSU campus and in the center of a commercial balanced air flow potato storage at Sandyland Farms, Inc., Howard City, MI. The potatoes in the cubicles were suberized for two weeks; one week at 60F and 95% r.h. and one week at 55F and 95% r.h. After suberization there potatoes were lowered 5F/week until the desired storage temperatures of 40F, 45F, and 50F were obtained.

Samples stored in commercial storage received 24 hr ventilation and were lowered in storage temperature approximately 1F every 2 days until the desired storage temperature of 50F was reached.

The management of the storage for the collaborating commercial growers was left to the discretion of the respective grower.

EVALUATION METHODS

Residue Analysis

Ten pounds of randomly selected tubers from the MSU Atlantic potatoes and from the potatoes grown by the collaborating growers were removed from selected treatments and air shipped to New Jersey for evaluation of TBZ residue. The results of the analysis are presented in Table 2 for the MSU Atlantic potatoes and in Table 3 for the potatoes grown by the collaborating growers. The potato assay for thiabendazole was performed from opposite quarters of each tuber by the Ag Chem Division of Merck Chemical Co., Rahway, NJ.

Bruise Analysis

Various lots of 80 lb samples of potatoes were collected: 1) after harvesting with the MSU plot harvester and 2) at the end of the bin piler just prior to placement in the storage bin. These samples were delivered to Ore-Ida Foods, Greenville, MI., where they were held at room temperature for 48 hours before evaluation for bruising (including both shatter bruise and black spot bruise). The bruise-free percent for the MSU Atlantic potatoes is presented in Table 4.

Market Quality

Market quality evaluations (Cargill, et al., 1985) were done on the samples of the MSU Atlantic potatoes in commercial storage after 124 days. MSU Atlantic potatoes in the MSU cubicles were evaluated after 70 and 165 days of storage. Market quality reported is presented as percent by number of tubers.

Weight Loss

The samples stored in the MSU cubicle were weighed after two weeks of suberization and at the market quality evaluation dates. Samples stored commercially were weighed upon removal from storage.

Shatter Bruise

All samples removed from the storages of the collaborating commercial growers were examined for shatter bruise. The tubers were classified as either marketable or non-marketable. The marketable tubers were those affected less than 5% by weight. The results of the analysis are presented as percent acceptable (marketable) by number.

The reason for the use of this category is to more efficiently describe the effects of the fungicide treatment. A potato that has no shatter bruise will not be affected by the fungicide treatment since there is no avenue for the fungus to enter the tuber. This classification deals only with those potatoes that had suffered a shatter bruise, indicating whether the bruise was allowed to consume the tuber, or if the bruise was restrained by the treatment to a level which is considered acceptable.

Black Spot Bruise

All samples removed from the storages of the collaborating commercial growers were examined for the occurence of black spot. A black spot bruise occurs when a potato is impacted in the handling process. However, the skin was not broken as in the case of the shatter bruise. The evaluation included peeling the marketable potatoes with a Toledo laboratory model of an abrasive vegetable peeler for approximately 10 seconds to expose the black spot bruise. Each tuber was then examined for degree of black spot. The tubers were classified into the following categories:

1. no black spot
2. slight black spot (less than 3/16" deep)
3. severe black spot

The results are reported as percent by number of the tubers in both class 1 and 2.

Cargill, BF, et al. 1985. Influence of prestorage chemical treatments on out-of-storage market quality of potatoes. ASAE Paper 85-4028.

RESULTS AND DISCUSSION

Harvest

Due to excessive soil moisture and rainfall on and around the date of harvest (the Stanton weather station received 10 inches of rain through the months of August and September, about 3 inches above normal with 2.3 inches falling in the last ten days of September) the amount of quality, harvestable potatoes was reduced by approximately one-half. This reduction in potato quality caused the MSU Atlantic project to be reduced in scale. All treatments were carried out. However, the amount of potatoes in each treatment was reduced. The reduced treatment size had an effect on the statistical significance that was observed. In most cases the treatments did exhibit sizable mean separations that are worth noting.

Market Quality

Table 5 shows the market quality for the MSU grown 1985 Atlantic project stored at MSU and Sandyland Farms. The data suggests the following mean separations:

1. Differences of 3.8 to 4% between treatment 3 (bruised check) and treatment 4 (Mertect and chlorine dioxide with water carrier) stored at 40F and 45F for 70 days at MSU.

2. Differences of 6.1 and 5.2% between treatment 3 (bruised check) and treatment 6 (Mertect and chlorine dioxide with water carrier) stored at 40F and 45F for 70 days at MSU (see Figures 1 and 3).

3. A difference of 3.3% between treatment 3 (bruised check) and treatment 4 (Mertect and chlorine dioxide with water carrier) stored at 50F for 124 days at Sandyland Farms.

4. A difference of 4.1% between treatment 3 (bruised check) and treatment 6 (Mertect and chlorine dioxide with oil carrier) stored at 50F for 124 days at Sandyland Farms.

5. Differences of 7.0 and 7.1% between treatment 3 (bruised check) and treatment 4 (Mertect and chlorine dioxide with water carrier) stored at 40F and 45F for 165 days at MSU (see Figures 2 and 4).

6. A difference of 5.7 between treatment 3 (bruised check) and treatment 6 (Mertect and chlorine dioxide with oil carrier) stored at 40F for 165 days at MSU.

The above differences indicate that the treatments used in this experiment have the greatest effect on potatoes with market quality less than 85% (see Table 4, treatment 3). The chemicals used in this study are primarily designed to act as protection to cover a wounded tuber. Potatoes with bruise free ratings higher than 85% had few wounds. These potatoes show less response to chemical treatments. The data does suggest slight increases in the market quality of the non-bruised treatments. However, no statistical difference was observed.

Table 6 shows the market quality for the potatoes grown by Sandyland Farms. These potatoes showed only slight changes between treated and check potatoes. However, these potatoes were all of high quality, thus the treatments were less effective.

Table 7 presents the weight loss data for the 1985 Atlantic Project. This data was inconclusive due to the relatively small mean separations.

Table 8 presents the market quality, shatter bruise and black spot data for the potatoes grown by the collaborating growers. Notice again that high quality tubers (low percentage of shatter bruise or black spot) generally exhibited only a slight response to the fungicide treatment.

Table 1. Treatments Performed in the MSU Atlantic Potato Storage Research Project.

Treatment No.	Mechanical handling	Chemical applied
1	MSU plot harvester	--
2	MSU plot harvester and bin piler	--
3	MSU plot harvester, bin piler and artificial bruising devices (windrower)	--
4	MSU plot harvester, bin piler and artificial bruising devices (windrower)	0.42 fl oz Mertect 340F, 4.2 oz water with 200 ppm chlorine dioxide
5	Plot harvester and bin piler	0.42 fl oz Mertect 340F, 4.2 oz water with 200 ppm chlorine dioxide
6	MSU plot harvester, bin piler and artificial bruising devices (windrower)	0.42 fl oz Mertect 340F, 4.2 oz soybean oil with 5% Rohn Hass food grade emulsifier
7	Plot harvester and bin piler	0.42 fl oz Mertect 340F, 4.2 oz soybean oil with 5% Rohn Hass food grade emulsifier

Table 2. Chemical Residue for MSU Atlantic Potatoes.

Treatment[1]	TBZ (ppm)
Check samples	--
Water carrier[1]	2.92
Oil carrier[2]	4.93

[1]Chemical solution equal to treatments 4 and 5 in Table 1.
[2]Chemical solution equal to treatments 6 and 7 in Table 1.

Table 3. Production and Residue Data for the Nine Growers Participating in the Prestorage Chemical Application Study

Grower Number	Variety	Date Treated	Days in Storage	MSU Storage Temperature	TBZ Residue (PPM)
1	Atlantic	9-14-85	128	50F	--
2	Atlantic	9-14-85	128	50F	--
3	Frito-Lay 945	10-29-85	179	45F	1.56 - 2.90
4	Monona	10-30-85	251	45F	1.48 - 2.46
5	Monona	10-10-85	190	45F	0.58 - 0.67
6	Superior	10-21-85	186	45F	6.70 - 8.90
7	Monona	10-03-85	190	45F	1.65 - 1.96
8	Shepody	9-30-85	244	-	1.75 - 2.30
9	Monona	10-29-85	235	45F	1.36 - 2.19

Table 4. Bruise Free Percent Evaluated by Ore-Ida Foods, Greenville, MI.

Mechanical handling	Bruise free rating (%)
MSU plot harvester	80
MSU plot harvester and bin piler	75
MSU plot harvester, bin piler and artificial bruising	62

Table 5. Market Quality (% Marketable by Number) for the 1985 MSU Grown Potatoes Stored at MSU and in commercial storage.

Treatment[1]	70 days			124 days[2]	165 days		
	40F	45F	50F	50F	40F	45F	50F
1	96.4	97.8	92.3	92.1	97.9	97.7	94.6
2	91.9	88.8	91.9	89.4	90.5	93.1	95.6
3	75.4	79.7	78.1	74.6	82.8	86.0	88.4
4	79.2	83.7	76.0	77.9	89.8	93.1	87.5
5	94.0	89.1	94.6	87.0	95.6	94.8	96.5
6	82.1	84.9	77.4	78.7	88.5	88.9	83.8
7	94.1	91.8	92.0	85.3	94.2	95.7	93.3

[1]Treatments listed in Table 1
[2]Stored in commercial storage at 50F

Table 6. Market Quality (% Marketable by Number) for the 1985 Sandyland Farms Atlantic Potatoes Stored at MSU and in commercial storage.

Treatment	70 days			124 days[1]	165 days		
	40F	45F	50F	50F	40F	45F	50F
Check truck	-	-	-	86.2	-	-	-
Check piler	90.2	88.7	87.9	89.5	90.3	88.9	89.4
Water carrier[2]	86.5	87.9	84.7	87.3	86.8	89.9	90.8
Oil carrier[3]	88.8	89.5	89.0	84.3	89.1	91.6	90.5
Oil only[4]	-	-	-	87.3	-	-	-

[1]Stored at Sandyland Farms, Inc., Howard City, MI, at 50F
[2]Chemical treatment equal to treatments 4 and 5 in Table 3
[3]Chemical treatment equal to treatments 6 and 7 in Table 3
[4]Treated with emulsified oil only

Table 7. Weight Loss Percentages for the MSU Atlantic Potatoes Stored at MSU and in commercial storage.

Treatment	70 days			124 days	165 days		
	40F	45F	50F	50F	40F	45F	50F
1	3.90	2.79	3.52	4.50	11.20	5.8	6.77
2	5.23	3.53	3.04	4.50	7.15	4.75	3.92
3	4.88	3.74	2.78	3.90	7.73	5.14	5.28
4	4.79	3.47	3.54	3.60	8.09	5.33	6.73
5	4.05	4.35	3.27	4.20	10.21	5.70	8.28
6	4.31	3.89	3.32	4.20	8.69	5.64	6.66
7	4.16	3.06	2.97	5.20	5.84	5.08	5.62
<u>Commercial Storage</u>							
check truck	-	-	-	5.49	-	-	-
check piler	5.31	3.99	4.49	6.08	8.42	5.16	7.42
H_2O/ Mertect	6.51	5.03	5.21	5.99	8.63	7.25	7.29
oil/ Mertect	5.63	3.59	3.77	5.35	9.93	6.44	5.97
oil	-	-	-	5.70	-	-	-

Table 8. Market Quality, Acceptable Shatter Bruise and Black Spot Bruise (% by number) for Potatoes Grown by Collaborating Growers.

Grower Number	Market Quality		Shatter Bruise		Black Spot Bruise	
	MSU	Grower	MSU	Grower	MSU	Grower
1 - Treated	91.2	91.8	79.2	80.5	83.0	79.3
Check	93.6	78.8	79.5	66.7	84.8	64.6
2 - Treated	93.7	85.1	76.5	67.0	82.5	63.5
Check	88.1	82.6	63.3	67.2	78.0	63.8
3 - Treated	96.6	95.4	92.2	85.3	92.0	89.9
Check	96.5	95.1	81.3	89.0	94.3	88.8
4 - Treated	98.2	88.1	92.9	60.3	96.5	76.6
Check	99.4	90.2	92.5	75.3	99.1	87.5
5 - Treated	97.3	96.0	89.1	82.8	95.3	91.4
Check	97.7	93.9	81.2	71.8	95.7	89.8
6 - Treated	96.4	94.1	81.8	84.4	92.6	89.5
Check	90.7	95.1	72.1	85.8	87.0	90.7
7 - No data due to poor harvest conditions						
8 - Treated	--	91.6	--	79.8	--	89.1
Check	--	92.2	--	74.7	--	90.8
9 - Treated	95.2	90.8	85.9	82.7	89.8	83.2
Check	90.7	95.9	78.4	90.7	86.8	92.8

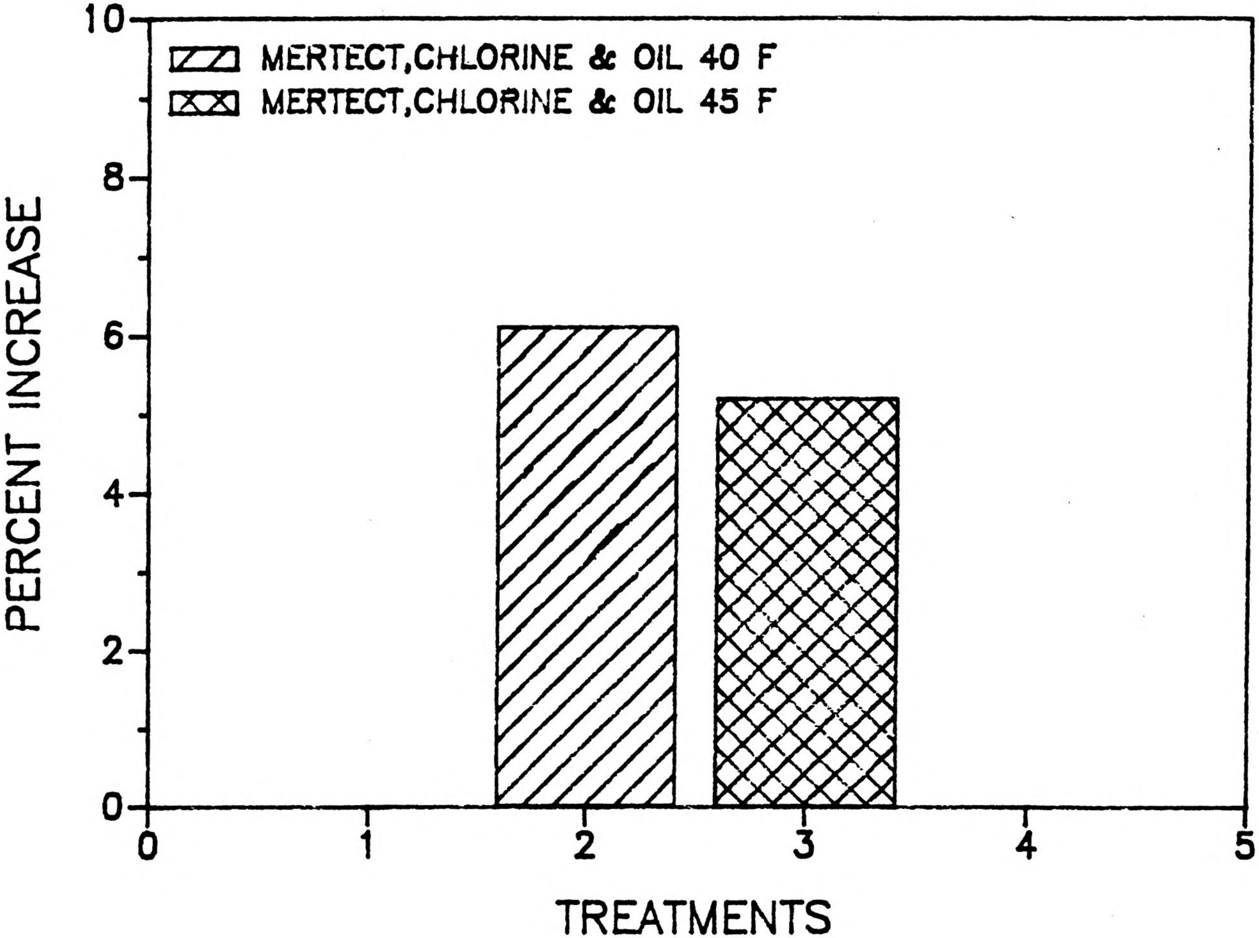


FIG. 1 PERCENT MARKETABLE INCREASE OVER CHECK

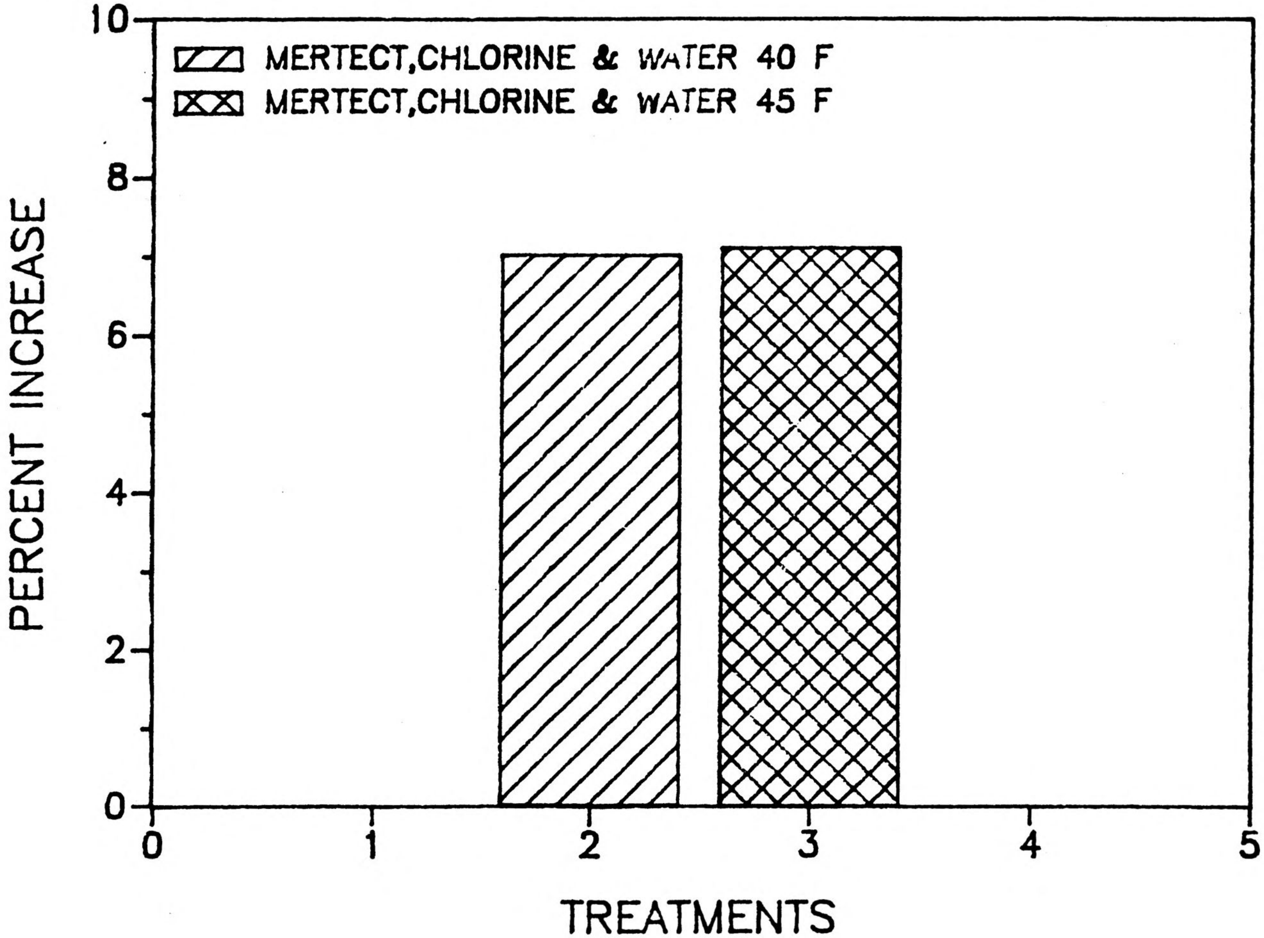


FIG. 2 PERCENT MARKETABLE INCREASE OVER CHECK

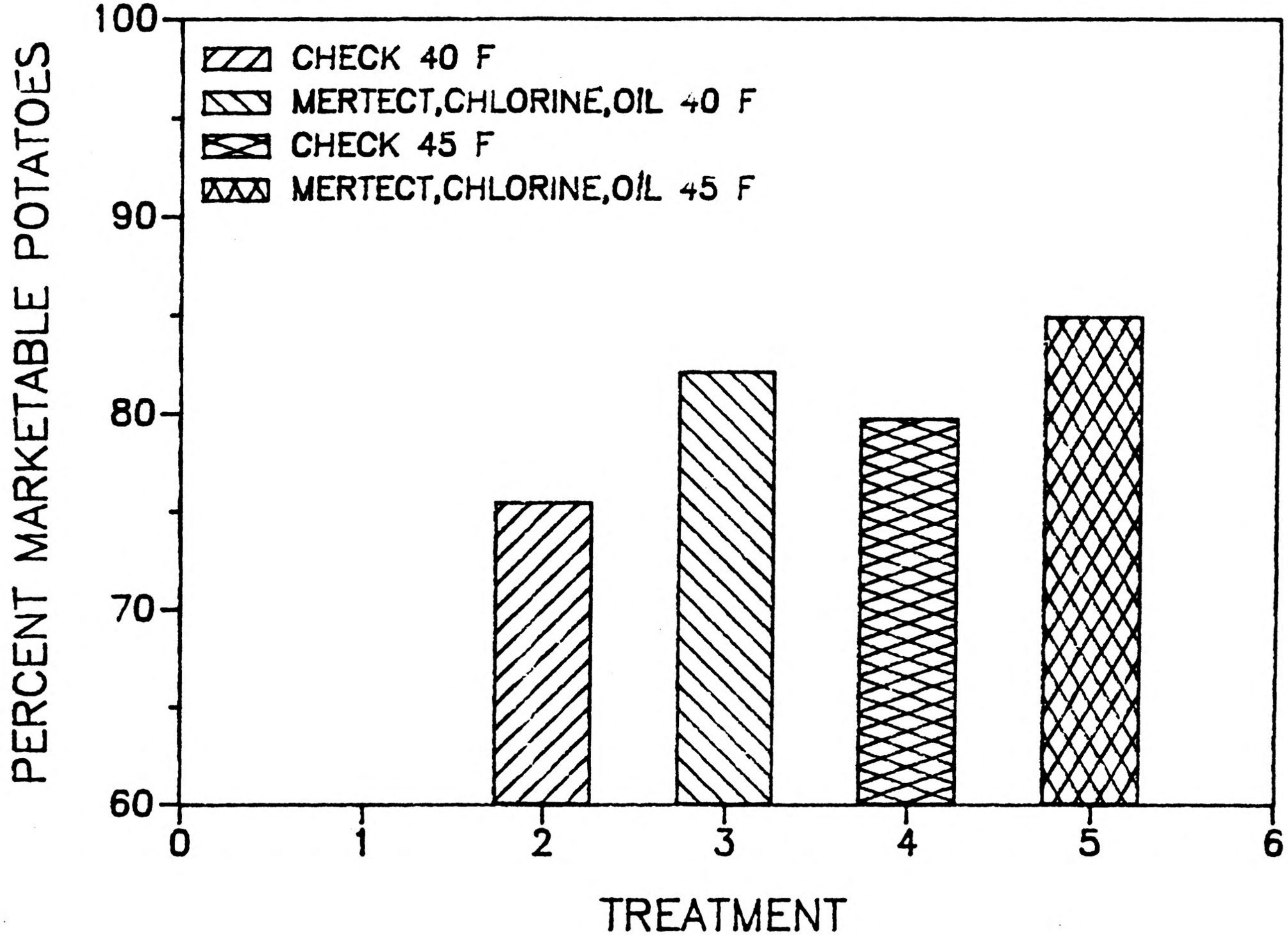


FIG. 3 MARKETABLE POTATOES (%) AFTER 70 DAYS

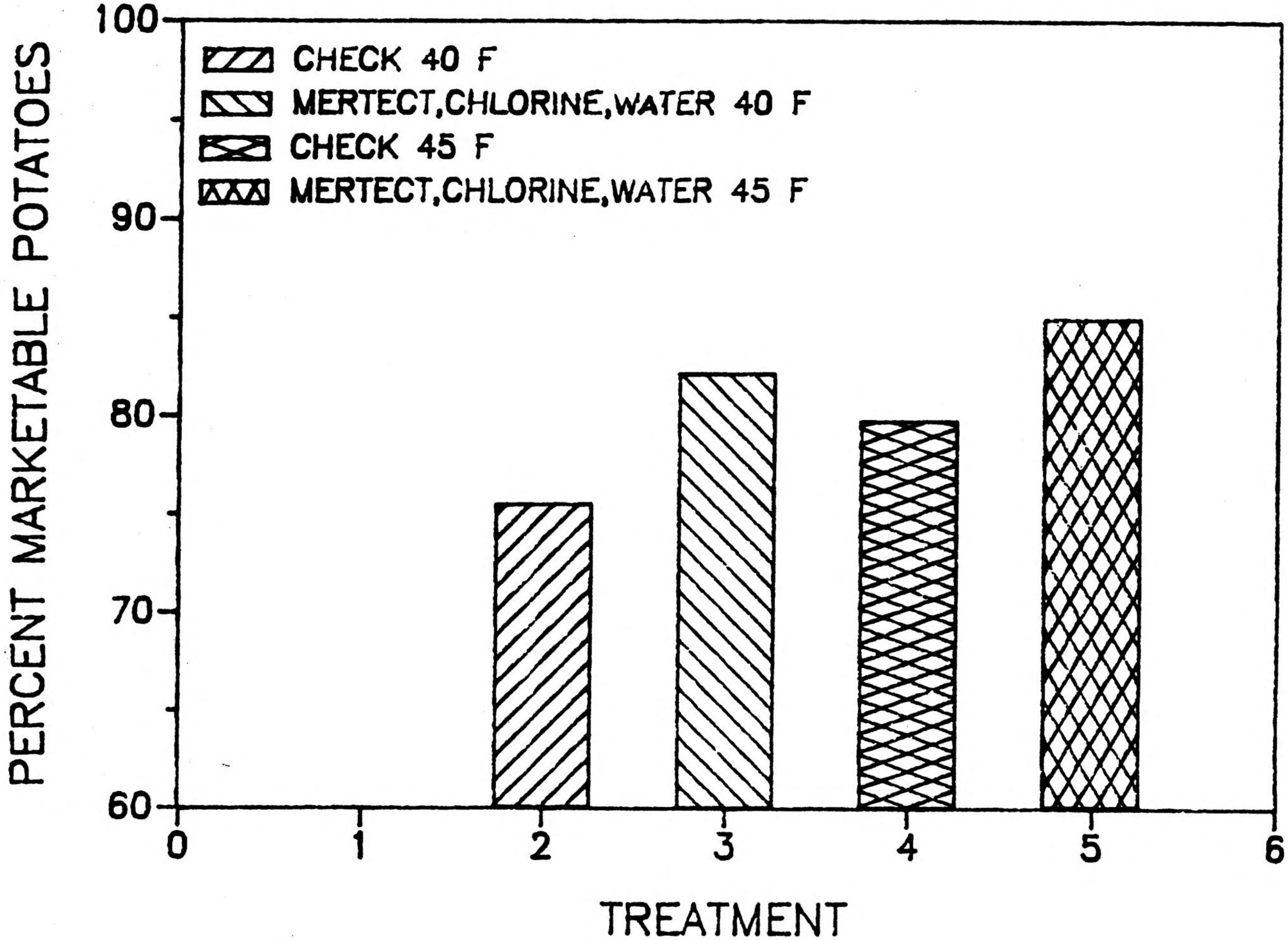


FIG. 4 MARKETABLE POTATOES (%) AFTER 165 DAYS

Funding: Federal Grant

TITLE: Potato Processing and Utilization for Improved Marketing

INVESTIGATORS: Jerry N. Cash and Ron Morgan Food Science and Human Nutrition Department, and Roger Griffin-School of Packaging, Michigan State University

OBJECTIVE: Improve utilization of the total potato crop by developing processed products which can use small, extra large and off-grade potatoes.

JUSTIFICATION:

In any given year, a portion of the potato crop will be graded into small, extra large or off-grade classes. Some of these tubers may find acceptance in certain types of processed products but this is usually minimal. Since this segment of the crop represents significant quantities of raw product, economics dictate that these potatoes be utilized in some manner, however, without processing alternatives a majority find their way into fresh market channels. This results in lowering the consumer's perception of Michigan potato quality, with attendant losses in sales and revenue. It is imperative that new processed products be developed which can utilize that portion of the potato crop which is not suited for use in presently established processed products.

PROCEDURES:

Efforts will be divided into short and long term projects but both will be carried out simultaneously, at the outset. The short term effort will concern a technology update and feasibility study of the potential for retort pouch processing. The long term effort will be aimed at developing new products. These proposed projects are described separately and with two distinctly different budgets.

I. Retort Pouch Feasibility Study: It is envisioned that this project would be funded on a one time basis and for approximately one calendar year.

A previous venture by a Michigan firm into the area of retort pouch processing of potatoes met with a degree of success during the early phases of their effort. The problems which led to the eventual demise of the company were both technical and managerial in nature. Since that time, a number of technological advances have been made in retort pouch operations. This proposed study will investigate preferred packaging materials and methods for obtaining optimum quality in products processed in retortable pouches. All processing will be done on a pilot plant scale but will utilize concepts which can be expanded to a full scale production operation with minimal effort. All products will be subjected to sensory evaluations to determine consumer acceptance and will undergo storage stability and shelf-life studies to assess the usable market life of the product. Although all initial efforts will involve potatoes, it is logical to assume that information and techniques developed in this work may be applicable to other low acid products (i.e. peas, carrots, etc.) and any processing operation developed can eventually expand to include processing of other crops. Also, work will be carried out in the long term product development studies to devise new products, such as soup bases and convenience foods for processing in pouches. Market pouch products will also be carried out.

II. New Product Development: Long term and continued for several years.

The primary thrust of this effort will be the development and evaluation of one or more convient, ready-to-serve potato products. One such item for initial investigation is development of a precooked, formed potato which could be used as a baked potato substitute in restaurants and other establishments where potatoes with a uniform size and shape are sought after. For this application, potatoes will be cooked in various ways (i.e. boiling, steam injection, dry heat) to determine the best preparation method. Peels will be removed after cooking and the potatoes will be mashed. The mash will be shaped by extrusion and the shaped pieces will be exposed to combinations of air, hot air and/or hot air plus steam, in an effort to cause case hardening, which will form a crust and simulate the potato skin. This critical step of forming a crust may provide a product which can be frozen without further treatment and subsequently heated for use as a baked potato. However, it may be necessary or more desirable to further treat the formed potato by applying a coating preparation such as a starch batter, wheat flour-cornstarch batter or an amylase coating material which can then be breaded to give better texture and add flavor to the product. Many variations and/or combinations of these preparations are likely to be tried before a suitable blend is formulated. If a precooked, formed product can be developed it will have not only the obvious advantages of using any size potato, but it would also reduce losses caused by peeling, cut down on waste disposal problems and yield a product with higher solids, i.e. more nutritive value, than conventional types of potato products. Also, it may be possible to use potatoes coming out of cold storage without developing poorly colored end products.

A number of other areas will also be explored, however, the very nature of product development, where one or more raw materials (in this case potatoes) provide the basis for the effort and are then built on from many different directions, makes it impossible to predict exactly what will be done or what the final outcome will be. This is the reason R&D work is time consuming and costly. In addition, there is never any guarantee that new products will be successfully developed.

RESULTS:

Retort Pouch:

New products being formulated include: german potato salad, potato soup bases and combinations of potatoes and other vegetables. These items will utilize potatoes but will fall into the category of convenience items, which will give the value added incentive for consumers to purchase them. Processing parameters for each of these items are being devised and further efforts in conjunction with Agricultural Economics are being undertaken to determine processing plant design and processing costs. These efforts include: specification of plant operations, operating conditions, determinations of requirements for equipment, building facilities, labor and calculations of annual costs of processing.

Remanufactured Potato Product:

The first step in this effort has been development of a computer model, using many variations of the wide variety of parameters which must be incorporated into the study. A number of models were tried and discarded but the final model developed from these efforts depends on temperature and times required for starch gelatinization. Studies were carried out at temperatures of 80°C, 90°C and 97°C with cooking times of 0, 3, 6, 8, 10, 12, 15 and 25 minutes at each temperature. For these studies, cylindrical samples 1 inch in length and 0.39 inches in diameter were taken from potatoes of the Superior variety. These cylindrical samples were placed in tubes, covered with distilled water and cooked in a circulating water bath at the previously indicated times and temperatures. The cooked samples were cooled and measured for viscosity, using a back extrusion method in the Instron presure testing machine. Curves reflecting the relation between time and puncture force were drawn and these data were further used in the following equation to develop information about the activation energy (time/temperatue) required for processing.

$$m_I = \left(\frac{1}{2\pi V_p}\right)\left(\frac{F_p}{L_p}\right)\left(1-K^2\right)\left(\ln\frac{1}{K}\right)\left(1+\frac{\alpha}{\ln K}\right)$$

M_I = Viscosity
V_p = Plunger Velocity
F_p = Puncture Force
L_p = Length of Wet Plunger

$K = \dfrac{\text{Radius of Plunger}}{\text{Radius of Sample Tube}}$

$\alpha = \dfrac{1 - K^2}{1 + K^2}$

The effort thus far represents approximately one third of the total project and has allowed us to begin actual processing procedures in the pilot plant with comercial extrusion equipment.

Funding: MPIC and PP(

Application of Potato Carbohydrate Analysis and CIPC Interaction in a Commercial Growing and Storage Operation

J.N. Cash, Food Science and Human Nutrition
R. Chase, Crop and Soil Sciences
A. Cameron, Horticulture
Michigan State University

Procedure:

Atlantic and Russet Burbank potatoes were commercially harvested on the Wayne J. Lennard and Sons farm in Monroe County. Thirty six, 30 pound samples of Atlantics and twenty seven, 30 pound samples of Russet Burbanks were placed in double mesh bags and buried in a commercial storage bin with 15,000 hundred weights of Atlantic potatoes. The samples were arranged in the bin to give four replications, with nine bags per rep, of Atlantics and three replications, with nine bags per rep of Russet Burbanks. One additional sample of Atlantics and Russet Burbanks containing specifically sized (small, medium and large) tubers was placed in each rep for PPG Industries, Inc. to use in their analysis of CIPC residues 48 hours after application of the sprout inhibitor. At the same time, the bags were being placed in the bin, plastic tubing was run from a point within each rep and at one point somewhat removed from the samples, for collecting gas for CO_2 analysis. The samples were placed in storage on September 5th and subsamples were taken for analysis. One set of samples (i.e. one bag of each cultivar from each rep) was removed for analysis after one week of storage and a second set was removed immediately before CIPC application on September 22nd. Subsequent samples were taken at 48 hours, 10 days, 20 days, 40 days and 80 days after CIPC application. The last samples will be removed at 120 and 160 days. At each sample time, gas samples were taken for CO_2 analysis and tubers were analyzed for specific gravity, sucrose, glucose, fructose, CIPC residue, chip color and sprout inhibition.

Results:

Tables 1 and 2 show that specific gravity did not change appreciably throughout the sampling period. CO_2 and O_2 remained relatively constant during the first three months storage although the respiration rate seemed to rise early in October (Table 3). It was anticipated that CO_2 levels might increase shortly after CIPC application and it is possible that the higher levels seen in early October constituted a delayed response to sprout inhibitor presence but this is uncertain. The CIPC analysis of tubers sent to PPG Industries, Inc. showed that the sprout inhibitor dissipation followed the expected pattern (Figures 1 and 2). Two days after CIPC application, residues on both cultivars ranged from 12-15 ppm. Within ten days, those levels had dropped to approximately 3-5 ppm and have remained in this area throughout the sampling period. Visual examination of tubers show that the remaining CIPC is effectively retarding sprouting, although some Atlantics show the initiation of primary sprouts which seem to have been inhibited after rudimentary growth.

The sucrose (Figure 3), glucose (Figure 4) and fructose (Figure 5) content of the Russet Burbanks increased during storage, thus contributing to an increase in the total sugar content for this cultivar (Figure 6).

Not unexpectedly, the color of chips made from these potatoes reflected the increases in the reducing sugars (fructose and glucose) and became darker as the storage time increased. The sucrose (Figure 3), glucose (Figure 4) and fructose (Figure 7) content of the Atlantic samples decreased slightly during storage, however, the fructose content showed a slight overall increase about 70 days in storage and this reflected in the color of chips made from these tubers. The fluctuations in total sugars (Figure 8) are due almost entirely to changes in fructose during the storage period.

At the December sampling time, which was approximately 100 days after harvest, the commercial bin of potatoes in this study seemed to be in good chipping condition and the analytical analysis do not indicate any problem areas. However, changes may occur rapidly in the latter stages of storage and if adverse conditions appear, it is anticipated that they can be detected early by one or more of the analytical procedures being employed.

Table 1. Specific Gravity of Atlantic Potatoes in Storage, Lennard Farm, 1986.

Date	Rep 1	Rep 2	Rep 3	Rep 4	Average
9/9	1.088*	-	-	-	
9/12	1.083	1.084	1.083	1.084	1.084
9/22	1.084	1.086	1.086	1.084	1.085
9/24	1.084	1.084	1.086	1.083	1.084
10/3	1.083	1.082	1.083	1.083	1.083
10/13	1.083	1.081	1.084	1.084	1.083

* All measurements are averages of 3 samples from each rep.

Table 2. Specific Gravity of Russet Burbank Potatoes in Storage, Lennard Farm, 1986.

Date	Rep 1	Rep 2	Rep 3	Rep 4	Average
9/9	1.078*	-	-	-	
9/12	1.075	1.077	1.077	-	1.076
9/22	1.078	1.075	1.074	-	1.076
9/24	1.078	1.077	1.078	-	1.078
10/3	1.075	1.076	1.075	-	1.075
10/13	1.076	1.073	1.072	-	1.074

* All measurements are averages of 3 samples from each rep.

Table 3. CO_2 and o_2 Content of Atlantic Potatoes in Storage, Lennard Farm, 1986.

Sampling Date	Rep 0 [1]		Rep 1		Rep 2		Rep 3		Rep 4	
	CO_2% [2]	O_2%	CO_2%	O_2%	CO_2%	O_2%	CO_2%	O_2%	CO_2%	O_2%
9/9	.22	21.20	.23	21.02	.21	20.76	.39	21.28	.34	20.37
9/24 [3]	.31	19.25	.24	19.00	.24	18.75	.20	20.95	.24	17.70
10/3	1.57	19.05	1.17	23.45	1.08	24.4	.98	24.6	1.18	19.00
10/13	.20	20.00	.20	20.00	.20	20.00	.20	20.00	.20	20.00
11/14	.22	23.5	.22	23.80	.21	23.70	.23	24.35	.28	23.30

[1] Rep 0 located at a point near the fan.

[2] All measurements are averages of two samples from each rep.

[3] Sample taken 48 hours after CIPC application.

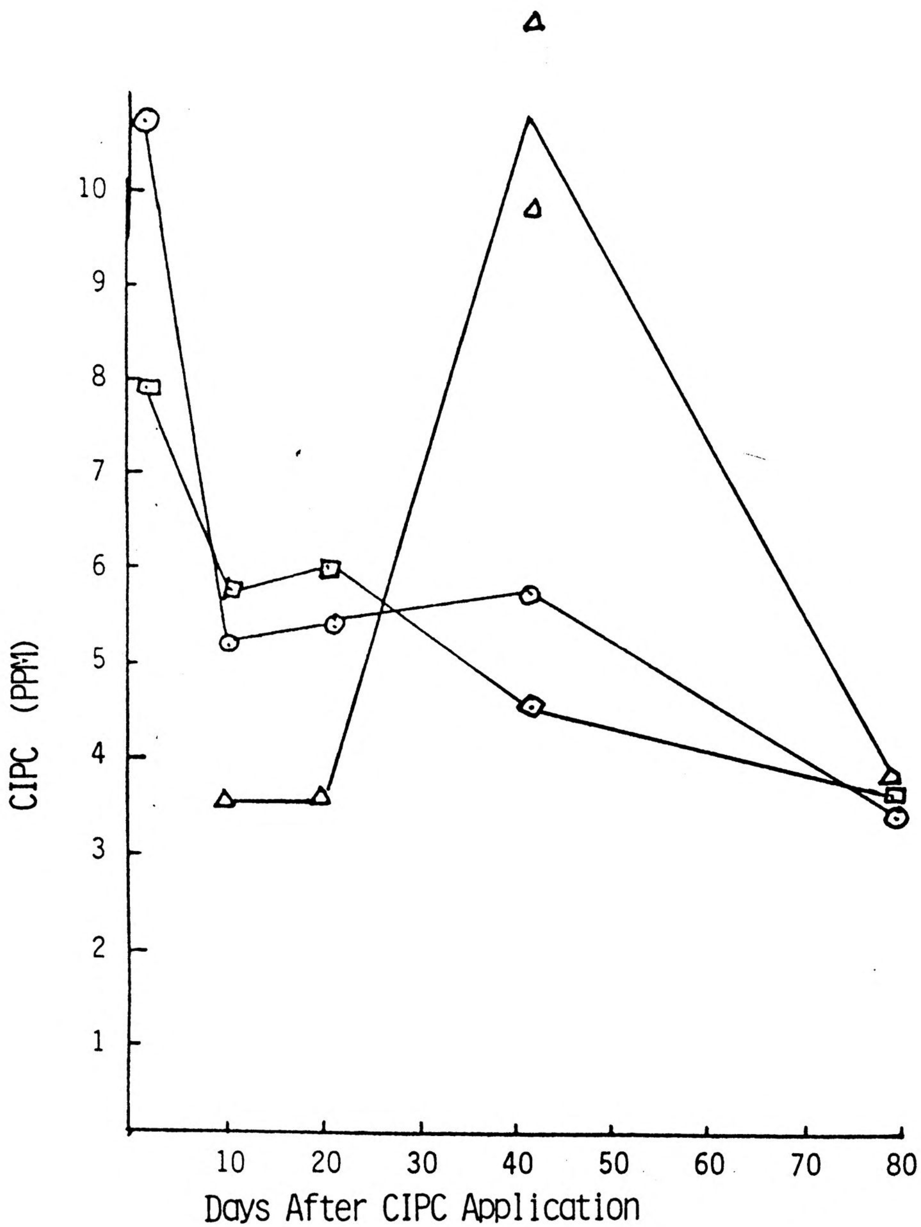


Figure 1. Dissipation of CIPC from Russet Burbanks, Lennard Farm, 1986.

Data supplied by PPG Industries, Inc.

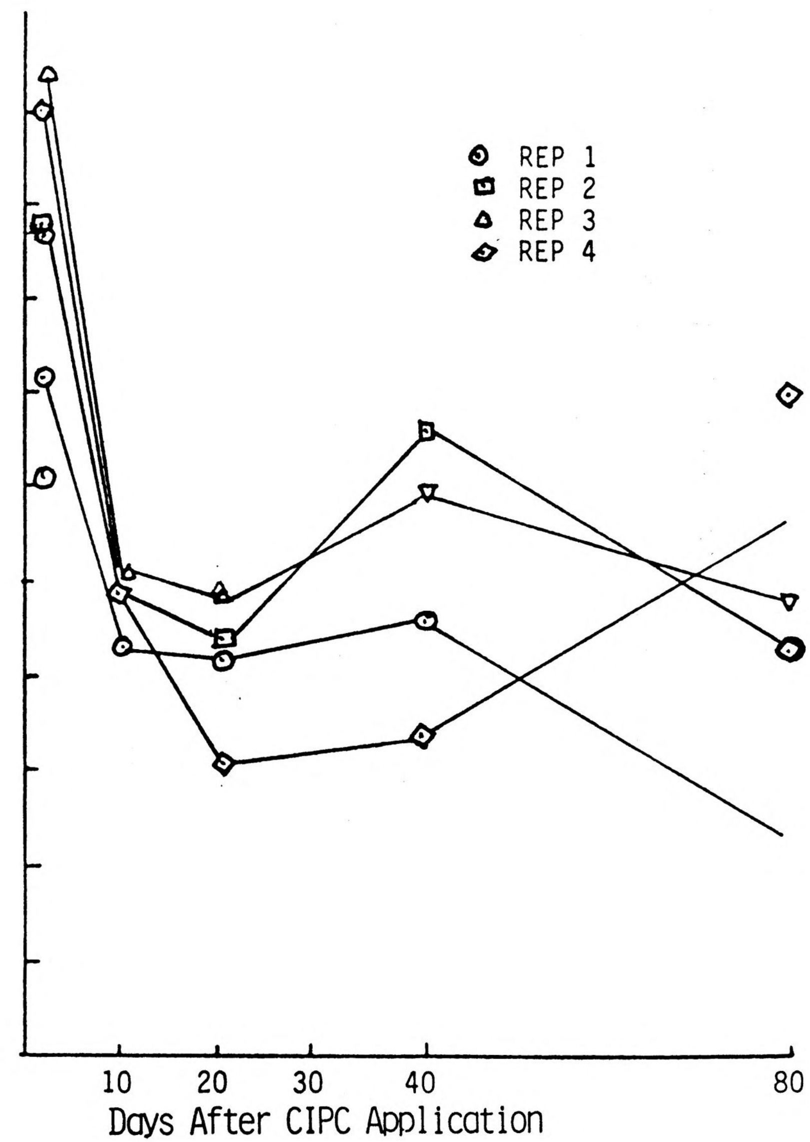


Figure 2. Dissipation of CIPC from Atlantics, Lennard Farm, 1986.

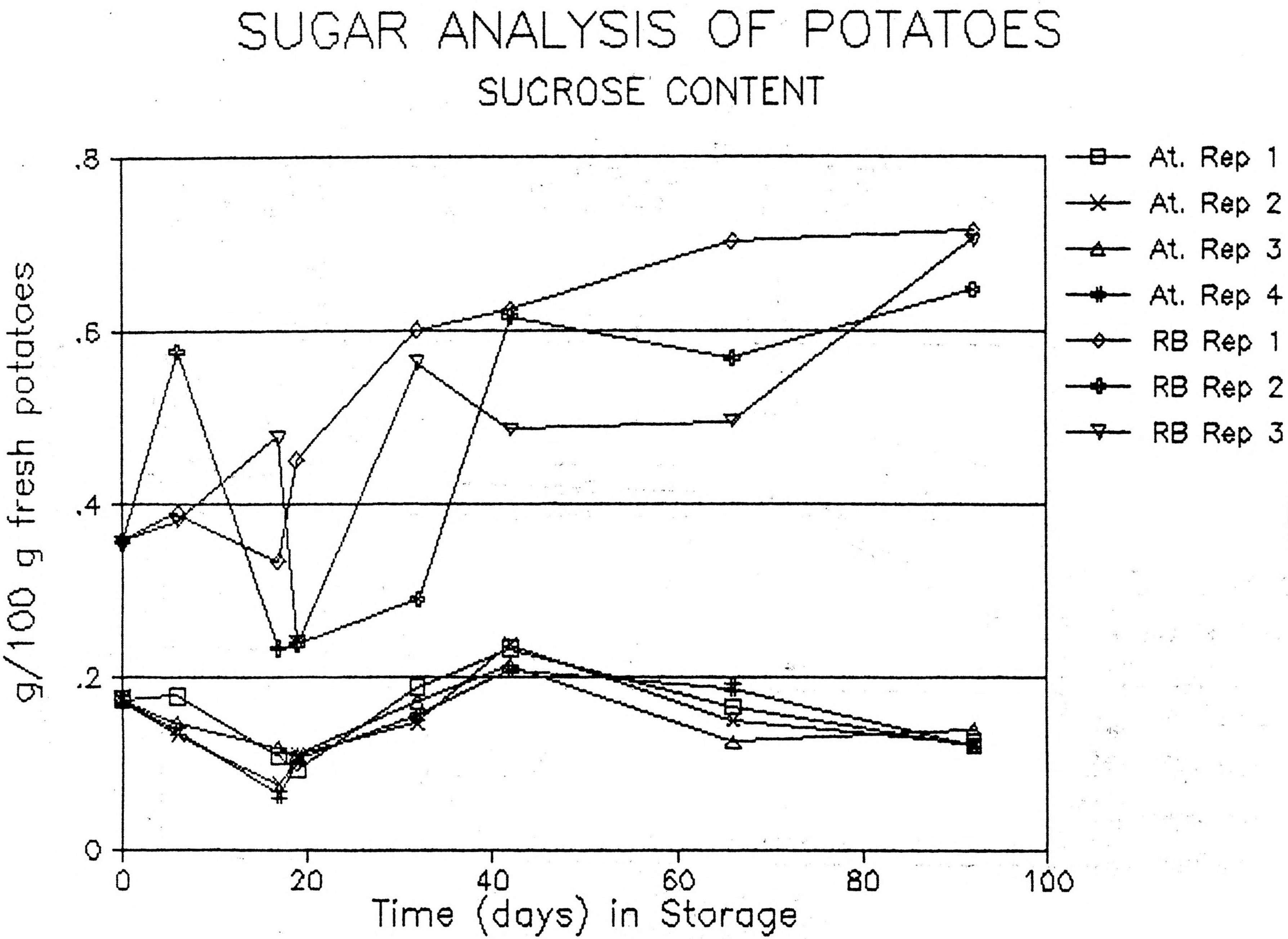


Figure 3. Sucrose Content of Atlantic and Russet Burbank Potatoes in Storage, Lennard Farm 1986.

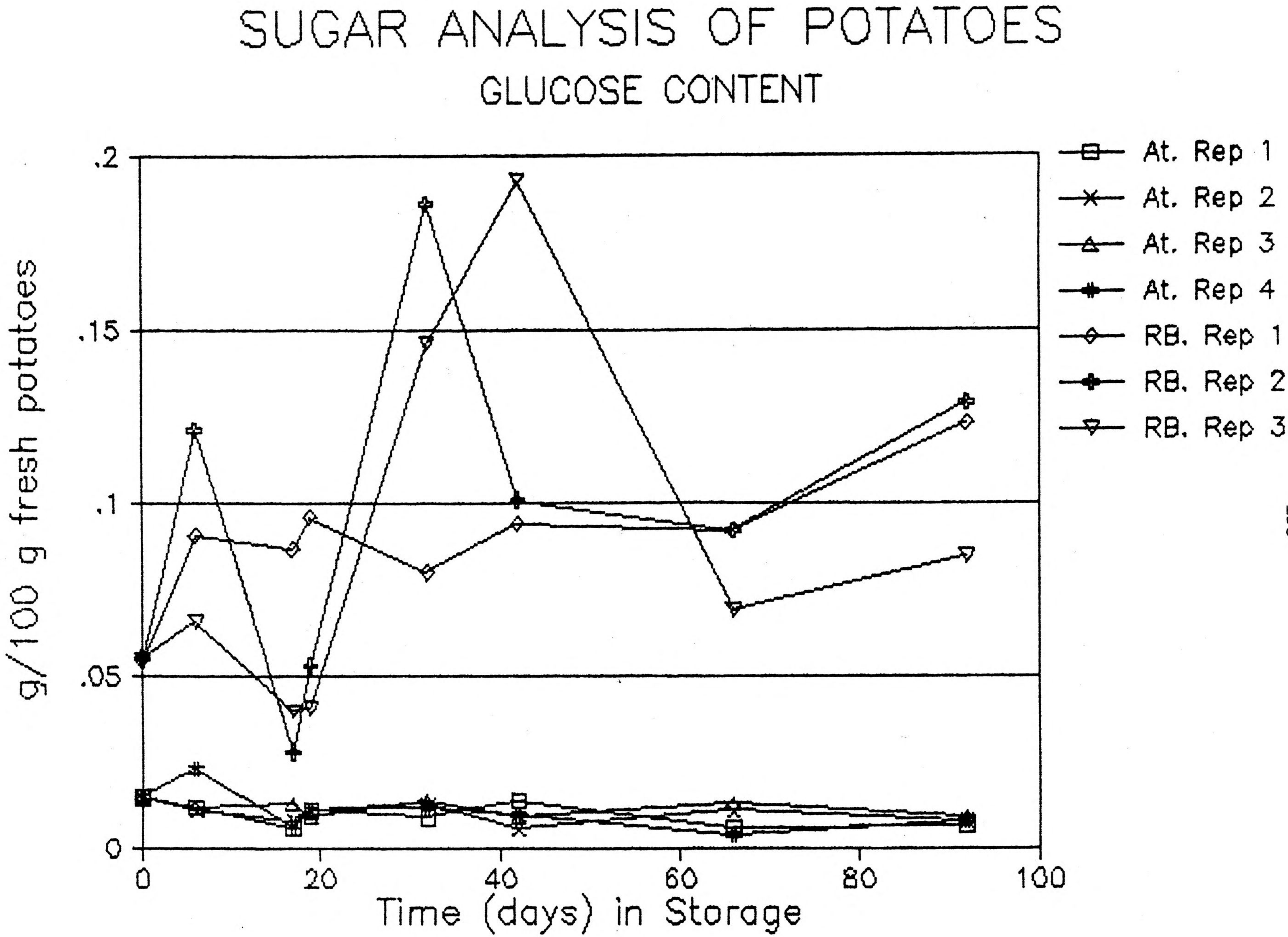


Figure 4. Glucose Content of Atlantic and Russet Burbank Potatoes in Storage, Lennard Farm 1986.

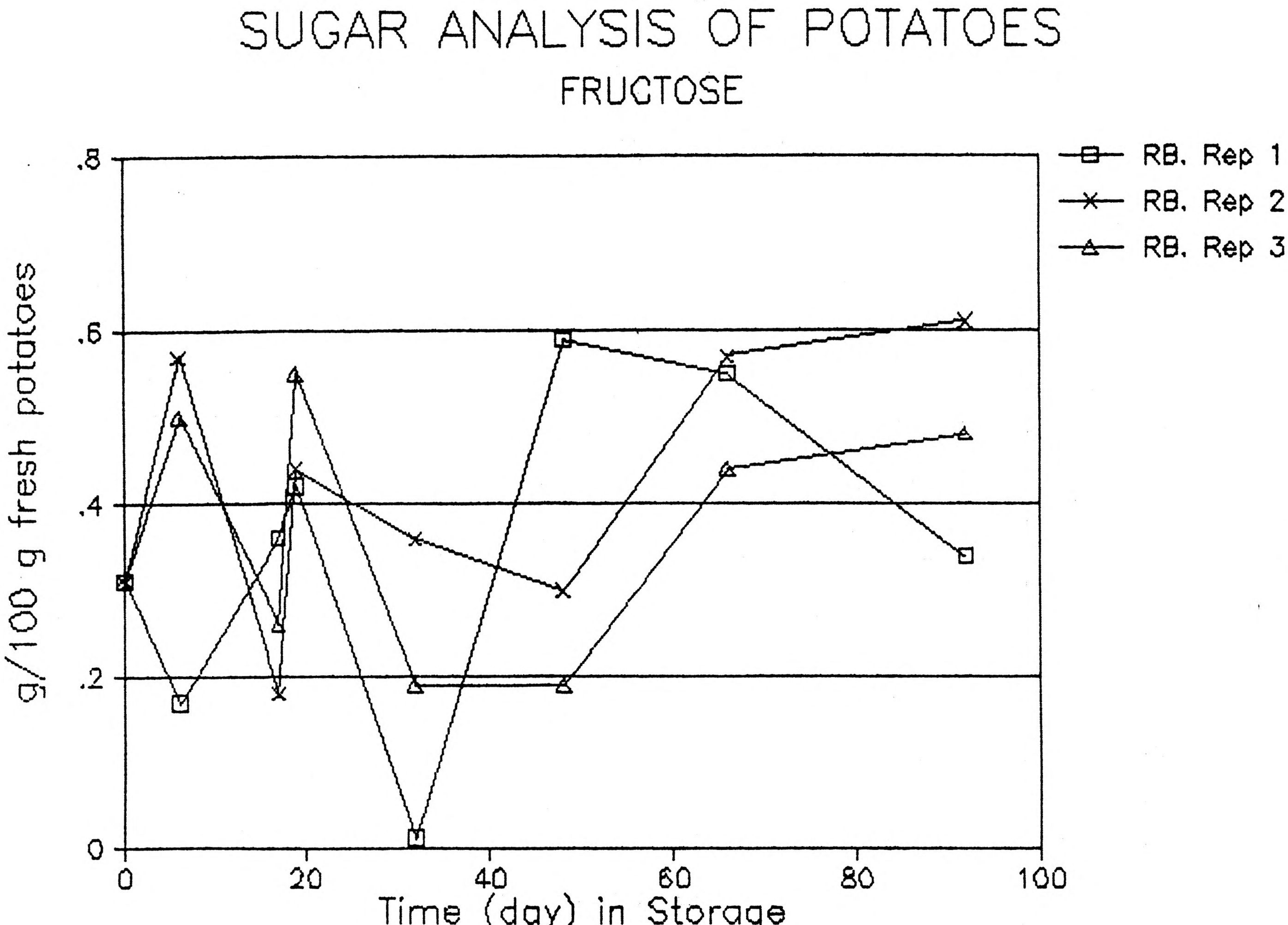


Figure 5. Fructose Content of Russet Burbank Potatoes in Storage, Lennard Farm 1986.

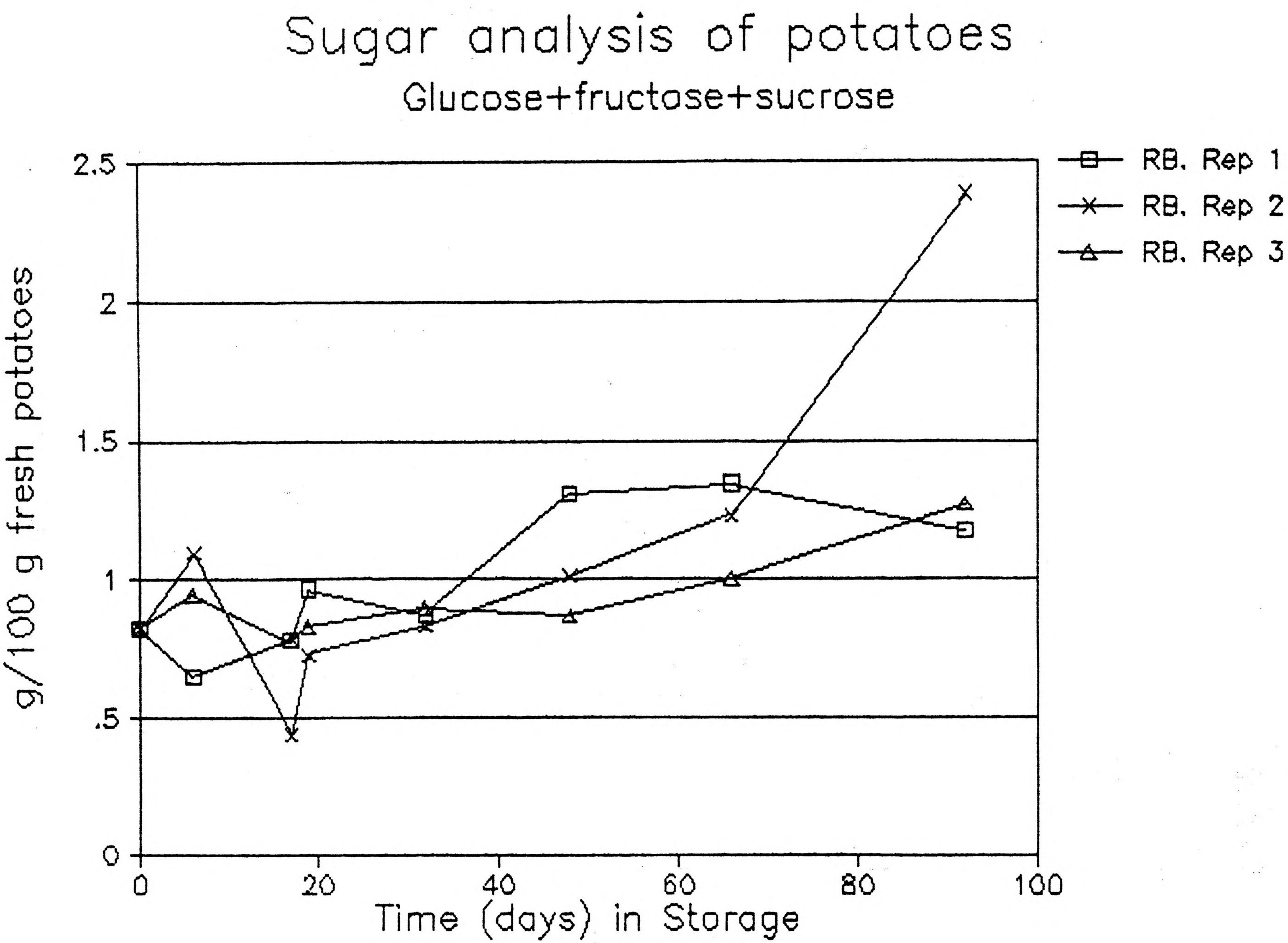


Figure 6. Total Sugar Content of Russet Burbank Potatoes in Storage, Lennard Farm 1986.

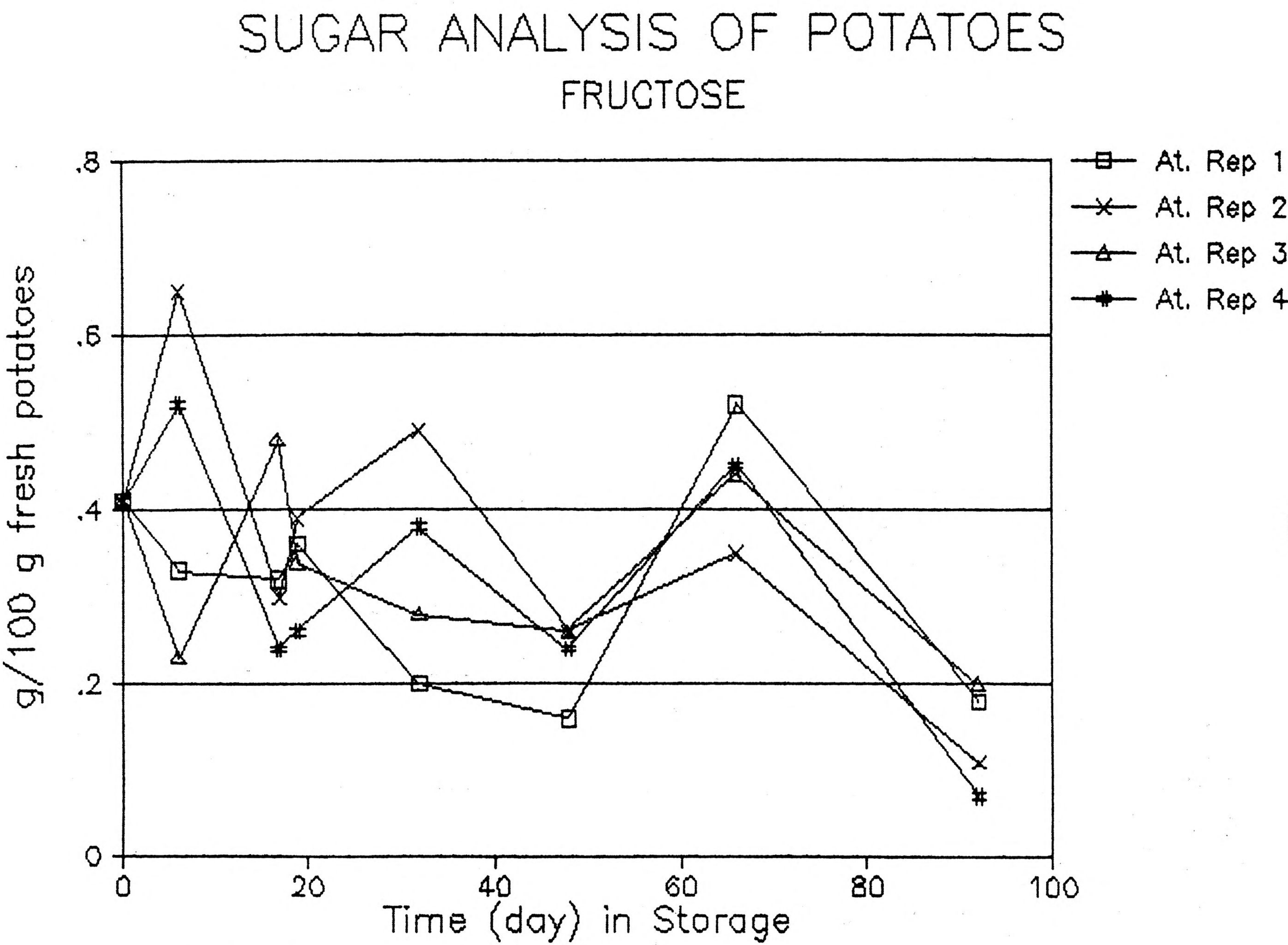


Figure 7. Fructose Content of Atlantic Potatoes in Storage, Lennard Farm 1986.

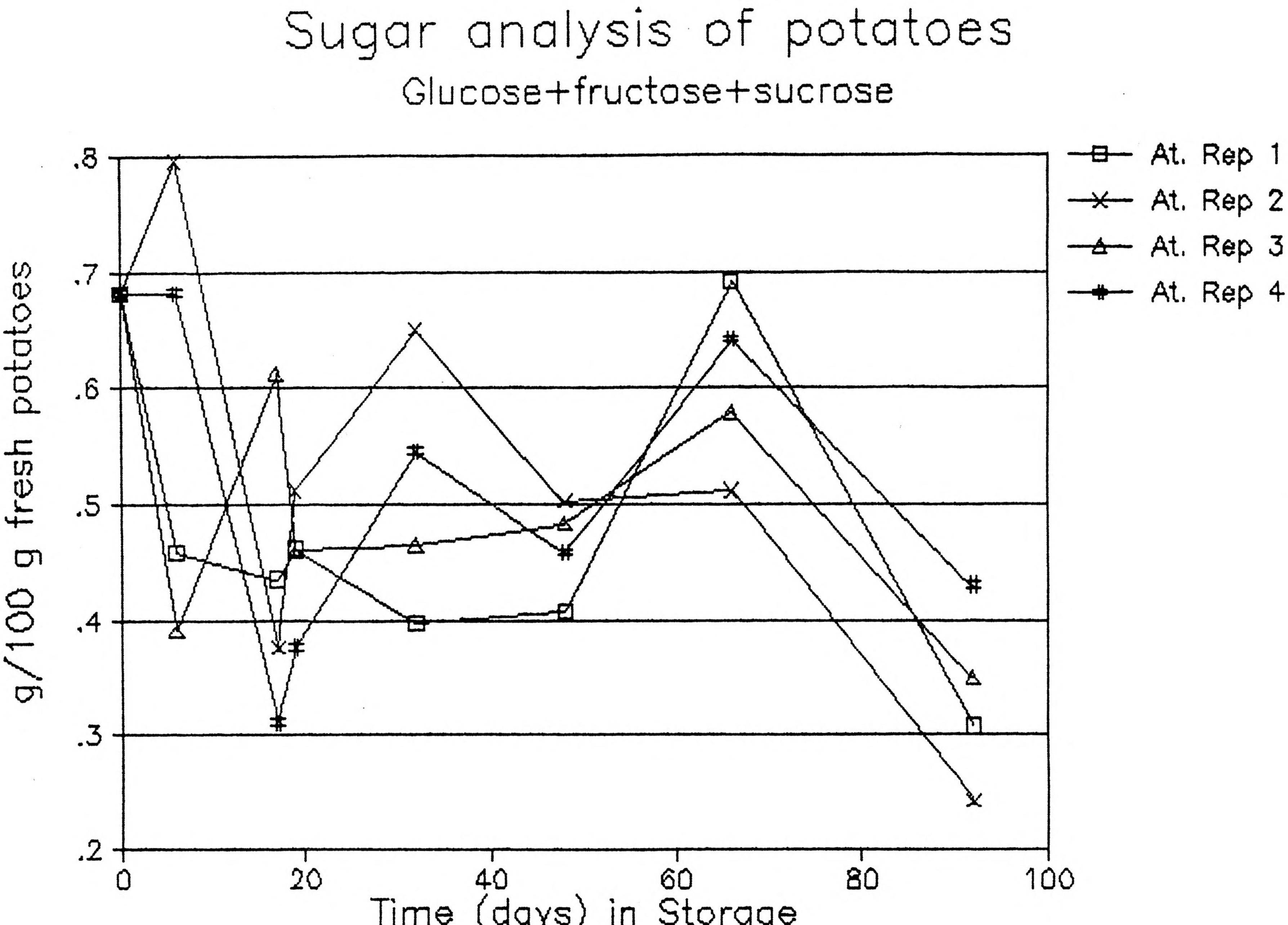


Figure 8. Total Sugar Content of Atlantic Potatoes in Storage, Lennard Farm 1986.

POTATO RESEARCH PROJECT REPORT

Title

Market and Economic Feasibility of Precooked (Retort Pouch) Potato Products.

Investigators

Thomas R. Pierson and Donald Hinman, Department of Agricultural Economics, Michigan State University.

Objectives

Earlier research (A Comparative Analysis of Potato Packing Costs: Assorted versus Specific Size Packs: Thomas R. Pierson, Department of Agricultural Economics, Investigator) was designed to determine costs per consumer package of round white potatoes in small, medium, and large sizes packed in both small and large packing plants. This proposal will build on that research to determine the following:

- Conduct a preliminary survey of institutional market interest in Michigan for retort potato products.
- Determine order of magnitude investment required for retort pouch potato processing plants which could utilize undersized and oversized potatoes resulting from a uniform size packing program. General recommendations will be made regarding plant sizes and an appropriate complement of manufacturing equipment.
- Estimate the potential number of jobs created by such processing facilities.

Justification

Each year a significant portion of the Michigan potato crop consists of small, extra large and otherwise off-grade product classes. Most growers believe that economic considerations mandate the sale of these potatoes. Without viable processing markets, the majority of these potatoes are sold in fresh market channels. This practice in turn has highly negative effects on Michigan's fresh market quality.

The present and long-term impact of the Michigan industry's poor quality reputation among wholesaler buyers and shoppers is very negative. Today's fresh produce business, including potatoes, is characterized by rising quality standards, thus, the long-term viability of the Michigan fresh potato industry is importantly influenced by the ability to market a quality fresh pack.

One approach for improving fresh pack quality is to identify and help develop a viable processing market outlet for small, extra large and otherwise off-grade potatoes. Precooked potatoes are a relatively new type of processed produce in need of economic and market evaluation.

Procedure

There are two major components to this research as indicated in the objectives section above. Research procedures are associated with each of the objectives:

- <u>Preliminary analysis of institutional market distributor and user interest in retort potato product concepts.</u>

  A participant interactive survey of Michigan institutional wholesalers and selected food service retailers will be undertaken to estimate potential demand and determine likely market acceptance for various product attributes.

- <u>Determination and analysis of economic costs and job creation associated with the operation of a commercial scale retort processing facility.</u>

  Budgeting techniques will be used to develop key fixed and variable operating costs for a retort pouch potato product processing plant. Knowledge of such cost estimates on a per unit of volume basis will permit preliminary cost and price comparisons with competing products in the marketplace. Cost information will be gathered from secondary sources as are available, however, it is likely that much information will be gathered from primary industry sources.

<u>Results</u>

The status of work on this project is as follows:

- Preliminary survey work to determine likely market interest in retort pouch potato products has been conducted. Additional survey work remains to be done.

- Procedures are complete for the processing plant cost analysis and work with university and industry sources to obtain needed cost information is well underway.

Funding: Federal Gran

POTATO RESEARCH PROJECT REPORT

Title

A Comparative Analysis of Potato Packing Costs: Assorted Versus Closely Sized Packs.

Investigators

Thomas R. Pierson and Lisa Allison, Department of Agricultural Economics, Michigan State University.

Objectives

The general objective is to help improve marketing methods of Michigan tablestock producers by providing cost information on potato packing plants and sizing operations. Specific objectives are to determine costs per consumer package of round white potatoes:

1) assorted sizes packed in small packing plants
2) assorted size packed in large packing plants
3) small, medium and large sizes packed in small packing plants
4) small, medium and large sizes packed in large packing plants

Justification

Potato production and marketing activities comprise an important and dynamic industry in Michigan and the midwest. Current and projected production and utilization trends support the importance of this Michigan industry, particularly if it is responsive to the critical problems and opportunities that exist.

Michigan potato industry leaders have identified the need to improve the fresh market quality and image of Michigan potatoes as the top priority concern that the industry must address in the immediate future. The dramatic changes that have been occurring in food consumption patterns because of changing lifestyles and nutritional concerns are having great impact on the kind and variety of food products demanded.

Expanding the demand for Michigan's fresh potatoes will necessitate that growers and marketers become market oriented rather than commodity oriented. Producers must recognize the importance of upgrading the appearance, uniformity, quality, variety and versatility of the products that are offered as well as the services they provide to capture a part of the expanding "fresh" demand. Michigan's fresh industry must drastically alter its commodity orientation to the production and marketing of fresh potatoes. Failure to adjust to a strong market orientation will limit the economic potential for this industry regardless of current or projected production and, utilization trends.

Procedures

Information and data for this research was collected from two primary sources; a literature search and personal on-site interviews. To meet the cost analysis objectives four packing plant layouts were considered; 1) a representative small plant, packing 10 lb. bags of assorted size potatoes; 2) a representative small plant, packing 10 lb. bags of small, medium and large sized potatoes; 3) a representative large plant, packing 10 lb. bags of assorted size potatoes; 4) a representative large plant, packing 10 lb. bags of small, medium and large sized potatoes. The plants are "representative" in that they reflect the usual machinery and building layouts of packing plants operating throughout Michigan.

The records, knowledge and experience of four main groups of people were relied on for the necessary data: 1) packing plant owners and managers of small and large packing plants throughout Michigan and in central Wisconsin; 2) potato packing equipment and building manufacturer sales representatives; 3) Michigan State farm management specialists and; 4) agricultural engineers.

Results

A thesis for a Master of Science Degree in Agricultural Economics is complete. Two industry oriented bulletins are in progress. The major findings are as follows: Michigan round white potato packers face a declining share of the fresh tablestock market and an overall low quality image. The study shows that the Michigan packing industry is characterized mainly by many small independent packers packing only assorted sized packs over a relatively short packing season and exhibiting high costs. Results also indicate that increasing plant size from small to large and plant utilization from Michigan's relatively low average to full utilization while packing closely sized packs may improve pack quality and reduce costs by up to thirty percent.

MICHIGAN POTATO INDUSTRY COMMISSION
13109 Schavey Road, Suite 7
DeWitt, Michigan 48820