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1985 MICHIGAN POTATO RESEARCH REPORT

MICHIGAN STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

IN COOPERATION WITH

THE MICHIGAN POTATO INDUSTRY COMMISSION

THE MICHIGAN POTATO INDUSTRY COMMISSION

February 28, 1986

TO: ALL MICHIGAN POTATO GROWERS AND SHIPPERS

This Potato Research Report includes the results of research projects that were carried on by Michigan State University at the Montcalm Research Farm, Entrican, Michigan, as well as other potato research projects conducted during 1985.

The continued research on Michigan potatoes is a direct result of the monies that growers and shippers have paid into the Michigan Potato Industry Commission. Only through this support can the potato industry in Michigan continue with similar research in the future.

Thank you for your continued support.

Sincerely,

The Michigan Potato Industry Commission

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1985 MICHIGAN POTATO

RESEARCH REPORT

Michigan State University

Agricultural Experiment Station

in Cooperation With

The Michigan Potato Industry Commission

TABLE OF CONTENTS

*1985 POTATO RESEARCH REPORT**

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INTRODUCTION AND ACKNOWLEDGEMENTS

The Montcalm Research Report prepared each year since 1967 is now being titled the Potato Research Report to better reflect its content. For some time it has contained projects and data other than that conducted at the Montcalm Research Farm and we are attempting to provide a vehicle for all MSU potato research results to be available to the Michigan potato industry.

Many of these projects are supported financially by the Michigan Potato Industry Commission and we acknowledge that excellent support. MSU researchers have also received assistance from many other companies and agencies and to each of them we give a special thanks. Many contributions are made in fertilizers, chemicals, seed, equipment, technical assistance, personal services and monetary grants.

Appreciation is also expressed for the excellent leadership of Dick Kitchen in the coordination of the production management needs of the Montcalm Research Farm throughout the planting, growing and harvest season. A special thanks is also due Theron Comden for his dedicated cooperation and assistance in many of the day-to-day operations.

WEATHER

Tables 1 and 2 summarize the 1985 temperature and rainfall data as compared with the 15 year average at the Montcalm Research Farm. Temperatures during April and May (particularly April) were substantially above the average which resulted in warm soils at the normal early May planting. The months of June and August were cooler than the average.

Total rainfall for the April - September growing season was exactly the same as the 15 year average. Although rainfall for April was .9 inches above average, May and June were drier than normal with the balance of the season near normal. As a consequence of lower rainfall during May, preemergence herbicides did not perform as well and overall weed control was not as good as in 1984.

Supplemental irrigations were applied on June 20, 24, 28, July 2, 5, 8, 11, 15, 18, 23, 29 and August 3 at the rate of 3/4 inch per application.

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*Printing and distribution of this 1985 Potato Research Report was made possible by the Michigan Potato Industry Commission.

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
1971	53	31	65	39	81	56	82	55	80	53	73	54	76	48
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
15-YR. AVG.	53	33	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
1971	1.59	0.93	1.50	1.22	2.67	4.00	11.91
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
15-YR. AVG.	2.73	2.76	3.34	2.50	4.17	3.45	18.95

SOIL TESTS

Soil test results for the general plot area were:

pH	P	K	Ca	Mg	% Organic Matter
6.4	579	232	1040	198	2.10

FERTILIZERS USED

The previous crop was corn for the 2 ranges where the variety trials were conducted and no-till soybeans for the remaining studies. For the entire 1985 research area, winter rye was planted in late fall of 1984. 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	400 lbs/A
banded at planting	24-8-8	500 lbs/A
sidedress at hilling	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 killed 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) 1/2 lb/A was applied. The sidedress urea was applied at the same time as hilling and no further tillage was required until harvest. Because of below average rainfall during late May and early June, weed control was not as desirable as in 1984.

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 July 1 and 10 applications were made throughout the balance of the season. Fungicides used were Bravo and Dithane M45. One application of Ridomil MZ-58 was made on August 16.

Foliar insecticides used were Thiodan on July 22, Furadan on August 1 and Cygon on August 8. The principal insect problem was the Colorado potato beetle.

1985 POTATO VARIETY EVALUATIONS

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A. DATES-OF-HARVEST

The 1985 dates-of-harvest study was conducted at the Montcalm Research Farm with 22 varieties and numbered selections. Three complete plantings of all varieties were made on May 7 in plots 23 ft x 34 inches and 12 inch plant spacings within the row. There were 4 replications and harvests were made on August 7 (92 days), August 29 (114 days) and September 19 (135 days) after planting.

The previous crop was corn and a winter rye cover crop. Fertilizers used were 400 lbs/A 0-0-60 plowdown, 500 lbs/A 24-8-8 in the planter and 180 lbs/A of 46-0-0 sidedressed. Aldicarb (Temik 15G) was applied at 20 lbs/A at planting. The sidedress application of urea, hilling and herbicide application were all made just as the potatoes were emerging which was done on May 28. 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 plots were irrigated and foliar insecticides and fungicides were applied as needed.

Results

Tables 1, 2 and 3 provide the yield and size distribution and quality results for each of the harvest dates. In general, yields were very good. As observed in previous years, the overall average specific gravity readings were lower on the third date of harvest than on the second harvest. Weather conditions were generally favorable through the growing season except that rainfall during May and June were below the average. Average maximum and minimum temperatures were 5F above average during both April and May and 4F below average during June and August. Temperatures were close to the 15 year average for both July and September.

Table 4 summarizes the culinary quality of after-cooking-darkening which was conducted on December 2. Peeled halves of 3 tubers selected at random and cooked uniformly in steam were evaluated at 0, 1 and 24 hours for tuber darkening. The incidence of any severe after-cooking-darkening was minimal.

Early blight was very prevalent in many varieties by late July and at that point, fungicide applications appeared to do little to arrest the problem. Conestoga yields were well below previous years data and seemed to result from a poor stand and weak growth of the remaining plants. In the 1984 trials this variety produced over 350 cwt/A at all three dates-of-harvest. Severe air check was observed on the G670-11 particularly at the first 2 dates-of-harvest. At the first date of harvest air checking was also noted on MS700-79, Simcoe, B9140-32 and MS702-91. The incidence was much less on the August 29 and September 19 harvests.

The internal defects were very minimal with almost no internal necrosis in any selection. Hollow heart was also judged to be very minimal. Pink eye was noted on some selections particularly on the last 2 dates of harvest.

Samples of all selections were collected from the third date of harvest for subsequent storage studies at both 53F and 40F and boiling studies for after-cooking-darkening and chip studies will be conducted later.

Variety Observations

MS700-79 - mid-season maturity, round white with average yields and medium specific gravity. Good scab tolerance.

MS700-83 - mid-season maturity, above average yields and good general appearance. Good internal quality and does chip out of field. Some scab tolerance.

MS701-22 - mid-season maturity, average yields, produces high percentage of potatoes over 3¼".

MS702-80 - medium-early variety, slightly below average yields. Good scab tolerance and chips well.

MS702-91 - medium-late maturity, with high yield potential. Low internal defects and good chips. Some variation in tuber shape from round to oblong.

MS704-10 - medium maturity and golden flesh. Sets heavy with average yields. High specific gravity.

MS716-15 - medium late maturity and below average yields. Well shaped, smooth and excellent general appearance.

G670-11 - late maturing, round white with high yield potential. Tubers susceptible to hollow heart, scab, shatter bruise and growth crack.

Acadia Russet - late maturing, long russet with average yields. Medium specific gravity. Fair in general appearance. Susceptible to scab.

Alasclear - late maturity, average yields, elongated shape. General tuber shape and appearance variable and not uniform. Good scab tolerance and medium specific gravity.

Atlantic - round white and above average yields. Good chip quality and high specific gravity.

Carlton - late maturity, round white for tablestock. Low specific gravity. Below average yields except at first harvest. Severe scab at Lake City Experiment Station seed increase plot.

Conestoga - early maturing, round white. Poor stands resulted in low yields. Medium deep eye. Some susceptibility to scab. Produced average yields in 1984.

Islander - late maturing, elongated white with below average yields. Good scab tolerance.

Onaway - early maturing, round white with good yields.

Russet Burbank - good yields but low percent No. 1's. High percentage of under 4 ounce potatoes and deformed tubers.

Shepody - long white, medium-late maturity with above average yields. Higher percentage of U.S. No. 1 then Russet Burbank. Comparable to Russet Burbank in specific gravity. Matures 2-3 weeks earlier than Russet Burbank. Good French fries and possible count pack. Susceptible to scab.

Simcoe - medium-early maturity but below average yield. Good chip color.

Yankee Chipper - medium-late maturity, oblong white. Average yields, medium specific gravity. Some scab susceptibility.

Yankee Supreme - medium-late, oblong to blocky tuber with slight netting. Sets and sizes tubers early but susceptible to scab.

Yukon Gold - medium-early, smooth tubers, shallow eye and golden flesh. Susceptible to scab. Above average yields and suitable for specialty fresh pack.

B9140-32 - medium maturing, oblong russet. Low yields at all dates of harvest.

B. UPPER PENINSULA TRIAL

A potato variety trial was conducted in Delta County, Michigan on the John VerBrigghe farm. Each variety was replicated four times in a randomized block experimental design. The plots were planted on May 24 and harvested on October 2, 1985. Yields, specific gravity and internal defects were determined.

The plot area was fertilized with a total of 105-72-120 pounds per acre of fertilizer. The soil test was pH - 6.5, P - 107 and K - 107. The previous crop was alfalfa. Thimet was applied at planting. 0.25 pounds per acre Lexone was applied postemergence for weed control. The plots were irrigated and managed as the entire field was. Favorable growing conditions resulted in excellent yields with good quality.

Results

The total yield ranged from 291 and 618 hundredweight per acre. The average total yield over 24 varieties was 395 hundredweight per acre. Yields of G670-11, Acadia Russet, Russet Burbank and MS716-15 were significantly higher than the average. Specific gravity ranged from 1.068 to 1.084 with the average at 1.075. Hollow heart was found in G670-11, however, only a small percentage of tubers contained hollow heart. The overall appearance and quality of the tubers was excellent which was probably due to excellent growing conditions.

Table 1. 1st Date-of-Harvest Yield Results (92 days). Harvested August 7, 1985.

	Yield cwt/A		Percent Size Distribution							Internal Defects*		
Variety	Total	No. 1	No. 1	Under 2"	2-3¼	Over 3¼	Pick Outs	Specific Gravity	Chip Rating	HH	Vas. Dis.	Int. Necrosis
Onaway	424	388	91	7	78	13	2	1.062	3.5	0	3 sl	0
MS702-91	389	346	89	10	81	8	1	1.078	1.0	0	1 sl	0
MS700-83	389	335	86	14	76	10	0	1.072	1.0	0	1 sl	0
Atlantic	355	301	85	14	73	12	1	1.082	1.0	0	0	0
Yukon Gold	331	291	88	10	71	17	2	1.077	1.0	0	2 sl	0
Carlton	321	289	91	8	69	22	1	1.062	2.5	0	3 sl	0
MS704-10(Y)	333	283	85	14	77	8	1	1.080	1.5	0	0	0
MS700-79	314	281	89	9	82	7	2	1.080	1.0	1	1 sl	0
MS701-22	308	281	91	8	78	13	1	1.077	1.0	0	0	0
Yankee Supreme	326	275	84	12	77	7	4	1.077	1.5	0	1 sl	0
Alasclear	334	269	81	15	78	3	4	1.075	1.5	0	3 sl	0
Islander	323	255	79	20	78	1	1	1.077	1.0	0	0	0
MS702-80	293	255	87	12	79	8	1	1.073	1.0	0	0	0
Yankee Chipper	331	249	75	23	72	3	2	1.078	1.0	0	0	0
G670-11	287	245	85	8	71	14	7	1.082	2.0	1	1 sl	0
MS716-15	277	235	85	15	79	6	0	1.086	1.0	0	0	0
B9140-32	269	227	84	14	81	3	2	1.082	1.0	1	1 sl, 1 sev	0
Shepody	272	218	80	17	65	15	3	1.072	2.5	0	2 sl	0
Simcoe	243	216	89	11	84	5	0	1.079	1.0	0	0	0
Russet Burbank	291	203	70	20	64	6	10	1.065	2.5	0	1 sl	0
Acadia Russet	288	199	69	29	68	1	2	1.076	2.5	0	2 sl	0
Conestoga	213	166	78	20	70	8	2	1.071	1.5	1	1 sl	0
OVERALL AVERAGE	301	264						1.076				

*20 tubers at random cut.

Table 2. 2nd Date-of-Harvest Yield Results (114 days). Harvested August 29, 1985.

	Yield-cwt/A		Percent Size Distribution							Internal Defects*		
Variety	Total	No. 1	No. 1	Under 2"	2-3¼	Over 3¼	Pick Outs	Specific Gravity	Chip Rating	HH	Vas. Dis.	Int. Necrosis
G670-11	508	448	88	5	52	36	7	1.090	2.0	0	1 sl	0
MS700-83	502	434	86	13	72	14	1	1.076	1.0	0	3 sl	0
Russet Burbank	446	340	76	14	63	13	10	1.079	2.0	0	4 sl	0
Shepody	440	380	86	6	64	22	8	1.077	1.5	0	4 sl	0
Onaway	436	400	91	8	74	17	1	1.064	3.5	0	7 sl	0
Atlantic	429	371	86	11	64	22	3	1.087	1.0	0	1 sl	0
Islander	417	354	85	13	75	6	2	1.076	1.0	0	0	0
MS701-22	407	385	94	5	60	34	1	1.083	1.0	0	0	0
MS702-91	405	353	88	11	77	11	1	1.077	1.0	0	4 sl	0
Yankee Chipper	403	314	78	20	72	6	2	1.078	1.5	0	6 sl	0
MS700-79	395	366	92	6	79	13	2	1.079	1.0	0	0	0
Acadia Russet	391	318	81	18	73	8	1	1.077	2.5	1	2 sl	0
Alasclear	389	331	85	12	82	3	3	1.080	2.0	0	6 sl	0
Yukon Gold	383	348	90	9	75	15	1	1.079	1.5	0	2 sl	0
MS704-10	366	318	86	12	71	15	2	1.083	1.5	0	3 sl	0
Yankee Supreme	353	300	85	14	79	6	1	1.074	2.0	1	1 sev	0
MS702-80	330	288	87	12	82	5	1	1.073	1.0	0	1 sl, 1 sev	0
Simcoe	329	300	91	9	80	11	0	1.080	1.0	0	0	0
MS716-15	308	262	85	15	79	6	0	1.085	1.0	0	0	0
B9140-32	297	251	84	15	80	4	1	1.084	1.0	0	2 sl	0
Carlton	261	236	90	10	75	15	0	1.060	2.5	0	4 sl	0
Conestoga	228	189	83	16	72	11	1	1.069	1.0	0	1 sl	0
OVERALL AVERAGE	383	331						1.078				

*20 tubers at random cut.

Table 3. 3rd Date-of-Harvest Yield Results (135 days). Harvested September 19, 1985.

	Yield-cwt/A		Percent Size Distribution							Internal Defects*		
Variety	Total	No. 1	No. 1	Under 2"	2-3¼	Over 3¼	Pick Outs	Specific Gravity	Chip Rating	HH	Vas. Dis.	Int. Necrosis
G670-11	659	592	90	3	44	46	7	1.085	2.5	3	0	0
MS702-91	560	527	94	5	69	25	1	1.077	1.0	0	1 sl	0
Atlantic	520	474	91	6	67	24	3	1.087	1.0	0	1 sl, 1 sev	0
Russet Burbank	520	306	59	16	39	20	25	1.077	2.0	1	1 sl	0
Onaway	494	466	92	6	70	22	2	1.061	3.5	0	4 sl	0
MS700-83	453	396	88	10	63	25	2	1.073	1.0	0	0	0
Yukon Gold	440	409	93	4	66	27	3	1.073	2.0	1	1 sl	0
Shepody	438	320	74	17	57	17	9	1.077	1.5	0	1 sl	0
Alasclear	409	325	80	16	69	11	4	1.077	1.5	0	3 sl	0
Acadia Russet	407	287	71	26	65	6	3	1.075	3.0	0	2 sl, 2 sev	0
MS701-22	400	388	97	3	49	48	0	1.080	1.5	0	0	0
MS704-10	400	360	90	10	77	13	0	1.075	1.5	0	3 sl	0
Yankee Chipper	385	314	81	16	75	6	3	1.076	1.0	0	4 sl	0
MS700-79	377	354	94	5	79	15	1	1.076	1.0	0	0	0
Yankee Supreme	377	329	87	9	72	15	4	1.073	2.0	0	2 sl	0
MS716-15	372	338	91	9	81	10	0	1.083	1.0	0	0	0
Simcoe	363	342	94	5	80	14	1	1.076	1.0	0	1 sl	0
Carlton	361	321	89	8	62	27	3	1.058	2.5	0	0	0
Islander	349	291	84	14	77	7	2	1.077	1.0	0	4 sl	0
MS702-80	342	311	91	8	79	12	1	1.073	1.0	0	2 sl	0
B9140-32	334	294	88	11	81	7	1	1.080	1.0	0	1 sev	0
Conestoga	237	196	83	14	77	6	3	1.071	1.0	0	1 sl	0
OVERALL AVERAGE	418	361						1.075				

*20 tubers at random cut.

Table 4. After-Cooking-Darkening of 22 varieties grown in 1985 Dates-of-Harvest Study*.

	0 Hours	1 Hour	24 Hours	Comments
MS700-79	1.0	1.5	1.5	some sloughing, 2 tubers with darkened stem end
MS700-83	1.5	1.5	1.5	3 slightly darkened stem end
MS701-22	1.0	1.0	1.5	some sloughing
MS702-80	1.0	1.0	1.0	
MS702-91	1.0	1.0	1.0	some sloughing
MS704-10	1.0	1.0	1.0	
MS716-15	1.0	1.0	1.0	some sloughing
G670-11	1.0	1.0	1.0	
Acadia Russet	1.0	1.0	1.0	
Alasclear	1.0	1.0	1.0	
Atlantic	1.0	1.0	1.0	some sloughing
Carlton	1.0	1.0	1.0	
Conestoga	1.0	1.5	2.0	3 with darkened stem ends
Islander	1.5	2.0	2.0	dark over all
Onaway	1.0	2.0	2.0	dark over all
Russet Burbank	1.0	1.0	1.0	
Shepody	1.0	1.0	1.0	some sloughing
Simcoe	1.0	1.0	1.0	1 with darkened stem end
Yankee Chipper	1.5	2.0	2.5	dark all over
Yankee Supreme	1.0	1.0	1.0	1 tuber with darkened stem end
Yukon Gold	1.0	1.0	1.0	1 tuber with darkened stem end
B9140-32	1.0	1.5	2.0	some sloughing

*Tubers stored at 53F since harvest. Rating scale 1-5; 1 = no darkening, 5 = severe darkening overall.

Table 5. The Yield, Size Distribution and Specific Gravity of Several Potato Varieties Grown in the Upper Peninsula.

Variety	cwt/A Total	cwt/A No. 1	Percent Size Distribution No. 1	<2"	2-3¼"	>3¼"	Pick Outs	S.G.
Acadia Russet	618	554	90	11	53	36	0	1.073
G670-11	492	479	97	3	49	48	0	1.084
MS716-15	492	456	93	2	63	30	0	1.081
Russet Burbank	521	451	87	11	70	17	2	1.079
MS702-91	456	427	94	6	55	38	0	1.070
Shepody	439	415	95	5	41	53	0	1.074
Alasclear	438	408	93	7	75	18	0	1.074
ND534-4	446	398	89	10	56	34	1	1.069
MS704-10	436	380	87	13	64	23	0	1.074
Carlton	435	378	87	5	34	51	10	1.068
Conestoga	382	352	92	8	73	19	0	1.071
NorKing Russet	390	337	86	13	80	6	1	1.078
Atlantic	368	332	90	9	71	19	0	1.083
MS700-79	346	331	96	5	58	37	0	1.076
Yankee Supreme	351	328	93	6	62	31	1	1.078
MS700-83	405	325	80	20	60	20	0	1.070
Nooksack	324	313	97	3	54	43	0	1.081
Yukon Gold	313	300	96	4	46	50	0	1.074
Superior	313	274	88	13	73	13	0	1.070
Simcoe	286	271	95	5	69	25	0	1.080
MS702-80	306	270	88	12	60	28	0	1.070
MS701-22	300	263	88	12	53	35	0	1.081
Yankee Chipper	329	253	77	23	68	9	0	1.077
Islander	291	214	74	32	64	3	0	1.072
AVERAGE	395	355						1.075

C. NORTHEAST REGIONAL TRIAL

Several selections were obtained from the Sangerville Farm in Maine where seed is maintained for several selections from the Northeast potato breeding programs. Most of the selections were selected for a high tolerance to scab. Included in the study were 4 russet selections. NorKing Russet was released in 1985 by North Dakota and ND534-4 is another very smooth and promising russet. Nooksack which has a very long dormancy and A74114-4 from the USDA-Aberdeen program were also included.

Plot dimensions, fertilizers and irrigation pest management were similar to the dates-of-harvest study. The plots were planted on May 8, 1985 and harvested on September 20 (135 days).

Results

Table 6 summarizes the yield and size distribution data for the several cultivars in the Northeast trial. Selections showing the greatest internal defects were AF339-5, Nooksack, ND534-4, CS77120-8 and CS73105-2R. Selections judged to have the best overall general appearance were CF7750-1, Tolaas (MN7973), NorKing Russet, ND534-4, A74114-4 and Atlantic.

Variety Observations

BR7088-18 - smooth round white with deep eyes, medium-late maturity, vigorous and good stand.

NY64 - late maturing, round white, scab and golden nematode resistance, good stands and vigorous.

A74114-4 - a long russet from USDA-Aberdeen program. Late maturity, good stand and vigor, good general appearance, one hollow heart and 3 with internal necrosis, trace of scab and some growth crack.

AF92-3 - medium-late maturity, round to oblong white, not uniform in tuber shape, some scab tolerance, good vigorous stand, no early blight noted and trace of growth crack.

Atlantic - good, vigorous stand, trace of scab and growth crack, one hollow heart.

NorKing Russet - very smooth, long russet, medium-late maturity and a vigorous growth, considerable early blight on foliage on August 12.

CS77120-8 - medium maturity, oval to oblong russet, considerable hollow heart and brown center, low specific gravity.

AF339-5 - medium-late maturity, oblong and flattened white tubers, uneven growth and average vigor, considerable hollow heart and some growth crack and vascular discoloration.

MN7973 (TOLAAS) - medium maturity, long white (sometimes russet), resistance to hollow heart and scab, high tolerance to late blight, smooth and good general appearance, trace growth crack. Showed some wilted stems in August, maybe blackleg.

AF9058-M - late maturing, oval white tubers, irregular in shape, some scab and internal necrosis, very uneven stand and poor vigor.

CS73105-2R - medium maturity, oblong russet, considerable vascular discoloration, good stand with average vigor.

ND534-4 - medium maturity, oblong to long russet, very smooth, lower specific gravity than NorKing Russet, good stand, many dead stalks in early August, some hollow heart and considerable internal necrosis.

WF564-3 (MAVERICK) - medium-late maturity, round to blocky russet, low specific gravity, has prominent eyebrows, resistant to scab, minimal internal defects, good stand and vigorous growth.

Russet Burbank - good total yield but poor sizing and 20% pick outs, minimal internal defects, good stand and vigorous growth.

CF76183-2 - early maturity, oblong white, trace of scab and growth crack, low specific gravity, good stand with average vigor.

CF7750-1 - medium-early maturity, oblong light russet, minimal internal defects, several black scurf and skin spots, small weak plants and average vigor.

Nooksack - late maturity, long russet, long dormancy, trace hollow heart, severe vascular discoloration, good stand with vigorous growth.

D. NORTH CENTRAL REGIONAL TRIAL

Eighteen selections from 7 mid-west potato breeding programs were compared with 5 check varieties in the 1985 North Central Regional Trial. Plots were planted on May 8 and harvested on September 23. Plot size, fertilizers and pest management were the same as for the dates-of-harvest study.

Results

Three MSU seedlings, MS700-83, MS704-10 and MS716-15 were included in the regional trial. Also included was G670-11, a selection developed at the University of Guelph. Tables 7 and 8 summarize the performance data. Yields in general were very good with 8 selections exceeding 400 cwt/A. The incidence of scab was not serious except for selection NE106. Selections G670-11 and BN9815-3 had a moderate level of scab. Internal defects were also minimal except for hollow heart in G670-11 and BN9815-3. The 3 MSU seedlings performed very well with MS700-83 producing very good yields and was judged as the first choice for the merit rating.

Table 6. The Yield, Size Distribution and Specific Gravity of Several Potato Cultivars Grown in the Northeast Regional Trial.

Variety	cwt/A		Percent Size Distribution					S.G.
	Total	No.1	No. 1	<2"	2-3¼"	>3¼"	Pick Outs	
BR7088-18	429	391	91	5	67	24	4	1.087
NY64	459	381	83	10	66	17	7	1.072
A74114-4	447	378	85	12	63	22	3	1.075
AF92-3	415	364	88	9	65	23	3	1.068
Atlantic	442	357	81	14	67	14	5	1.086
NorKing Russet	420	331	79	16	63	16	5	1.080
CS77120-8	381	310	81	8	57	24	11	1.067
AF339-5	342	289	85	5	32	52	11	1.076
MN7973 (TOLAAS)	326	287	88	7	68	20	5	1.063
AF9058M	334	271	81	9	48	33	10	1.069
CS73105-2R	310	266	86	12	73	13	2	1.067
ND534-4	326	264	81	13	58	23	6	1.070
WF564-3 (MAVERICK)	399	260	65	29	60	5	6	1.066
Russet Burbank	405	251	62	18	52	10	20	1.079
CF76183-2	288	228	79	15	60	19	6	1.063
CF7750-1	247	203	82	18	70	12	0	1.073
Nooksack	232	180	78	20	73	4	3	1.090
AVERAGE	364	294	81					1.073

Table 7. Yield, Solids, Maturity and Chip Quality of Several Cultivars Grown in the North Central Regional Trial.

Selection Number Or Variety	Aver. Mat. 1/	Most Representative Scab Area-Type 2/	CWT/A Aver. Yield	CWT/A Aver. Yield US #1	Aver. Percent US #1	Aver. Total Solids	Gen. Merit Rating 3/	Chip Color 4/	Early Blight Reading 5/	Comments and General Notes
EARLY TO MEDIUM EARLY										
Norland	1	0	341	314	92	15.0		2.0	DATA NOT AVAILABLE	growth cracks
MN 11705	1	0	166	72	43	16.9		1.0		pear shape; short dor.
NE 9.75-1	2	1-3	437	379	87	17.5		1.5		knobs; growth crack
ND 651-9	2	T-3	343	286	83	17.7		1.0		sl. knobs
ND 860-2	1	0	202	137	68	18.4		1.0		
MEDIUM TO LATE										
La 12-59	4	0	414	392	95	18.8		2.0		
La 01-38	4	0	480	463	96	19.2	4	2.0		
MS700-83	3	0	464	423	91	19.2	1	1.0		
MS704-10	3	0	389	351	93	20.3		1.5		sl. growth crack
MS716-15	4	T-3	375	330	88	20.9	2	1.0		
G670-11	5	2-3	493	445	90	21.8		2.0		growth crack
MN 11816	3	0	173	129	74	17.1	3	2.0	DATA NOT AVAILABLE	sl. knobs
MN 11903	3	T-3	320	290	91	16.7		1.5		sl. pointed
NE 106	4	5-2	382	334	87	19.4		1.5		sl. growth crack
BN 9815-3	3	2-3	222	199	90	18.8		2.0		
ND671-4Russ	3	1-3	367	252	69	18.0	5	3.5		growth crack
W 842	4	T-2	387	345	89	22.0		1.0		sl. growth crack,
W 903	3	0	452	348	77	17.5		2.0		pear shape \ pointed
W 949R	3	T-3	435	413	95	16.7		3.0		
Red Pontiac	3	0	580	509	88	15.6		3.5		
Russet Burbank	4	0	383	245	64	19.4		3.0		knobs
Norgold Russet	3	0	273	153	56	17.1		3.5		sl. knobs
Norchip	3	0	317	277	88	19.2		1.0		growth crack

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 - 10-20%; 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 or Agtron. 1-5 scale

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

Table 8. Summary of External and Internal Grade Defects of North Central Regional Trial.

Selection Number or Variety	EXTERNAL DEFECTS				Total (4) Tubers Free of External Defects	INTERNAL DEFECTS			Normal Tubers (5)
	Scab (3)	Growth Cracks	Second Growth	Sun Green		Hollow Heart	Internal Necrosis	Vascular Discoloration	
EARLY TO MEDIUM EARLY									
Norland	0	0	0	2	98	0	0	0	100
MN 11705	0	0	6	0	94	0	0	10	90
NE 9.75-1	10	2	2	2	84	0	0	6	94
ND 651-9	2	4	2	2	90	0	0	12	88
ND 860-2	0	0	0	0	100	0	4	2	94
MEDIUM TO LATE									
La 12-59	0	0	2	0	98	0	0	2	98
La 01-38	0	0	0	4	96	0	0	2	98
MS700-83	0	0	0	0	100	0	0	10	90
MS704-10	0	0	0	0	100	0	0	2	98
MS716-15	4	0	0	0	96	0	0	10	90
G670-11	8	4	0	6	82	14	0	2	84
MN 11816	0	2	2	4	92	0	0	28	72
MN 11903	2	0	0	2	96	0	2	8	90
NE 106	90	0	2	0	8	8	0	10	82
BN 9815-3	20	0	0	8	72	20	0	12	68
ND671-4Russ	2	0	2	8	88	4	2	6	88
W 842	4	0	0	0	96	2	0	4	94
W 903	0	0	0	2	98	0	0	2	98
W 949R	2	0	2	2	94	0	0	6	94
Red Pontiac	0	0	8	2	90	2	2	12	84
Russet Burbank	0	0	10	10	80	4	0	4	92
Norgold Russet	0	0	0	2	98	0	0	2	98
Norchip	0	2	8	2	88	0	2	24	74

(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 all tubers with scab lesions whether merely surface, pitted or otherwise and regardless of area. Be sure 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.

E. BELTSVILLE TRIAL

Thirteen selections from the USDA-Beltsville potato breeding program were evaluated in comparison to Atlantic. The plots were planted on May 8 and harvested on September 10 (125 days). Plot size, fertilizers and pest management were the same as for the dates of harvest study.

Results

Several selections yielded below the accepted level of at least 300 cwt/A and several selections had a low percentage of U.S. No. 1's (Table 9). In most instances the tubers did not size adequately as evidenced by the high percentage of tubers under 2 inches. Selections WF31-4, WF46-3 and WF46-4 are white-flower siblings of Atlantic and all yielded very comparable to Atlantic. In tests to date, they have not exhibited any superior characteristics when compared to Atlantic. Selection B6887-3(y) is a golden flesh variety which is oblong in shape and many tubes were pear shaped.

F. OVERSTATE DEMONSTRATION TRIALS

Potato variety demonstration trials were conducted on four commercial farms in 1985. These trials are established as on-farm demonstration plantings and are not replicated. Locations were at Ray Vermeesch in Bay County (Table 10), Ray Bourdo and Sons in Allegan County (Table 11), Keilen Farms in Ingham County (Table 12), and Wilk Farms in Presque Isle County (Table 13).

Table 9. The Yield, Size Distribution and Specific Gravity of Several Potato Cultivars Grown in the Beltsville Trial.

Variety	cwt/A Total	cwt/A No. 1	Percent Size Distribution No. 1	<2"	2-3¼"	>3¼"	Pick Outs	S.G.
WF31-4	482	431	89	8	71	19	2	1.088
Atlantic	466	409	88	7	65	23	5	1.085
WF46-4	451	406	90	8	70	20	2	1.084
WF46-3	424	381	90	8	75	15	2	1.085
B9140-32	385	324	84	14	82	2	2	1.083
B6887-3(y)	430	324	75	23	59	16	2	1.064
B9192-1	269	237	88	9	75	13	3	1.066
B9540-29(Rus)	334	207	62	36	56	6	2	1.075
B9569-2(Rus)	322	186	58	37	54	4	5	1.065
B9553-6(Rus)	290	184	64	30	53	10	7	1.066
B9398-2(Rus)	259	175	68	25	59	8	8	1.072
B9540-53(Rus)	225	113	50	49	49	1	1	1.072
B9540-62(NemaRus)	182	76	42	55	39	3	3	1.063
B9540-55(Rus)	160	62	38	58	37	2	3	1.062
AVERAGE	334	251	75					1.073

Table 10. Ray Vermeesch Farm, Bay County. Cooperator: Howard Wetters, Bay County Extension Agricultural Agent.

Variety	cwt/A		Percent Size Distribution[1]						
	Total Yield	No. 1 Yield	No. 1	Under 2"	2-3¼	Over 3¼"	Pick Outs	Specific Gravity	Chip[2] Score
Atlantic	317	302	95	5	73	22	0	1.090	1.0
Superior	292	283	96	3	78	18	1	1.070	2.0
Conestoga	290	276	95	5	66	29	0	1.075	1.0
Yankee Supreme	292	268	92	4	70	22	4	1.074	1.5
MS700-83	281	263	94	6	66	28	0	1.078	1.0
Onaway PF	262	252	96	4	68	28	0	1.069	3.5
Simcoe	261	252	96	3	57	39	0	1.079	1.0
MS704-10 (Y)	259	243	94	6	69	25	0	1.081	1.5
Yukon Gold (Y)	244	226	92	4	61	31	4	1.077	1.5
Jemseg	223	215	92	7	74	18	1	1.071	1.5
Onaway year-from-certified	185	168	91	9	80	11	0	1.072	3.0

[1]Based on size only.

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

Fertilizer: plowdown 200 lbs/A 0-0-60
200 lbs/A Sulpomag
planter 1000 lbs/A 9-18-18 + 2% MN, 2% Mn
sidedress 100 lbs Nitrogen/A May 21

Planting date: April 18, 1985

Harvest date: July 24, 1985 (97 days)

Soil test: pH 5.7
phosphorus 600 lbs
potassium 116 lbs
calcium 800 lbs
magnesium 56 lbs
zinc 13 ppm
manganese 23 ppm

Vermeesch Farm Variety Observations:

Atlantic - considerable green growth remaining — some overall lightening of green color. Considerable skinning of tubers and some scab observed. Internal defects were 2 tubers with dark centers.

Superior - estimated at 90% maturity. Tubers were well shaped with good skin set. Trace of scab. Internal defects were 2 tubers with slight vascular discoloration and one with internal browning.

Conestoga - 80% mature. Severe scab at both ends of row with only a trace noted in the center area. Tubers bright in appearance and generally smooth. Internal defects, 1 slight vascular discoloration.

Yankee Supreme - considerable green growth remaining. Severe scab throughout the row — estimate that 90% of all tubers showing some scab. Internal defects were 1 dark center.

MS700-83 - still considerable growth remaining. Tubers smooth, bright appearance, some scab noted and trace of growth crack. Still considerable skinning of tubers. Internal defects were 2 with internal browning.

Onaway PF - good vine growth and estimated at 80% mature. Some skinning of tubers and moderate scab on both ends of field. Internal defects were 2 tubers with slight vascular discoloration.

Simcoe - near full maturity but severe scab throughout the row. Tubers bright and slightly flattened but estimate that 75% of the tubers were scabby. Internal defects were 1 tuber with slight vascular discoloration.

MS704-10(Y) - considerable green vine still remains and tubers had considerable skinning. Tubers well shaped and good golden flesh color. Internal defects were 3 tubers with slight vascular discoloration.

Yukon Gold - estimated at 75% mature. Tubers well shaped with definite golden appearance. Considerable scab noted throughout the row and most severe on both ends of row. No internal defects.

Jemseg - variety all but totally mature. Tubers well shaped and good skin set. Considerable scab on north end of row. Internal defects were 1 tuber with slight vascular discoloration.

Onaway - year from certified - much less vine growth and more mature than Onaway PF. Average tuber size much smaller. Some scab noted on both ends of row. Yield or marketable tubers only two thirds of that of Onaway PF. No internal defects.

Table 11. Bourdo Farms, Allegan County. Cooperator: George Mansell, Allegan County Extension Director.

	Yield-cwt/A		Percent Size Distribution					
Variety	Total	No. 1	No. 1	Under 2"	2-3¼	Over 3¼	Pick Outs	Specific Gravity
Atlantic	455	365	81	8	60	21	11	1.080
MS702-80	429	388	90	4	58	32	6	1.068
G670-11	387	343	88	4	48	40	8	1.076
Yankee Chipper	371	317	85	8	74	11	7	1.075
Yankee Supreme	291	222	77	9	60	17	14	1.073
Simcoe	290	273	94	5	61	33	1	1.072
Acadia Russet	290	212	73	15	56	17	12	1.073
Islander	231	180	78	16	77	1	6	1.068
AVERAGE	343	287						1.073

Planted: May 20, 1985

Harvested: October 2, 1985 (135 days)

Muck Soil - not irrigated

Fertilizer:	plowdown	300 lbs/A	0-0-60
		250 lbs/A	45-0-0
	planter	40 gals/A	10-34-0
	sidedress	250 lbs/A	45-0-0
		350 lbs/A	13-13-13

Table 12. Keilen Farms, Ingham County.

Variety	Yield-cwt/A Total	Yield-cwt/A No. 1	Percent Size Distribution No. 1	Under 2"	2-3¼	Over 3¼	Pick Outs	Specific Gravity
MS700-83	464	405	87	9	78	9	4	1.071
MS702-91	373	316	85	12	68	17	3	1.070
Shepody	359	295	82	7	62	20	11	1.071
Simcoe	329	294	89	10	82	7	1	1.078
Alasclear	281	235	84	12	81	3	4	1.078
MS700-79	251	223	89	11	82	7	0	1.075
AVERAGE	343	295						1.074

Planted: May 18, 1985

Harvested: October 11, 1985 (146 days)

Muck Soil - irrigated

Table 13. Wilk Farm, Presque Isle County. Cooperator: Dick Long, Presque Isle County Extension Director.

	Yield-cwt/A		Percent Size Distribution					
Variety	Total	No. 1	No. 1	Under 2"	2-3¼	Over 3¼	Pick Outs	Specific Gravity
Snowchip	392	372	95	3	66	29	2	1.069
Rideau (pre-cut)	343	330	96	3	55	41	1	1.069
Rideau (cut & plant)	341	325	95	4	44	51	1	1.073
Atlantic	299	287	96	4	64	32	0	1.084
Katahdin	271	261	96	3	63	33	1	1.070
Alasclear	274	219	80	10	67	13	10	1.078
MS704-10(y)	264	248	93	6	72	21	1	1.084
MS716-15	264	248	94	6	72	22	0	1.086
MS702-80	240	229	95	5	79	16	0	1.077
MS700-83	238	221	93	6	64	29	1	1.076
Yukon Gold	213	197	92	6	74	18	2	1.078
Carlton	174	151	87	6	69	18	7	1.066
AVERAGE	276	257						1.076

Planted: May 17, 1985

Harvested: October 8, 1985 (144 days)

Previous Crop: Oats and red clover

Fertilizer: plowdown 200 lbs/A 0-0-60
planter 425 lbs/A 19-19-19

EVALUATION OF PRODUCTION MANAGEMENT INPUTS TO IMPROVE RUSSET BURBANK QUALITY - I

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Procedure: A field experiment was conducted at the Montcalm Research Farm to evaluate alternatives to existing tillage systems for potato production on sandy soils in Michigan and their effect on tuber quality and yield of Russet Burbank. Five tillage treatments were evaluated

- conventional tillage - moldboard plowing followed immediately by planting,
- conventional tillage preceded by subsoiling in the row with a Kelly subsoil unit,
- Bush Hog Ro-till - one pass (this is an in-the-row subsoil equiped with surface tillage tools)
- Bush Hog Ro-till - two passes
- Paraplow in-the-row (a subsoil tillage unit that fractures the soil with minimal surface disturbance)

Tillage was performed immediately prior to planting in either four or six row (depending on tillage) plots 50 feet long. The intent of the Bush Hog Ro-till and the Paraplow treatments is to loosen the soil in a zone within the row and leave the interrow area untilled. This would leave a strip of untilled rye in the interrow area until hilling to provide erosion control during that period. The rye cover crop was sprayed with Roundup on April 19th. The killed rye behaved like a sod and was difficult to manage. Therefore, all but the Bush Hog treatments were disked twice with a light disc prior to tillage to cut the rye cover crop. The working depth (inches) of the tillage tools was - the Kelly, 16; the moldboard, 8; the paraplow, 14; and the Bush Hog, 12.

The plots were planted with a two row planter on April 26, 1985. Prior to planting, 400 lbs/ac of 0-0-60 was broadcast and at planting 500 lbs/ac of 24--8-8 was applied. Di-Syston was applied through the planter at 3 lb a.i./ac as the soil applied insecticide to allow for the nematode evaluation portion of the study. A sidedress application of 80 lbs/ac of 46-0-0 was applied pre-emergence. Hilling was done at early emergence.

Results:

The yield, specific gravity, internal defects, and yield size distribution are given in Table 1. Yields ranged from 350 cwt/ac for the conventional treatments to 385 cwt/ac for the paraplow treatment, with the Bush Hog treatments intermediate. While not highly significant ($p = 0.08$), the yield differences observed in the 1985 growing season are economically important. Differences in specific gravity among tillage treatments were small and not significant ($p = 0.14$). The internal defect as measured by the occurence of hollow heart in 10 # 1 potatoes > 10 oz was significantly higher in the paraplow treatment while no hollow heart was observed in the Bush Hog treatments. This may be an indication that other cultural practices, such plant spacing, irrigation, and fertility need to be adjusted with the use of these new tillage systems. The quality of the Russet Burbank was improved with both the Bush Hog and papaplow treatments as evidenced by the increase in the percentage of marketable yield (70 versus 63 and 64 precent). All size distributions in No. 1 potato classes were improved with these tillage treatments (p-values ranged from 0.052 to 0.089) while the No. 2 potatoes < 10 oz were significantly ($p = 0.018$) reduced.

Potato petioles were sampled on June 28th and analyzed for eleven chemical elements. The data are given in Table 2. All nutrients were found to be in the sufficient range for optimal growth. Zinc (Zn) and Manganese (Mn) concentrations were the only nutrients significantly affected by the tillage treatments. Both nutrients increased in concentration where the Bush Hog and the Paraplow were used. The changes may be associated with deeper rooting systems or perhaps a lower subsoil pH making these nutrients more available. Calcium (Ca) and Magnesium (Mg) concentrations, however, did not decrease as might be expected with lower subsurface soil pH. Additional studies will be needed to determine the exact cause of the observed differences in nutrient composition.

The population dynamics of the Pratylenchus penetrans (root-lesion nematode) was monitored on these plots thoughout the growing season. The P. penetrans population densities associated with the tillage treatments are given in Table 3. None of the tillage treatments had any significant ($p = 0.05$) impact on the population dynamics or final population densities of the root-lesion nematode. The mid-season population densities were low. However, this was common throughout Michigan in 1985. These densities of the root-lesion nematode should have resulted in tuber losses of about 50 cwt/ac as a result of the potato early-die disease complex.

Table 1. The yield, size distribution, specific gravity and incident of hollow heart of Russet Burbank grown under five tillage treatments at Montcalm Research Farm in 1985.

Tillage	Yield cwt/a	Specific Gravity	Hollow* Heart
Conv.	351	1.077	0.25
BH1	365	1.078	0
BH2	372	1.079	0
Kelly	348	1.075	0.25
PPlow	385	1.079	1.25
Prob	0.080	0.138	0.0001

* No. 1 > 10 oz potatoes with hollow heart out of 10 potatoes examined averaged over four reps.

	Size Distribution						
						No. 2	
Tillage	No. 1	< 4oz	4-6 oz	6-10 oz	> 10oz	< 10oz	>10 oz
	%						
Conv.	63	21	25	29	9	7	8
BH1	70	20	27	29	14	4	6
BH2	70	19	26	32	11	5	6
Kelly	64	21	27	28	10	6	9
PPlow	70	19	27	29	14	4	7
Prob (p value)	-	ns	0.089	0.065	0.052	0.018	ns

Table 2. Elemental composition of potato petioles sampled on June 28, 1985 as affected by four tillage systems.

Treatments	Elements				
	NO_3-N	P	K	Ca	Mg
	%				
Conventional	2.25	0.31	10.24	0.63	0.46
Bush Hog 1 pass	2.28	0.29	10.27	0.67	0.49
Bush Hog 2 passes	2.37	0.29	10.26	0.66	0.48
Kelly + Conventional	2.25	0.31	10.09	0.68	0.50
Paraplow	2.45	0.28	10.21	0.70	0.50

Treatments	Elements					
	Zn	Mn	Cu	B	Fe	Al
	ppm					
Conventional	56a	126a	7	28	72	57
Bush Hog 1 pass	64b	212b	8	32	80	65
Bush Hog 2 passes	62b	206b	9	28	78	61
Kelly + Conventional	55a	128a	8	29	77	64
Paraplow	63b	227b	10	28	76	61

1/ Any two means followed by different letters are signifcantly different as measured by the LSD method ($p = 0.05$).

Table 3. Pratylenchus penetrans population densities associated with various tillage treatments as the Montcalm Research Farm.

Treatment	Pratylenchus penetrans: Pretill, $100 cm^3$ soil (4/25)	Midseason, $100 cm^3$ soil (7/1)	Midseason, $100 cm^3$ soil & 1.0 g root (7/1)	Harvest, $100 cm^3$ soil (9/18)	Total Plant parasites/ 100cm3 soil 4/25	7/1	9/1
Conventional	5	2	4	70	13	2	122
Bush Hog 1 pass	4	5	10	43	6	7	147
Bush Hog 2 passes	1	4	7	75	4	6	146
Kelly subsoil & Conventional	7	3	4	47	13	3	159
Paraplow	4	3	3	62	11	2	243

EVALUATION OF PRODUCTION MANAGEMENT INPUTS TO IMPROVE RUSSET BURBANK QUALITY - II

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PROCEDURE: A field experiment was conducted at the Montcalm Research Farm to evaluate the interaction of plant spacing, nitrogen levels and maleic hydrazide on tuber quality of Russet Burbank. Four row plots 47 feet long of two spacings (8.5 and 10.5 inches) were planted with a 2 row planter using whole seed on May 2, 1985. The 1984 crop was no-till soybeans followed by winter rye. Prior to planting, 400 lbs/A of 0-0-60 was plowed under and at planting 500 lbs/A of 24-8-8 was applied. Temik was applied at 20 lbs/A.

Nitrogen levels were 150, 200 and 250 lbs/A. On June 4, 65 lbs/A of 46-0-0 were applied to all plots, 108 lbs of 46-0-0 were applied to the 200 and 250 lb plots on June 28 and 108 lbs were applied to the 250 lb plots on July 11. The maleic hydrazide (MH30) was applied July 26 at 2 gal/A in 37 gpa of water. The plots were harvested on September 30.

RESULTS: Plant growth was very uniform among all plots through the growing season and no substantial differences were noted even on the plots receiving the high level of nitrogen. Approximately 2 weeks after application of the MH30, the treated plots showed a noticeable yellowing compared to the untreated plots, however, no adverse effects were noted in the yields and quality data.

Table 1 summarizes the results of the interaction between nitrogen levels and spacing. There is a trend toward a reduced specific gravity at the wider plant spacing and this occurred at all levels of nitrogen. Yield levels and responses to the treatments were lower than anticipated. Performance of the same seed in other studies was substantially better in terms of total yields and sizing. In this study there was essentially no response to the additional nitrogen.

Table 2 summarizes the response of Russet Burbank at 2 plant spacings and maleic hydrazide. As previously noted, specific gravity levels were highest at the closer spacing. There was no effect on total or marketable yields. One obvious concern is the high percentage of tubers under 4 ounces suggesting that tuber sizing throughout the study was hindered. This is also noted in the small percentage of tubers over 10 ounces.

The response to nitrogen regardless of the other variables is presented in Table 3. Disregarding all other variables, there was no response to increased nitrogen levels in terms of total and marketable yield or size distribution. There was a trend toward a lower specific gravity with the increased level of nitrogen and this would be suspected as reported in numerous other studies.

SUMMARY: It is obvious from this study that there must be factors other than nitrogen and maleic hydrazide which limited the improvement in Russet Burbank sizing and quality. Projections for 1986 are to consider the tillage management in conjunction with spacings and nitrogen levels. Water management may need to be modified also.

Table 1. The total, marketable yield and specific gravity of Russet Burbank grown at two plant spacings and three nitrogen levels.

Plant Spacing	150 lbs N/A cwt/A Total	150 lbs N/A cwt/A No. 1	150 lbs N/A % No. 1	150 lbs N/A S.G.	200 lbs N/A cwt/A Total	200 lbs N/A cwt/A No. 1	200 lbs N/A % No. 1	200 lbs N/A S.G.	250 lbs N/A cwt/A Total	250 lbs N/A cwt/A No. 1	250 lbs N/A % No. 1	250 lbs N/A S.G.
8.5	346	183	54	1.077	357	188	53	1.077	346	176	51	1.074
10.5	348	213	62	1.075	338	201	60	1.074	308	169	55	1.073

Table 2. The yield size distribution and specific gravity of Russet Burbank grown at two spaces and with and without maleic hydrazide.

	Plant Spacing	Yield cwt/A Total	Yield cwt/A No. 1	Percent Size Distribution No. 1	Under 4 oz	4-6 oz	6-10 oz	Over 10 oz	No. 2 <10 oz	No. 2 >10 oz	S.G.
MH30	8.5	349	184	53	40	26	22	5	5	3	1.076
	10.5	328	193	59	32	25	26	8	5	5	1.075
Check	8.5	350	181	52	36	24	21	7	7	5	1.075
	10.5	334	196	59	32	24	26	6	6	4	1.073

Table 3. The yield, size distribution and specific gravity of Russet Burbank grown at three levels of nitrogen.

	Yield cwt/A Total	Yield cwt/A No. 1	Percent Size Distribution No. 1	Under 4 oz	4-6 oz	6-10 oz	Over 10 oz	No. 2 <10 oz	No. 2 >10 oz	S.G.
150	347	198	57	34	27	24	7	4	5	1.076
200	347	194	56	34	24	25	7	6	4	1.075
250	327	173	53	36	24	23	6	7	5	1.074

NITROGEN CARRIER, RATE AND PLACEMENT EFFECT ON GROWTH, YIELD AND QUALITY OF POTATOES GROWN IN ORGANIC SOIL

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Approximately ten percent of the Michigan potato crop is grown in organic soil. However, very little research data is available regarding appropriate fertilization practices for potato production in these soils. In mineral soils, nitrogen rate has been shown to be important for potato yield and quality. With organic soils considerable nitrogen may become available by mineralization of organic matter during the growing season. Hence, the most economic rate of nitrogen can be expected to be less than with mineral soils. This study was designed to look at the response of potatoes grown in organic soil to different nitrogen carriers, increasing rates of nitrogen and placement of nitrogen.

A nitrogen carrier study and a nitrogen rate study were established on an Adrian muck and a Houghton muck. The Adrian muck was located on the David Leep and Sons Farm in Allegan County. The Houghton muck was at the Michigan State University Muck Research Farm. The nitrogen carriers evaluated were ammonium nitrate, calcium nitrate, sodium nitrate, ammonium sulfate and urea. Each carrier was applied to supply 80 lb N/A preplant and 40 lb N/A as a sidedress application. Ammonium nitrate was used in the nitrogen rate and time of application study. The specific treatments are given in Tables 2, 5 and 6. In both studies each treatment was replicated four times. On the Leep Farm, the preplant nitrogen treatments were broadcast and plowed in whereas at the Muck Research Farm the same treatments were incorporated after plowing. On the Leep Farm, 32 lb N/A was applied in the banded planting time fertilizer. Atlantic potatoes were planted on May 14 and 15 at the Leep Farm and Muck Research Farm, respectively. Sidedress nitrogen applications were made June 19 and 20. Other production inputs were made according to good management practices. Neither of the two sites were irrigated during the growing season.

Potato petioles from the youngest mature leaves were collected at early blossom (July 9 and 12) and analyzed for nitrate-N content. The nitrate-N content of the petioles was not significantly affected by nitrogen carrier at either location (Table 1). However, the nitrate-N concentration of the petioles was significantly higher on the Leep Farm. This difference may be partially related to the planting time nitrogen applied and/or more nitrogen may have been mineralized from the Adrian muck. At the Muck Research Farm the water table during May and June was higher than at the Leep Farm. Therefore, much of the mineralized nitrogen in the Houghton muck may have been lost by denitrification. Ammonium sulfate treated potatoes had slightly lower petiole nitrate concentrations at both locations.

Increasing the rate of applied nitrogen significantly increased the nitrate-N concentration in the petioles at both locations (Table 2). The response was quite marked up to 120 lb N/A where the petiole nitrate content tended to level off. Whether the nitrogen was applied preplant or sidedress had little effect on petiole nitrate concentration. It appears from these data that the 120 lb N/A rate was adequate to supply the nitrogen requirements of the potatoes. Supplying 160 lb N/A did not result in additional nitrogen uptake.

Nitrogen carrier had no appreciable effect on potato yield, size distribution or specific gravity of tubers (Tables 3 and 4). Yields and quality were quite uniform on the Leep Farm (Table 3) with over 92 percent of the harvested potatoes being number ones. Potato yields were more variable at the Muck Research Farm but still not significantly different across nitrogen carriers (Table 4). Calcium nitrate produced the highest total yield, but also had the highest percent of small and cull potatoes. Hence, the yield of number 1 potatoes was essentially the same for the five nitrogen carriers. Specific gravity and chip color were very similar with all carriers.

Increasing nitrogen rate generally increased total and number 1 potato yields with the highest yield occurring at 160 lb N/A (Tables 5 and 6). At the Leep Farm yields increased fairly consistently with nitrogen rate except for 120 lb N/A rate where yields fell below the trend line (Table 5). The trend line would indicate that yields are beginning to plateau near 120 lb N/A. Sidedressing 80 lb N/A resulted in a lower yield than when preplant incorporated. Splitting the 160 lb N/A rate between preplant incorporation and a sidedress application had no additional beneficial effect on yield. The distribution of potato sizes did not change with nitrogen rate. Nitrogen rate also had no effect on specific gravity of number 1 tubers.

Total and number 1 potato yields were somewhat variable at the Muck Research Farm (Table 6). Although there were no significant treatment differences, there was a general trend toward higher yields with increasing nitrogen rates. And yields appeared to plateau between 120 and 160 lb N/A. Sidedressing all the nitrogen consistently resulted in lower yields. Although the petiole nitrate content was good at early bloom, the early growth apparently was reduced by an insufficient supply of nitrogen. At the Muck Research Farm applying 80 lbs N/A preplant and sidedressing with 80 lbs N/A produced the highest yield. For some unexplained reason the 160 lbs N/A rate performed very poorly.

Even though the yields did not vary significantly, observable differences in foliage color did occur during the first two weeks of September. The no nitrogen plots looked quite yellow and the 120 and 160 lb N/A plots had a good green color. The rates in between slowed varying degrees of yellowing.

In summary, potato yields and quality were not affected by the form of nitrogen applied. Hence, potato growers can use the most cost effective nitrogen carrier. Both nitrate petiole concentration and yield data point toward the optimum nitrogen rate being between 120 and 160 lb/A. Sidedressing part of the nitrogen four weeks after emergence does not appear to provide any yield benefits under non-irrigated conditions. Under field conditions experienced in 1985, high nitrogen rates did not lower the specific gravity of number 1 tubers.

Table 1

Influence of nitrogen carrier on nitrate-N concentration in petioles of potatoes grown in organic soil.[a]

Nitrogen Carrier[b]	Nitrate-N in Petioles Muck Research Farm	Leep Farm
	- - - - - mg NO_3-N/kg dry tissue	- - - - -
Ammonium Nitrate	9,801	23,137
Calcium Nitrate	10,446	23,067
Sodium Nitrate	10,379	23,706
Ammonium Sulfate	8,731	21,770
Urea	10,609	23,062
HSD .10	NS	NS

[a] Petiole samples were collected on July 9 and 12 for the Leep Farm and MSU Muck Research Farm, respectively. This corresponded to early bloom.

[b] Each carrier was applied at 80 lb N/A preplant and 40 lb N/A sidedress. Potatoes were planted May 14 and 15, and sidedressed May 19 and 20, respectively.

Table 2

Influence of nitrogen rate and time of application on nitrate-N concentration in petioles of potatoes grown in organic soil.[a]

Nitrogen Rate PPI	SD	Nitrate N in Petioles Muck Research Farm	Leep Farm
- - - -lb N/A	- - -	- - - - mg NO_3-N/kg dry tissue	- - -
0	0	13,205	15,936
40	0	15,581	20,207
80	0	19,085	27,093
0	80	19,401	26,737
120	0	24,164	28,276
0	120	22,398	27,486
160	0	22,234	29,801
80	80	21,128	29,029
HSD .10		7,760	10,695

[a] Petiole samples were collected at early bloom, July 9 and 12 for the Leep Farm and MSU Muck Research Farm, respectively.

Table 3

Influence of nitrogen carrier on yield and specific gravity of potatoes (cv. Atlantic) grown in an Adrian muck. Leep Farm - 1985.

Nitrogen Carrier[a]	Yield Total	Yield No. 1	Size Distribution No. 1	Size Distribution <2"	Size Distribution 2-3 1/4"	Size Distribution >3 1/4"	Specific Gravity
	- - cwt/A - -		- - - - - - - - % - - - - - - - -				
Ammonium Nitrate	376	350	93	5	89	4	1.084
Calcium Nitrate	376	353	94	5	91	3	1.087
Sodium Nitrate	390	363	93	4	89	4	1.086
Ammonium Sulfate	397	365	92	5	88	4	1.087
Urea	395	363	92	5	87	5	1.084
HSD .10	NS	NS	NS	NS	NS	NS	NS

[a] All carriers were applied to supply 80 lb N/A plowed in and 40 lb N/A side-dress. All plots received 32 lb N/A at planting, May 14. Plots were side-dressed June 19 and harvested October 2.

Table 4

Influence of nitrogen carrier on yield and specific gravity of potatoes (cv. Atlantic) grown in a Houghton muck. MSU Muck Research Farm - 1985.

Nitrogen Carrier[a]	Yield Total	Yield No. 1	Size Distribution No.1	Size Distribution <2"	Size Distribution 2-3 1/4"	Size Distribution >3 1/4"	Specific Gravity
	- - cwt/A - -		- - - - - - - - % - - - - - - - -				
Ammonium Nitrate	449	387	86	11	77	9	1.080
Calcium Nitrate	492	400	81	11	74	7	1.083
Sodium Nitrate	462	396	86	9	76	10	1.082
Ammonium Sulfate	439	375	85	10	77	8	1.082
Urea	452	373	82	10	74	8	1.081
HSD .10	NS	NS	NS	NS		NS	NS

[a] Each carrier was applied to supply 80 lb N/A preplant incorporated and 40 lb N/A sidedress. Potatoes were planted May 15 and sidedressed June 20 and harvested October 4.

Table 5

Influence of nitrogen rate and time of application on the yield and specific gravity of potatoes (cv. Atlantic) grown in an Adrian muck. Leep Farm-1985.

Nitrogen Rate[a]		Yield		Size Distributin				Specific
PPI	SD	Total	No.1	No.1	<2"	2-3 1/4"	>3 1/4"	Gravity
- -lb N/A- -		- - -cwt/A- -		- - - - - - - % - - - - - - - -				
0	0	376	313	83	9	78	5	1.085
40	0	399	345	86	8	81	5	1.085
80	0	427	366	86	9	79	7	1.084
0	80	380	316	83	11	79	4	1.086
120	0	420	356	85	10	79	6	1.083
0	120	414	348	84	10	77	7	1.087
160	0	440	383	87	9	80	7	1.084
80	80	431	374	87	9	80	7	1.086
HSD .10		61	57	NS	NS	NS	2	NS

[a] Nitrogen was applied as ammonium nitrate either plowed in (PPI) or sidedressed (SD). Potatoes were planted May 14 and sidedressed June 19. All plots received 32 lbs N/A at planting. Harvest occurred on October 2.

Table 6

Influence of nitrogen rate and time of application on the yield and specific gravity of potatoes (cv. Atlantic) grown in a Houghton muck. MSU Muck Research Farm-1985.

Nitrogen Rate[a]		Yield		Side Distribution				Specific
PPI	SD	Total	No. 1	No. 1	<2"	2-3 1/4"	>3 1/4"	Gravity
- - lb N/A - -		- - cwt/A - -		- - - - - - - - % - - - - - - - - -				
0	0	359	288	80	13	72	8	1.079
40	0	396	315	79	12	71	8	1.083
80	0	375	302	80	12	72	8	1.078
0	80	370	291	79	14	72	7	1.080
120	0	405	328	81	12	73	8	1.078
0	120	356	294	82	11	73	9	1.079
160	0	368	311	84	12	75	9	1.081
80	80	410	341	83	11	76	7	1.079
HSD .10		NS	NS	NS	NS	NS	NS	NS

[a] Nitrogen was applied as ammonium nitrate either preplant incorporated (PPI) or sidedress (SD) at hilling. Potatoes were planted May 15 and sidedressed June 20. Harvest occurred on October 4.

CONTROL OF SCAB AND RHIZOCTONIA DISEASES

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INTRODUCTION

Scab and Rhizoctonia diseases continue to present problems in production of high quality potatoes. Research was carried out to examine the role of two factors reported to reduce scab severity (Nitrogen source and irrigation), evaluate named and number selections for scab resistance and further evaluate seed treatments for Rhizoctonia control.

Variety evaluations for scab resistance

Disease resistance is a major factor in developing a long-term solution for the scab problem. Thirty-five named and numbered selections were evaluated for scab at two locations (Bay and Montcalm counties). Each selection was replicated four times in the first plots at both locations. Approximately ten pound samples were taken from each plot and examined, after washing, for type of scab and percent coverage of tubers by scab lesions.

Results: Several varieties exhibited good resistance and yields close to or over 90% marketable tubers at both locations (Table 1). These include Alasclear, Onaway, Russet, Burbank and Superior. Of the numbered selections, B9192-1, B9398-2, B9540-53, B9540-62, MS700-79, and MS702-80 exhibited very good resistance, although Alasclear exhibited very good resistance, irregular tuber shape and a noted susceptibility to Alternaria (Early blight) tuber infection will probably limit this varieties acceptance. Several other varieties also seemed to exhibit a higher degree of black scurf and deformations associated with Rhizoctonia (see Table 1). The varieties exhibited some tolerance to scab included B9540-29, B9450-55, Islander and MS700-83. The other varieties are susceptible to some degree.

Irrigation and N form:

Last years research and literature reports have demonstrated that irrigation at the time of tuber initiation (approximately 1 week after emergence) and soil acidifiying forms of N have a positive effect on controlling scab. In this experiment, we tested the role of early irrigation and N form (urea vs. ammonium sulfate) on the control of scab.

The research was carried out at the MSU soils farm in a plot known to be infested with scab. The soil type was a metea loamy sand. Soil tests of the plot were: pH 6.0; P 85 lb/A, K 160 lb/A; Ca 800 lb/A, Mg 225 lb/A. The previous crop was quack grass. Herbicides used were 1½ qt/A Roundup before plowing and 3/4 qt Lasso + 2½ qt Lorox after planting. Aldicarb was applied at planting for insect control. The starter fertilizer was 100 lbs N-P_2O_5-K_2O and topdress fertilizer was 100 lbs N. N was used in two different forms in four combinations. These were urea/urea, urea/ammonium sulfate, ammonium sulfate/urea and ammonium sulfate/ammonium sulfate as the starter/topdress, respectively. These four combinations provided 0, 114, 114 and 228 lbs sulfur/A, respectively, The Atlantic variety was used and planting was on 30 May. One side of the plot was maintained at a soil moisture of 50 cb or less (high irrigation).

The other side of the plot (low irrigation) received water every other time the high water side was irrigated. Irrigation was initiated when tuber initiation (stolon swelling) was first evident. This was determined by examining individual plants after emergence for when stolon swelling was beginning.

Results: Maintaining irrigation at 50 cb or less resulted in significantly less scab than the drier conditions. This was evident by both the per cent scab-free tubers produced and the percent that would make No 1. grade (Table 2). In addition to less scab coverage on the high irrigation side of the plot, the tubers from this side had less severe forms of the disease (less pitting). There was no significant effect of the fertilizer treatments on the amount of scab. However, there was a trend toward less scab as the amount of S applied to the plots (Table 2) increased. These results confirm previous research indicating that irrigation (if applied at the correct time) and acid forming fertilizers aid in decreasing scab. Timing of irrigation is critical for scab control and must begin shortly after plant emergence (the time of the earliest tuber initiation).

There was no significant effect on yield or distribution of sizes of tubers among or between the various N form-irrigation treatments (Table 3). Specific gravity was higher on the high irrigation side as compared to the low irrigation (Table 4). There were no fertilizer effect noted on specific gravity (Table 4).

Other factors

Trials with Manganese applied at 20 and 40 lbs/A were inconclusive due to very high scab pressure in the field where this was tested.

Seed treatments for Rhizoctonia control

Previous years experiments demonstrated that seed piece treatment designed at controlling seed-borne Rhizoctonia resulted in more No 1 tubers and fewer off size and culls. This work was repeated on the Onaway variety with two treatments demonstrated to control this disease and four others. Seed was treated at the recommended rate immediately after cutting. Seed was planted immediately after treating.

Results

TOPS, NTN, Captan and Dithane treatments resulted in higher yields than the check (untreated). The lowest yields were seen with Apron and Ridomil. None of the yields, however, were significantly different. The NTN, TOPS, Apron and Ridomil resulted in the lowest percentage of deformed (cracked, russeted) cull tubers (Table 5).

TABLE 1
SCAB VARIETY TRIAL

VARIETY	MONTCALM COUNTY RATING[a]	MONTCALM COUNTY %0 SCAB	MONTCALM COUNTY %<5% SCAB	BAY COUNTY RATING[a]	BAY COUNTY %0 SCAB	BAY COUNTY %<5% SCAB	COMMENTS
Acadia Russett	2.55	9.0	50.0	3.00	0.0	23.0	Pitted scab
Alasclear	1.30	69.4	100.0	1.34	74.3	88.6	Small, superficial scabs, poor shape
Atlantic	2.20	14.3	65.7	2.61	0.0	61.0	Some pitted, raised scab
B6887-3	3.45	0.0	5.0	3.07	2.6	10.5	Pitted scab
B9140-32	2.75	0.0	33.3	3.09	2.7	16.7	Pitted scab, black scurf
B9192-1	1.32	70.2	97.0	1.38	74.0	96.2	Superficial scabs
B9398-2	1.34	75.2	95.0	1.43	70.1	92.3	Superficial scabs
B9540-29	1.39	60.6	100.0	1.75	45.9	78.3	Small scabs
B9540-53	1.22	80.6	97.2	1.32	72.6	95.4	Rhizoc. russetting
B9540-55	1.69	36.1	94.4	2.31	2.3	56.3	slight scab to heavy russet type
B9540-62	1.21	78.9	100.0	1.35	70.9	93.5	very slight scab
B9553-4	2.72	0.0	36.1	2.29	16.1	54.8	Pitted scab, black scurf
B9569-2	2.43	9.7	46.3	2.68	8.5	38.2	surface and raised scab
Chipbelle	2.71	2.8	34.3	2.47	11.7	44.1	Pitted and surface scab
Conestoga	2.48	8.3	52.8	2.55	11.2	45.6	Raised and pitted scab
G670-11	3.26	2.9	14.7	3.03	6.9	20.7	Pitted scab
Islander	1.52	52.5	95.0	2.00	18.2	72.7	Surface
MS700-79	1.43	56.1	100.0	1.65	43.8	90.6	Very good
MS700-83	1.91	19.4	88.9	1.96	21.4	82.1	Some pits
MS701-22	2.88	2.9	25.7	2.96	3.0	24.2	Raised and pitted
MS702-80	1.18	83.8	97.3	1.30	86.7	90.9	Slight scab
MS704-10	2.21	16.2	59.4	2.02	37.8	62.1	Some pits, surface scab
MS716-15	2.28	26.3	50.0	2.41	13.9	50.0	Raised and pitted scab
Onaway	1.62	37.5	100.0	1.56	41.1	95.6	Slight scab
Russet Burbank	1.40	65.6	93.8	1.40	63.6	95.5	Small scabs
Shepody	2.25	2.9	60.0	2.72	5.6	38.8	Raised and pitted scab
Simcoe	2.25	8.3	69.4	2.77	5.5	30.6	Pitted
Snowchip	2.33	0.0	68.5	3.00	5.3	18.4	Pitted and raised
Superior	1.15	84.6	100.0	1.47	56.8	95.5	Slight scab
WF31-4	2.30	13.0	65.2	2.07	21.1	73.7	Pitted and Rhizoc russetting
WF46-3	2.22	8.6	71.4	2.16	27.8	66.7	surface
WF46-4	2.25	9.5	71.4	1.96	34.5	72.4	surface
Yankee Chipper	2.48	3.0	51.5	2.19	22.5	61.3	Surface, pitted scab; black scurf
Yankee Supreme	2.60	0.0	42.4	2.93	6.3	31.3	Pitted scab, black scurf
Yukon Gold	2.50	3.1	50.0	2.52	0.0	58.8	Surface and pitted, some pitted scab

[a] 1=No scab; 2=1-5% scab coverage;3=6-25% coverage;4=26-50% coverage; 5=over 50% coverage.

TABLE 2

SCAB CONTROL

Treatment[A]	% < 5% Scab	% Scab Free
IRRIGATION		
High	90.9 A	70.4 A
Low	62.2 B	35.2 B
N FORM		
U-U	72.4	49.4
U-AS	75.7	53.3
AS-U	76.3	50.9
AS-AS	81.3	57.5
N FORM X IRRIG.		
HIGH IRRIG.		
U-U	85.8	67.8
U-AS	93.8	69.8
AS-U	88.5	69.5
AS-AS	94.3	74.5
LOW IRRIG.		
U-U	59.0	31.0
U-AS	57.5	36.8
AS-U	64.0	32.2
AS-AS	68.3	40.5

[A]High irrig=soil depleted no more than 50 CB. Irrigation started at tuber initiation. Low irrig=Irrigation carried out every other irrigation time for high irrig. U=urea, AS=ammonium sulfate. First letter=starter; second letter=top dress.

TABLE 3

YIELD RESULTS

Treatment[A]	Total Yield[B]	% No. 1
IRRIGATION		
High	366.61	94.86
Low	354.90	92.56
N FORM		
U-U	352.59	93.38
U-AS	370.28	93.90
AS-U	352.45	93.37
AS-AS	367.70	94.18
N FORM X IRRIG.		
HIGH IRRIG.		
U-U	361.91	95.04
U-AS	380.42	94.77
AS-U	365.99	93.94
AS-AS	358.10	95.67
LOW IRRIG.		
U-U	343.26	91.71
U-AS	360.14	93.03
AS-U	338.91	92.81
AS-AS	377.29	92.68

[A]See Table 2

[B]cwt/A

TABLE 4

SPECIFIC GRAVITY OF SCAB CONTROL TRIAL

Treatment[A]	Specific Gravity
IRRIGATION	
High	1.084
Low	1.078
N-FORM	
U-U	1.082
U-AS	1.081
AS-U	1.081
AS-AS	1.082
IRRIG. X N FORM	
HIGH IRRIG.	
U-U	1.084
U-AS	1.084
AS-U	1.084
AS-AS	1.086
LOW IRRIG.	
U-U	1.079
U-AS	1.077
AS-U	1.077
AS-AS	1.078

[A]See Table 1

TABLE 5

SEED PIECE TREATMENTS

TREATMENT[a]	NO. 1	B	OVER	CULL	TOTAL YIELD[b]
CHECK	65.3	7.2	9.2	18.3	323.8
NTN 19701	78.4	7.8	11.9	1.9	349.2
TOPS 2.5D	73.2	9.1	11.1	6.6	341.7
CAPTAN 7.5D	64.7	7.4	10.4	17.6	333.4
DITHANE M-45 WP	63.2	7.2	17.2	12.4	341.2
APRON 25 WP + CAPTAN 7.5D	76.8	6.9	12.7	3.6	315.4
RIDOMIL MZ-58 WP	62.4	11.7	17.6	8.2	310.2

[a]Treatments applied to freshly cut Onaway seed just prior to planting. Seed was not infested with Rhizoctonia.

[b]CWT/A; No significant differences found among the means.

POTATO INSECT MANAGEMENT

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Department of Entomology

Summary: Research in 1985 included: demonstrations of the dip test for resistance in Colorado potato beetle, studies on dispersal and host-finding of Colorado potato beetles in relation to crop rotation, monitoring of variegated and black cutworm adult flight activity, and evaluation of insecticides for control of the Colorado potato beetle. A final report on the effects of temperature on toxicity of insecticides to the Colorado potato beetle is included. Studies on the biochemistry and mechanisms of insecticide resistance in the Colorado potato beetle were also begun.

CPB Dip Test

The dip test for insecticide resistance in Colorado potato beetles was demonstrated at meetings in Allegan, Montcalm, and Bay counties during the summer.

Beetles from a problem site in Bay Co. were tested for tolerance to Imidan (an organophosphate), Sevin (a carbamate), and Pounce (a pyrethroid)(figure 1). Results indicated no apparent tolerance to Imidan - greater than 50% were killed at a concentration designed to kill 50% and 100% were killed at a concentration 10 times higher. However, tolerance to Sevin appeared to be present. Only 17% were killed at the concentration designed to kill 50% and 1 beetle survived the 10x concentration. Some slight tolerance to Pounce may also have been present, since only 35% were killed by the concentration designed to kill 50%.

Based on these results, problems with Sevin might be expected and further tests with the same or different materials might be useful to the grower to verify the results and establish baseline data for future comparisons.

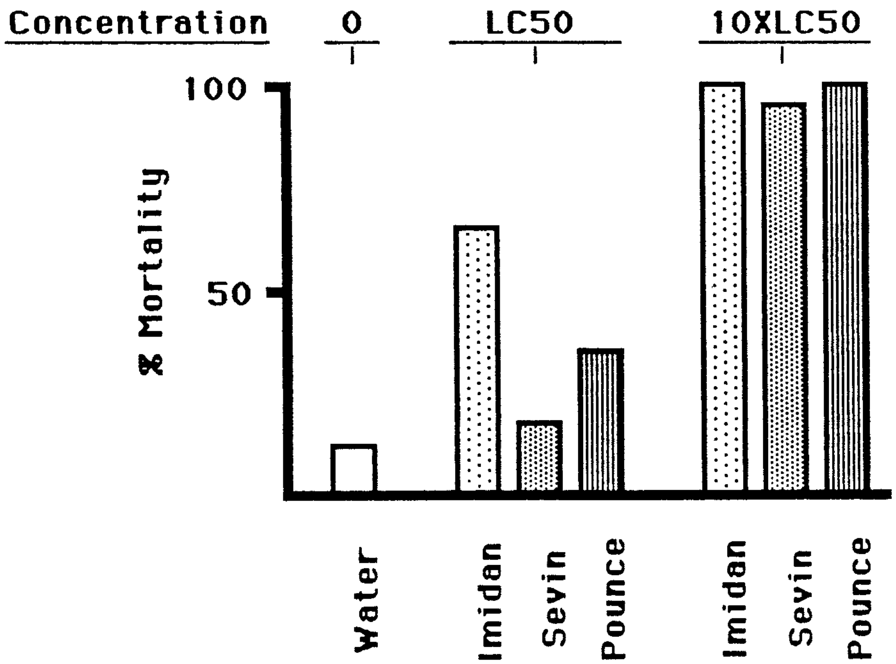
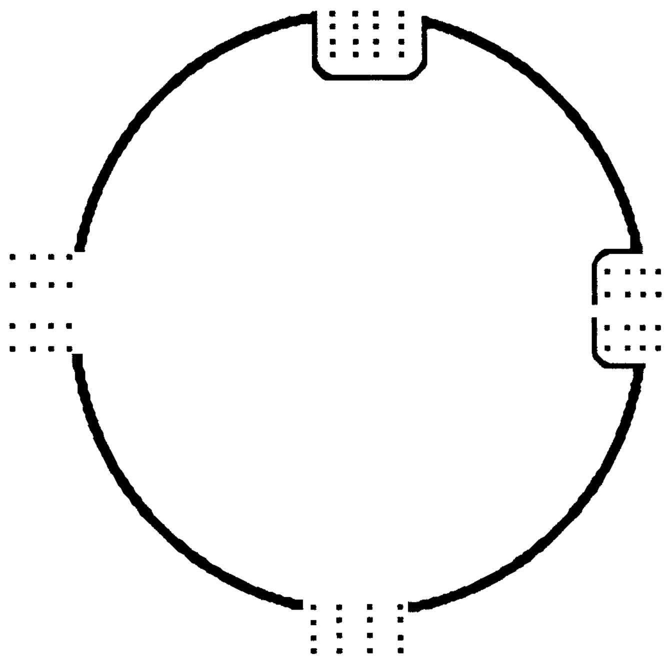


Figure 1. Mortality of Colorado potato beetles from Bay Co. dipped in various concentrations of Imidan (an organophosphate), Sevin (a carbamate), or Pounce (a pyrethroid). LC50 indicates a concentration estimated to kill 50% of a susceptible population.

Dispersal and Host-finding of the Colorado Potato Beetle

Laboratory studies on host-finding behavior were conducted in a wind-tunnel situation with a constant air flow and visible potato plants within 2-3 feet of the release point. Preliminary results indicated that beetles tended to walk upwind but were not strongly attracted to potato plants, even after 1 to 2 weeks starvation. Further studies will investigate the conditions that cause the strongest host attraction (e.g. adults freshly emerged from pupae vs. older adults, starved vs. fed adults, strong vs. light wind).

Field studies were conducted with adults collected during overwintering and kept under refrigeration or with summer adults collected from the field. Beetles were individually marked and released in small groups in the center of 100 ft. diameter arenas surrounded by a circular trap with groups of potato plants at the north, south, east, and west sides (figure 2).



Nearly all previous studies indicate that the Colorado potato beetle moves from field to field primarily by walking. In contrast to these reports, our preliminary results indicate that long-distance flight may be very common, especially for beetles starved for 1 to 2 weeks after emerging from overwintering. Depending primarily on temperature, up to 100% of post-overwintering, starved beetles flew shortly after release. Temperatures as low as 15C (59F) allow some flight, but 18 to 20C (64 to 68F) seemed to be needed for maximum flight activity (figure 3). Many of the flights observed were at heights of more than 50 feet and may have covered distances of 1/4 to 1/2 mile or more. Beetles most often took off into the wind, then turned and flew with the wind.

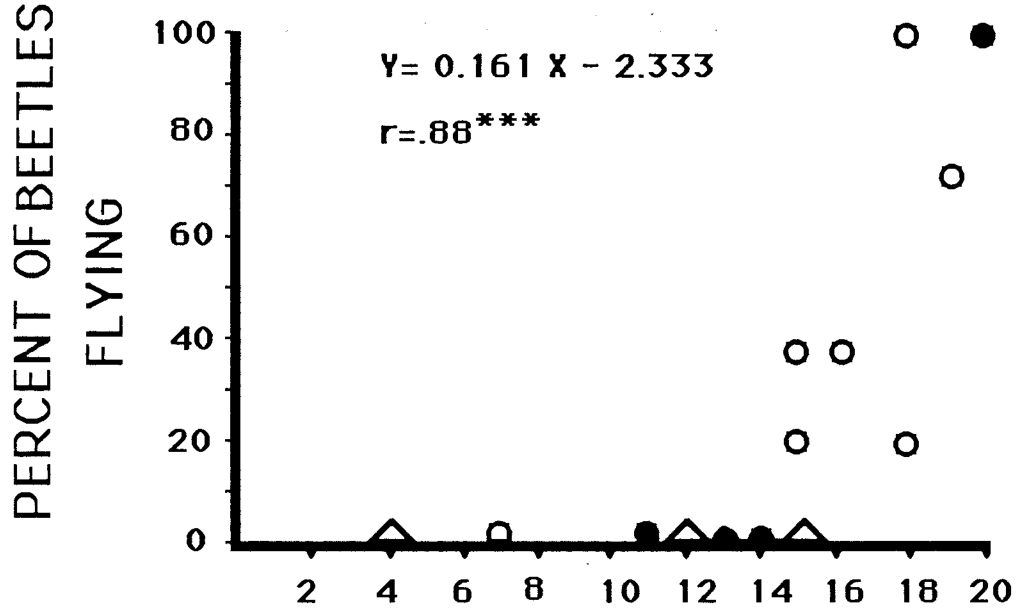


Figure 3. Colorado potato beetle flight in relation to air temperature.

Direction of movement, as in the laboratory, seemed to be largely upwind (figure 4) and potato plants did appear to be attractive, although the attractive distance was not clear.

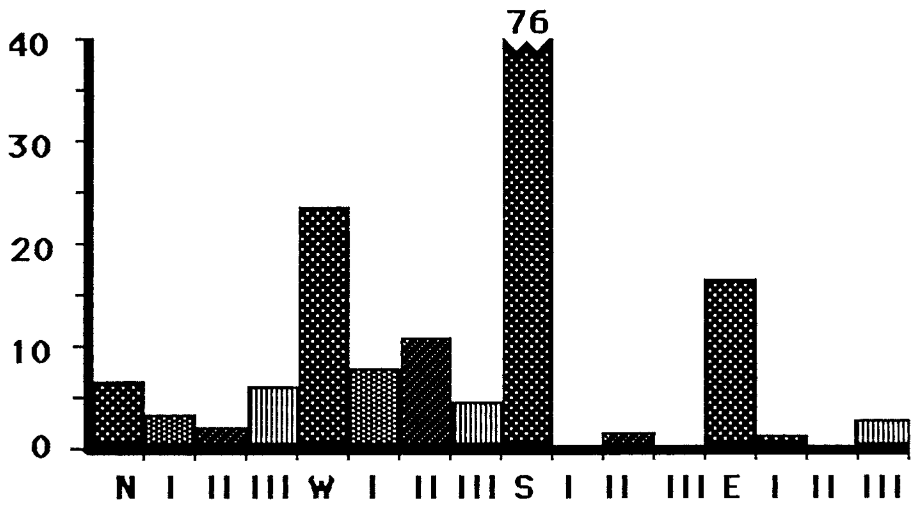
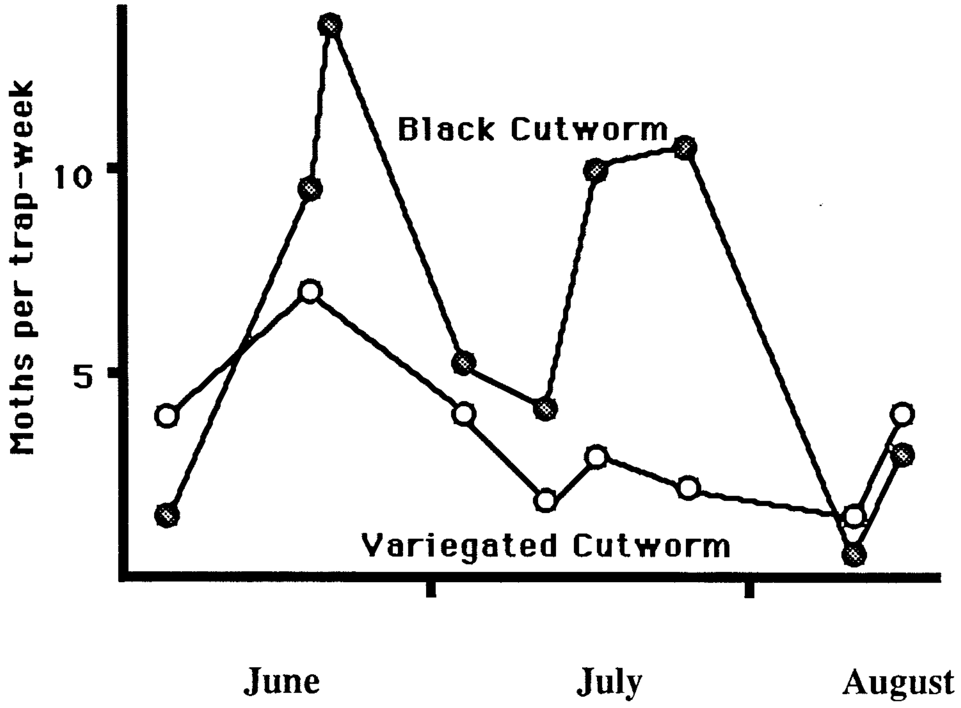


Figure 4. Numbers of Colorado potato beetles trapped at various locations around a circular arena. (Potato plants were grouped at N, S, E, and W directions. Wind was from the SW).

Black and Variegated Cutworm Flight Activity

Sex attractant traps were loacted adjacent to the research plots at the Montcalm Co. Potato Research Farm. Traps were checked approximately weekly and numbers recorded. Peak trap catches were moderately high for black cutworms (one of the primary tuber-feeding species). Variegated cutworm trap catches were low in comparison with other years (catches of 30 or more per week occur during peak years). Adult activity of both species extended over a longer period of time than normal.



Colorado Potato Beetle Control

Potatoes were planted 2 May '85 at the MSU Montcalm Potato Research Farm. Plots were 3 rows wide (34 inch spacing) by 45 feet, with five feet of buffer before the next plot. Two untreated rows were left between adjacent plots. Insecticides evaluated included: standard foliar or soil treatments (Temik, Disyston, Thimet, Imidan, Ambush, and Pydrin); new pyrethroids (Spur and Baythroid); a mineral-based toxin (Kryocide); a biologically-produced toxin (Thuringiensin); and new types of materials, including insect growth regulators (RH-3421, F-4999). 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 (20 May), or as weekly foliar treatments from 20 June to 8 August. Foliar treatments were applied with a tractor-mounted boom sprayer at 30 gal/acre, 40 psi, with a cluster of nozzles over each of the three rows. One nozzle was pointed directly over the top, with the other two directed at the sides of the plants. Weekly insect counts (12 June- 12 August), were made from two randomly selected plants in the center row of each plot. On 3 July, Cygon was sprayed on all plots to control the potato leafhopper infestation. On 12 August, the plots were rated for Colorado potato beetle damage. Yields were taken from the center row of each plot on 11 Sept. Analysis of variance was done on the season total number of adults and large larvae. Analysis was also done on individual dates for large larvae and adults. Multiple comparisons (SNK) were made where significant results were obtained.

Colorado potato beetle adult numbers ranged as high as 152 per plant (2 August) and larval numbers were a high as 63 per plant (2 July). Seasonal mean number (ave. over 7 dates) of large Colorado potato beetle larvae exceeded the economic threshold of 2-3 beetles per plant in many of the treatments. The summer generation of adults was so large that upon emergence, plots were invaded and decimated within 1-2 weeks. The potatoes died earlier than would be expected for this variety. This is reflected in the yield data.

As seen in Table 1, large larvae were not controlled by most of the pyrethroids. Baythroid is the only pyrethroid that was not signifcantly worse than the standards, Temik 15G (3 lb AI/A at planting) and Imidan 50WP (1 lb AI/A weekly foliar). Analysis of season long number of adults shows no significant difference between treatments. However, when analyzing individual dates, a higher number of adults were seen in the untreated plots, early (25 July). The most adults on 8 August were in the Thuringiesin (40g) treatment. On 12 August, the most adults were seen in the Spur, Thuringiensin (10g), and Thuringiensin (20g) treatments. These adults are either the result of movement into these plots, a result of high numbers of larvae present in the plots, or a sign of poor control of the materials on adults.

The harvest information shows that Temik 15G (3 lb AI/A at planting) and Di-Syston 15G (23 oz/1000') as standards were not different from most of the treatments but were significantly higher in yield than the F4999 15SC (0.01 lb AI/A) treatment (Table 3).

Table 1. Mean number of large larvae per treatment on selected dates and seasonal total (over 7 dates)[a].

	Rate	June 25	July 2	July 9	July 16	Season Total
Soil Treatments						
At planting in row						
Temik 15G	3 lb ai/A	0.00a	0.12a	0.00a	0.00a	0.25a
Di-Syston 15G	23 oz/1000'	5.87abc	5.62ab	14.75cd	3.12a	32.00bc
Thimet 15G	17.3 oz/1000'	0.80a	0.00a	0.50a	1.00a	2.25a
+Pay-Off	.06 lb ai/A					
Side-dressed at hilling						
Temik 15G	2 lb ai/A	0.25a	0.00a	0.12a	0.00a	0.87a
Foliar Treatments						
Thuringiensin	10 g ai/A	4.50abc	4.83ab	1.33a	1.50a	13.00a
Thuringiensin	20 g ai/A	5.62abc	3.12a	1.25a	1.87a	12.50a
Thuringiensin	40 g ai/A	2.87ab	1.25a	1.37a	1.25a	8.75a
Thuringiensin	80 g ai/A	5.83abc	3.50a	0.17a	2.17a	12.00a
RH-3421 1E	0.038 lb ai/A	0.75a	0.50a	0.00a	0.00a	1.25a
RH-3421 1E	0.075 lb ai/A	0.25a	0.00a	0.00a	0.00a	0.25a
RH-3421 1E (+sticker)	0.075 lb ai/A	1.75ab	0.25a	0.00a	0.00a	2.12a
RH-3421 1E	0.15 lb ai/A	0.12a	0.00a	0.00a	0.00a	0.12a
F4999 15SC	0.01 lb ai/A	6.88abc	6.50ab	1.37a	0.25a	15.12a
F4999 15 SC	0.02 lb ai/A	12.75c	5.25ab	0.75a	0.62a	19.37a
F4999 15SC	0.03 lb ai/A	5.00abc	4.00ab	0.87a	0.12a	10.00a
F4999 15SC	0.04 lb ai/A	4.25abc	2.75a	0.00a	0.00a	7.12a
Kryocide 96WP	11.5 lb ai/A	2.37ab	1.00a	1.00a	2.25a	6.62a
Baythroid 2E	0.05 lb ai/A	3.62ab	6.25ab	0.87a	0.62a	12.50a
Spur 2EC	0.05 lb ai/A	5.87abc	11.00abc	14.00bcd	5.75ab	39.00bc
Ambush 2EC	0.15 lb ai/A	5.17abc	11.67abc	9. 83bc	11.83b	51.17c
Ambush 2EC	0.20 lb ai/A	2.62ab	15.12bcd	11.25bcd	7.25ab	40.25bc
Pydrin 2.4EC	0.15 lb ai/A	10.25bc	22.12d	11.00bcd	3.25a	48.87bc
Imidan 50WP	1.0 lb ai/A	3.62ab	2.25a	1.75a	0.50a	9.00a
Untreated	------	4.00abc	16.62cd	18.00d	11.62b	55.37c
Untreated	------	8.12abc	17.50cd	7.12ab	3.87a	39.87bc

[a]Means followed by the same letter are not significantly different (SNK, P<.05)

Table 2. Mean number of adults on selected dates and seasonal total (Ave. over 7 dates)[a].

	Rate	July 24	August 2	August 12	Season Total[b]
Soil treatments					
At planting in row					
Temik 15G	3 lb ai/A	0.87a	3.12ab	4.12a	8.2
Di-Syston 15G	23 oz/1000'	0.75a	6.87ab	2.62a	11.3
Thimet 15G	17.3 oz/1000'	1.25a	2.87ab	2.87a	8.37
+Pay-Off	.06 lb ai/A				
Side-dressed at hilling					
Temik 15G	2 lb ai/A	0.75a	5.00ab	4.87a	11.12
Foliar Treatments					
Thuringiensin	10 g ai/A	0.83a	0.50a	10.16ab	12.00
Thuringiensin	20 g ai/A	0.62a	3.87ab	8.62ab	13.50
Thuringiensin	40 g ai/A	2.00a	24.50b	1.62a	28.87
Thuringiensin	80 g ai/A	1.50a	17.00ab	1.16a	20.16
RH-3421 1E	0.038 lb ai/A	0.00a	0.50a	1.87a	2.75
RH-3421 1E	0.075 lb ai/A	0.25a	5.62ab	2.37a	8.87
RH-3421 1E (+sticker)	0.075 lb ai/A	0.62a	1.87ab	5.87a	9.12
RH-3421 1E	0.15 lb ai/A	0.62a	1.25a	1.12a	3.12
F4999 15SC	0.01 lb ai/A	2.25a	7.75ab	1.25a	12.00
F4999 15 SC	0.02 lb ai/A	1.37a	10.12ab	0.12a	12.37
F4999 15SC	0.03 lb ai/A	3.62a	4.50ab	3.25a	12.00
F4999 15SC	0.04 lb ai/A	2.50a	5.62ab	2.87a	11.37
Kryocide 96WP	11.5 lb ai/A	1.50a	6.75ab	1.62a	10.50
Baythroid 2E	0.05 lb ai/A	1.50a	5.75ab	5.37a	13.62
Spur 2EC	0.05 lb ai/A	3.00a	6.50ab	16.12b	27.62
Ambush 2EC	0.15 lb ai/A	5.83a	2.00ab	2.83a	12.16
Ambush 2EC	0.20 lb ai/A	4.50a	4.25ab	2.62a	12.00
Pydrin 2.4EC	0.15 lb ai/A	4.37a	7.62ab	4.00a	18.25
Imidan 50WP	1.0 lb ai/A	1.87a	9.37ab	1.87a	13.50
Untreated	------	9.25b	6.62ab	0.75a	18.37
Untreated	------	4.87a	3.50ab	1.25a	11.87ns

[a]Means with the same letter are not significantly different (SNK $P<.05$)
[b]Season mean total number of adults averaged over the season (seven dates)

Table 3. Mean yield in lbs per 40 ft row.

	Rate	Weight in lbs (40 ft row)[a]
Soil treatments		
At planting in row		
Temik 15G	3 lb ai/A	79.12a
Di-Syston 15G	23 oz/1000'	76.62a
Thimet 15G	17.3 oz/1000'	62.75ab
+Pay-Off	.06 lb ai/A	
Side-dressed at hilling		
Temik 15G	2 lb ai/A	72.06ab
Foliar Treatments		
Thuringiensin	10 g ai/A	75.25ab
Thuringiensin	20 g ai/A	64.18ab
Thuringiensin	40 g ai/A	57.56ab
Thuringiensin	80 g ai/A	57.08ab
RH-3421 1E	0.038 lb ai/A	70.37ab
RH-3421 1E	0.075 lb ai/A	68.12ab
RH-3421 1E	0.075 lb ai/A	62.50ab
+sticker		
RH-3421 1E	0.15 lb ai/A	72.18ab
F4999 15SC	0.01 lb ai/A	51.31b
F4999 15 SC	0.02 lb ai/A	57.31ab
F4999 15SC	0.03 lb ai/A	63.44ab
F4999 15SC	0.04 lb ai/A	72.12ab
Kryocide 96WP	11.5 lb ai/A	58.12ab
Baythroid 2E	0.05 lb ai/A	64.37ab
Spur 2EC	0.05 lb ai/A	60.00ab
Ambush 2EC	0.15 lb ai/A	61.58ab
Ambush 2EC	0.20 lb ai/A	62.12ab
Pydrin 2.4EC	0.15 lb ai/A	61.56ab
Imidan 50WP	1.0 lb ai/A	70.44ab
Untreated	------	57.12ab
Untreated	------	55.06ab

[a]Means with the same letter are not significantly different (SNK $P<.05$)

Effects of Temperature on Toxicity of Insecticides to the Colorado Potato Beetle

Adult Colorado potato beetles were collected from the M.S.U. Montcalm Experimental Farm in central lower Michigan (Montcalm Co.) and reared in the greenhouse for 2 generations (temperature range = ca. 15 - 30°C. The field population had been exposed to a normal range and frequency of insecticides, including aldicarb, endosulfan, methamidophos, and carbaryl. The pyrethroid, fenvalerate, had been used to limited degree (1 or 2 applications per year) in 1982 and 1983. Field data indicate that some tolerance to synthetic pyrethroids may be present in the population (Morrow, et al. 1985). All beetles tested were 1 - 3 weeks old (post-emergence from pupae).

Trials were conducted at 14, 23, 30, and 35°C, R.H. 85 - 95%. At temperatures below 14°C, beetles were extremely inactive and did not feed. At 35°C, beetles fed less than at lower temperatures and many preferred to burrow into the soil at the base of plants if they were on live plants. At 40°C, 100% mortality occurred within 24h.

Prior to treatment, beetles were acclimated for 24 h at the appropriate temperature. Beetles were subjected to room temperature (20 - 25°C) for a maximum of 10 minutes during treatment before being returned to the experimental temperature. They were held in groups of 9 or10 in 236 ml paper cups and fed untreated potato foliage every 1 - 2 days, as needed.

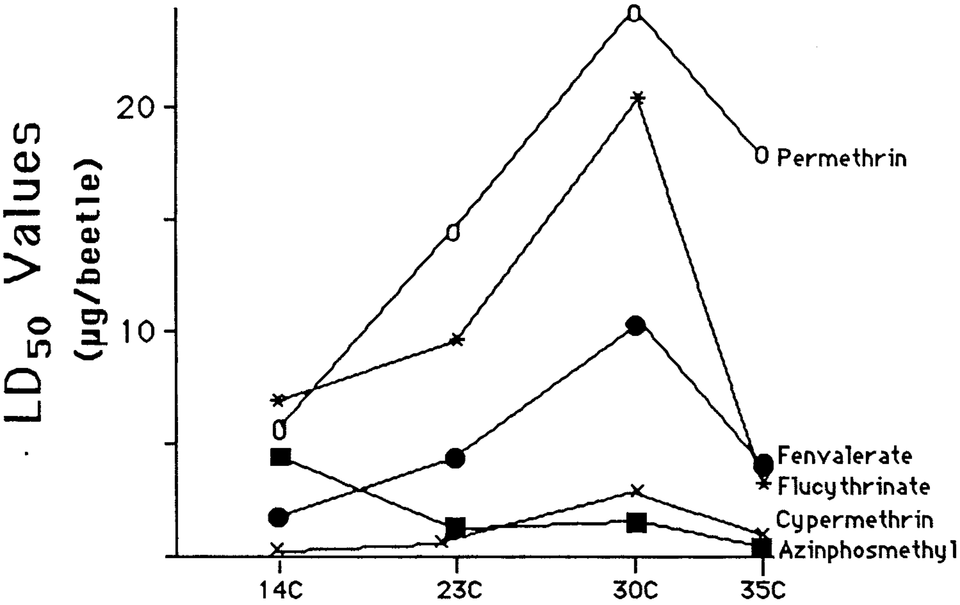
The insecticides tested were: azinphosmethyl (an organophosphate), and the pyrethroids cypermethrin, fenvalerate, flucythrinate, and permethrin. The materials used were technical grade formulations of the respective insecticides, provided by the manufacturers. The materials were dissolved in acetone at the appropriate concentrations and applied to the underside of the insects' abdomens (1 ul per insect). Doses were selected, based on preliminary trials, to give a range of 0 - 100% mortality with several intermediate values. Eight to eighteen replications of nine or ten beetles each were tested for each temperature X insecticide treatment.

Mortality, defined as the inability to walk or remain upright, was assessed 6 d post-treatment. In most cases, all mortality had occurred within 2 - 3 d post-treatment. However, at 14°C, mortality was not always apparent for several days and some beetles recovered from the treatment after 1 - 2 d, hence the need for the long observation period. Movement was sometimes exhibited by individuals that were incapable of walking. Data were analyzed and LD_{50} values calculated using standard log-probit analyses (SAS program).

LD_{50} values ranged from 0.35 ug per beetle for cypermethrin at 14°C to 24.10 ug per beetle for permethrin at 30°C. Results indicated significant levels of resistance to synthetic pyrethroids. LD_{50} values for fenvalerate were more than 35 times levels for Maine beetles and 4 times levels reported from New Jersey in 1979 by Forgash. Values for permethrin were more than 7 times those from New Jersey in 1979. Although LD_{50} values differ greatly between chemicals at a given temperature (up to 34 fold at 35°C), field results may not reflect these differences, since a variety of factors (e.g. residual activity, ingestion toxicity) occur in the field that were not measured in this study.

Toxicity of the organophosphate, azinphosmethyl, increased between 14 and 23°C and leveled from 23 to 30°C . Temperature coefficients were positive or only slightly negative . All of the pyrethroids showed decreases in toxicity between 14 and 30°C (3.1 to 14.3 fold) and temperature coefficients were negative between 14 and 23°C and 23 and 30°C.

Between 30 and 35°C, LD_{50} values for all of the materials decreased 1.3 to 7.2 fold and temperature coefficients were positive. These increases in toxicity between 30 and 35°C apparently resulted from increased stress on the beetles at 35°C. Stress is suggested by the beetles' abnormal behavior at 35°C and death at 40°C. Temperature-toxicity relationships may therefore be dependent, not only on the material involved (organophosphate or synthetic pyrethroid), but also on the temperature range and the insect's physiological and biological response(s) to temperature. Other stresses, such as low food quality or availability, may also reduce the insect's tolerance to toxicants.



Implications for Field Control

The results indicate that there may be a problem with the use of synthetic pyrethroids for control of the Colorado potato beetle at higher temperatures, especially with a material such as fenvalerate, where toxicity decreases by more than 5X between 14 and 30°C. Insecticide resistance or tolerance will increase the problem. However, it is difficult to apply this data directly to field situations. For example, if the normal field application rate is 10 - 20 times more than needed for control, a change of 5 fold in toxicity will not be detectable. Higher temperatures will presumably also affect residual effectiveness and ingestion toxicity of pyrethroids in the field. As noted earlier, factors such as residual activity, mode of uptake, and fluctuating temperatures and other stresses on the insects may also affect control in the field but were not investigated in this study.

1985 PROGRESS REPORT

EVALUATION OF THREE PEST-CROP MODELS FOR PREDICTING POTATO PLANT GROWTH AND TUBER YIELD IN FOUR NORTH-CENTRAL POTATO PRODUCTION SYSTEMS

AN INTERDISCIPLINARY-MULTISTATE IPM RESEARCH PROJECT

FUNDED BY THE

NORTH CENTRAL REGIONAL IPM COMPETITIVE GRANTS PROGRAM[1]

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Integration of pest control procedures for multiple pests is an objective of integrated pest management (IPM). To meet this objective, it is necessary to understand interactions among the pests and environmental variables, as they affect plant growth and yield. At the same time, impact of the dynamics of the physiology of the plant on pest dynamics must be considered. The purely statistical approach to studying interactions among a number of pest factors requires field plot designs that are difficult to implement when more than two or three factors are being considered. The resulting statistical models are site specific with respect to environmental factors. An alternative approach is to develop dynamic plant growth models based on reasonable assumptions about the behavior of the system. These assumptions may be based on experiments conducted in the laboratory, field growth chamber. An understanding of the impacts of pests on host growth may be obtained by collecting field data for evaluation of the model's response under several environmental conditions. Unfortunately, most large scale plant growth models have not been evaluated in detail for a wide range of cropping conditions. This is true even though researchers in several states may be independently collecting similar data on the same crop. While it would be difficult for researchers in several states to design a large combined statistical field plot design incorporating location (production system) as one of the experimental factors, researchers from several states could design complementary experiments that would contribute toward development and testing of dynamic growth models that incorporate pests. In this research project, the investigators have begun testing three models, each with strengths and weaknesses, but which have the potential to meet one or more specific research objective.

Potato is a crop with many key pest problems. The crop is usually managed intensively with pesticides playing a major role in pest control. Several explanatory potato plant growth models have been developed. Two of them have been chosen because they represent different approaches to modeling plant growth although each appears to have performed well previously. These are POTATO developed by Ng and Loomis (1984) and SPUDGRO developed by Johnson (1986). A third model, POTATOPEST, developed at

Michigan State University was designed from the outset to relate nematode population dynamics to potato growth and yield (1985). As part of the research effort to gain a better (i.e. quantitative) understanding of multiple pest and environment interactions, it was proposed to design, develop and couple pest submodels to the above mentioned plant growth models.

To date, our immediate objectives have been:

1. **To evaluate three existing computer models for predicting potato plant growth and development and tuber yield from five sites representing four North Central Regional (NCR) potato production systems.**

2. **To describe and quantify the influence of selected pests (insects, fungi, weeds, and nematodes) on plant growth and development, and tuber yield at five sites representing four NCR potato production systems.**

3. **To evaluate each model for its ability to be coupled to various pest submodels, and the ability of each coupled model to describe the effect of particular pests on potato growth and yield.**

MATERIALS AND METHODS: In April of 1985, the researchers met to formulate field plot designs for each of the five locations. Based on the intensive discussion over the course of this two day meeting, the following experimental plan was implemented at each location. Six-row plots, either 40 or 50 feet in length were planted at a density of 3.2 potato hills per square meter. Rows 1, 4, and 6 were boarder rows. Rows 2 and 3 were used to destructively sample for plant growth. Row 5 was used for estimation of final yield, tuber grade, and determination of specific gravity. Four or five replicates of each treatment were planted in a randomized design using certified seed of cultivar 'Russet Burbank' from Wisconsin. Because of the plant to plant variability associated with dryland potato production in the Red River Valley, 10 replicates were used at their location. Common to all sites was a treatment consisting of a best management practice (BMP) for each production system (Table 1). Additional treatments were included at each location depending on the pest problems prevalent in that production system (Table 2). The Grand Forks and Oaks locations provided replication within a single production system. At these locations a second cultivar was included to provide some preliminary data for model recalibration for a second cultivar.

Treatments were randomized at each location. To establish different levels of Verticillium dahliae at the Wisconsin site, inoculum was produced by growing the fungus on sterile rye seed. The inoculum was subsequently dried and ground in a Wiley mill after which it was incorporated in the field plots to a depth of 20 cm using a rotary cultivator. Colorado potato beetle (CPB) treatments were obtained at the Michigan and North Dakota locations by using an insecticide not effective against CPB (Cygon). The nematode treatments in Michigan were established by fumigating infested soil. Potato leafhopper treatments in Minnesota and Wisconsin were established by controlling natural populations with insecticides. Early blight treatments were established in Minnesota by lightly inoculating plots at full bloom to initiate an epidemic. An early blight treatment was established in Wisconsin by deleting the use of fungicide from the BMP.

A standard set of data were collected at each location, including environmental, plant growth, pest, and yield observations. The environmental data included soil moisture (determined gravimetrically) taken approximately weekly at three soil depths (0, 15, 30 cm), soil temperature, daily maximum and minimum air temperature, average wind

Table 1. 1985 best management practices for each potato production system.

Best Management Practices	Michigan	Wisconsin	Minnesota	North Dakota Grand Forks	North Dakota Oaks
Soil type	Sandy loam	loamy sand	silt loam	silt clay loam	
planting date	9 May	29 April	22 May	22 April	
Emergence date	29 May		May 20	15 June	10 June
Tillage					
preplant	disk/plow	disk/plow	disk/plow	field cultivator	
post emerg	hilling	hilling	hilling	hilling	
Irrigation	9" (12 appl)	21" (28 appl)	none	none	
Fertilizer					
preplant	400lbs 0-0-60	400lbs 0-0-50	200# 8-10-30		
at planting	500lbs 24-8-8	700lbs 6-24-24	200# 30-0-0	300lbs 20-20-10	
at emerg	180lbs 46-0-0	300lbs 34-0-0			
mid June		300lbs 34-0-0			
Herbicide					
preplant	Dual + Lexone		Eptam	Eptam	Eptam
post emerg	Dual + Lexone	Lorox	Prowl	Prowl	
Nematicide	Vorlex	none	none	none	none
Insecticide					
at planting	Temik, Thimet	Disyston	none	Thimet/Cygon	Thimet
during season	Imidan (2 appl)	Pydrin (5 appl)	Furadan (4 appl)	Pydrin	
Fungicide	Bravo (7 appl) Dithane M-45 (2 appl) Ridomil (1 appl)	Bravo (8 appl)	Bravo (5 appl)	none	none

speed, relative humidity, total solar radiation, percent sunshine, and rainfall. Microprocessor based environmental data loggers (Campbell Sci. Inc., Logan, Utah) were used to collect most of these data. The instruments were located within the field plots or close to them. Percent sunshine data were obtained from national weather service stations at Madison WI, Minneapolis MN, Lansing MI, and Grand Forks ND.

Beginning from emergence, plant samples were harvested every fourteen days throughout the season for a total of 8 sampling dates. Four plants were sampled from each replicate plot of each treatment on each harvest date. Three plants were bulked together and the fourth plant processed separately. Dry weights of roots, stolons and tubers were obtained after drying at 60 C. Mainstems and branches were separated. All mainstem leaves and branch leaves were separated and dry weights obtained after drying at 60 C. Leaf area was obtained for the single plant as well as leaf dry weight to obtain a relationship between leaf area and dry weight. The total number of mainstems, branch stems, mainstem leaves, and branch leaves were recorded for each replicate. At the end of the season (late September), final yields were taken from each plot by machine harvesting row 5.

Table 2. Pest treatments at each location (production system).

			North Dakota	
Michigan	Wisconsin	Minnesota	Grand Forks	Oaks
BMP	BMP	BMP	BMP	BMP
BMP minus insecticide	BMP minus insecticide	BMP minus insecticide	BMP minus Thimet (Cygon used for leaf hoppers)	BMP minus
	BMP minus fungicide	BMP minus fungicide		
	BMP plus infestation with low level Verticillium			
	BMP plus infestation with med level Verticillium	BMP plus infestation with med level Verticillium		
	BMP plus infestation with high level Verticillium			

Pest data were collected for CPB, early blight fungus, Verticillium wilt fungus, root-lesion nematode, and potato leafhoppers. Four plants were randomly sampled from each plot each week to estimate CPB populations. The number of adults, egg masses, small and large larvae on the entire plants were counted. Plant damage was rated on a numerical 0 to 6 scale. Early blight disease severity was recorded as % stem length defoliated, % of remaining foliage showing symptoms, and % of leaf area covered by lesions using standard area diagrams. Hopper burn was recorded in a similar way to early blight. Late blight was not observed in any of the production systems in 1985. Weed severity data were obtained by estimating weed population density. Because of the use of herbicides at all locations weeds were not a significant pest problem. Next year we intend to include herbicide minus treatments in our experimental design.

RESULTS: Simulated and or observed values of selected state variables (e.g. leaf dry weight) were plotted against time for the five sites. Only the Michigan data are reported in Fig. 1. POTATO simulations (Figure 1, A-F) were produced without prior recalibration of the model parameters at each site. There was a systematic trend for total leaf weights to be underestimated late in the season. This may be explained in part by the fact that the current version of the model does not have a layered soil water subroutine to simulate dynamic soil water potentials. Thus, soil water was assumed to be nonlimiting throughout the season at each site. This was clearly not true for the North Dakota and Minnesota sites, and some periodic but significant soil water deficits are also likely to have occurred at the end of the irrigation cycles at the sandy Wisconsin site. With declining soil water potentials, leaf water potentials will also decline reducing leaf growth. In the model, leaf growth is more sensitive than stem and tuber growth to plant water stress. A working soil water routine is now being added to the model and should allow for more accurate simulations of leaf biomass and, perhaps, stem and tuber biomass as well. If necessary, adjustments will be made to model options concerning partitioning of dry matter to leaves, stems, and tubers.

SPUDGRO was calibrated for tuber initiation date at each site based on 1985 observations. The model predictions fit the observed plant growth closely (Figure 2). Improved data collection for soil moisture would probably improve the predictions.

A preliminary Verticillium wilt submodel was developed and coupled to the POTATO model. Actual and simulated Verticillium wilt effects on tuber growth were compared for the Verticillium treatment in Wisconsin. The coupled model reproduced the actual yield loss behavior fairly well, but was inaccurate in its diseased crop tuber production because of its inaccurate healthy crop predictions. SPUDGRO has been coupled with a subroutine to model feeding effects of potato leafhoppers on plant growth. With two years of data, the coupled model emulated actual growth reasonably well.

The process of analyzing all of our data is not yet complete. Work is progressing on comparing actual with simulated data for POTATOPEST as well as examining the data from treatments other than the BMP. Each of the models will require some modifications based on the data collected in 1985. In addition, the project will continue to develop pest submodels to couple to the plant growth models. POTATO now has Verticillium wilt, early blight, and insect defoliation (CPB) submodels in stages of development and testing. SPUDGRO submodels have been developed for early blight and Verticillium wilt, as well as potato leafhoppers. Continued data collection and testing of these submodels will be a major emphasis for 1986, in addition to refinement and evaluation of the three plant growth models.

LITERATURE CITED:

Ng, E. and R. S. Loomis. 1984. Simulation of growth and yield of the potato crop. 148 pp. PUDOC, Wageningen, Netherlands.

Johnson, K. B., S. B. Johnson, and P.S. Teng. 1986. Development of a simple potato growth model for use in crop-pest management. Agric. Systems (submitted).

Bird, G. W., R. L. Tummala, S. H. Gage. 1985. The role of systems science and data base management systems in nematology In Advanced Meloidogyne Treatise, Vol. II. J. N. Sasser (ed.) Academic Press.

Figure 1. 1985 plant growth data.

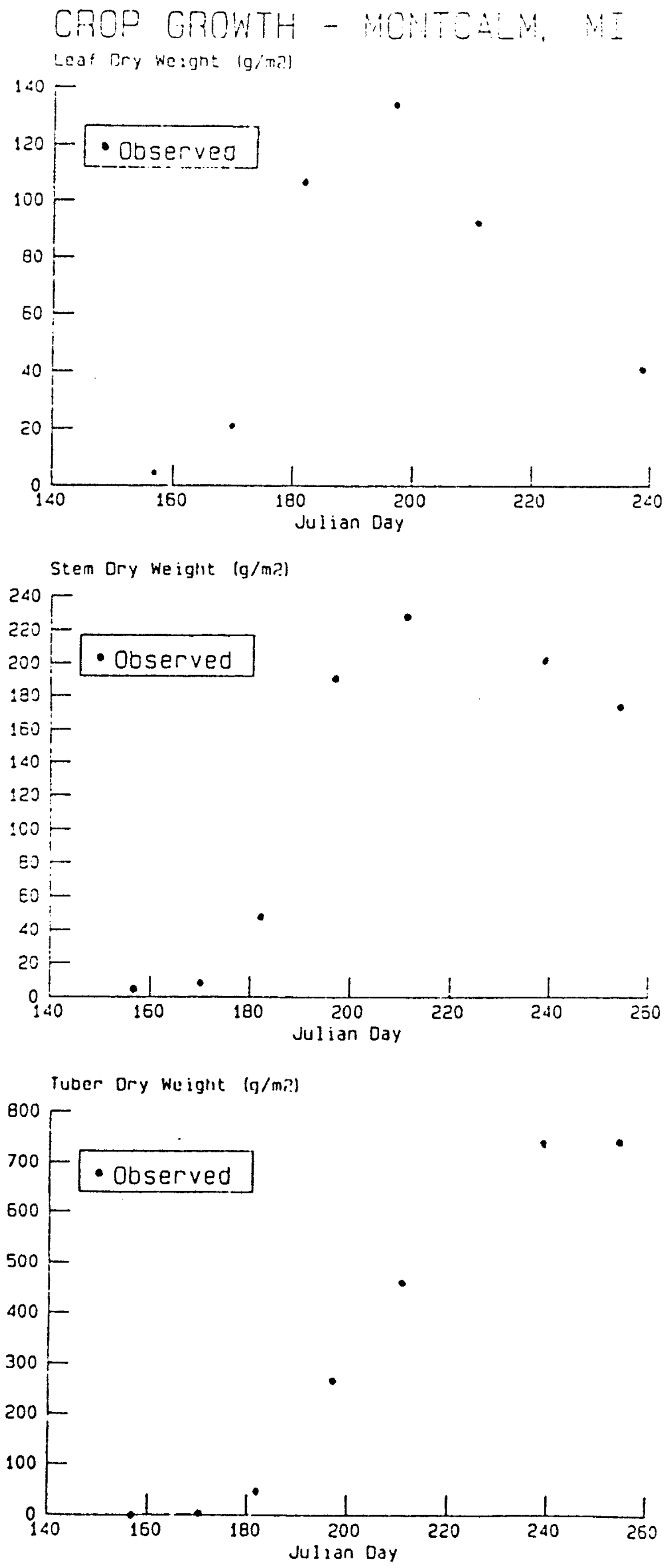
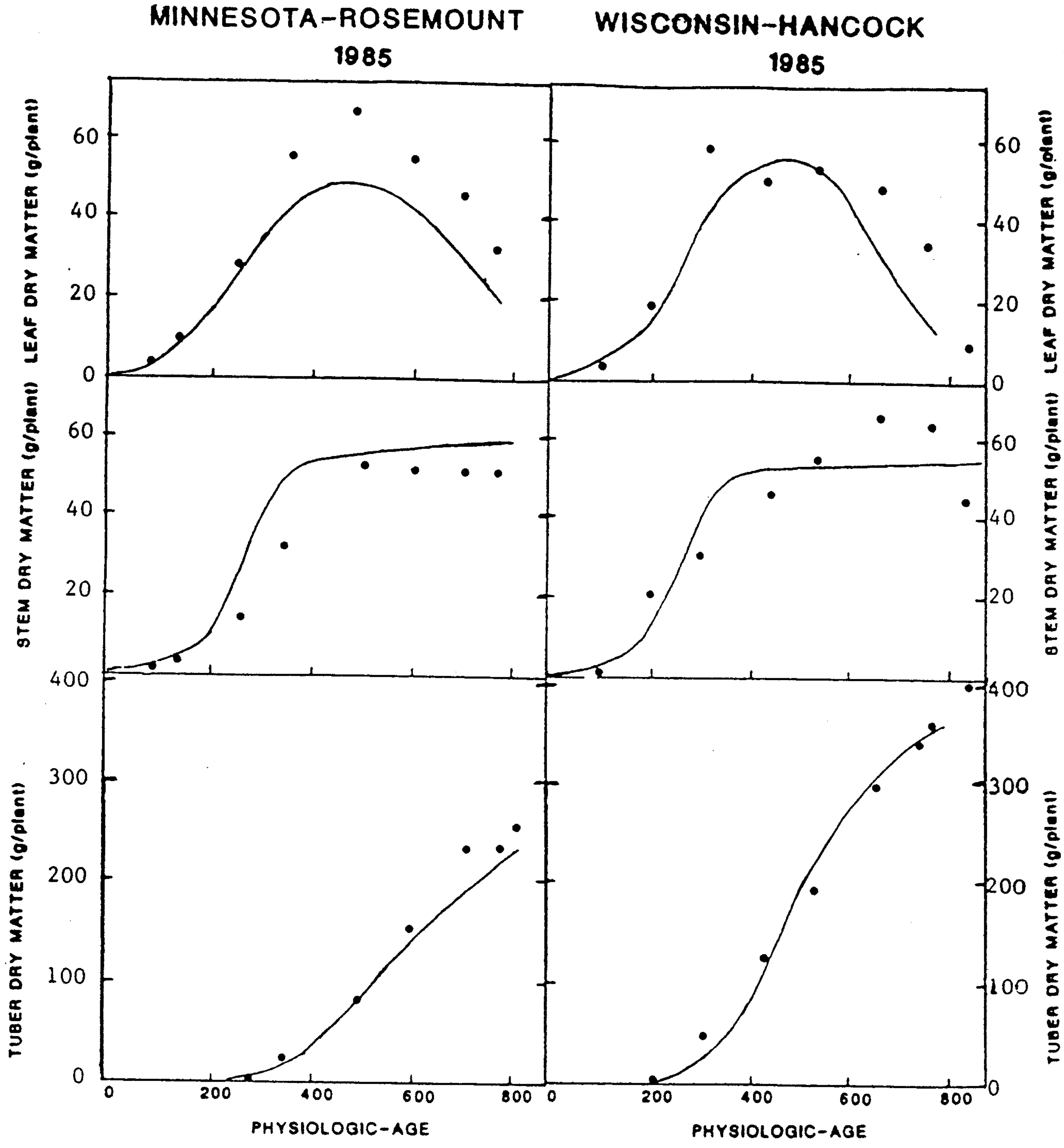


Figure 2. 1985 potato plant growth data from two locations in the North Central United States and simulated plant growth values using the model of Johnson et al.



NEMATODE RESEARCH

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Department of Entomology

A root-lesion nematode and Verticillium fungus survey of 33 sites in 7 Michigan counties was conducted in 1985. The root-lesion nematode was more common than in either the 1975 or 1982 survey (Table 1). Because several alternate Verticillium sample processing procedures needed to e examined, the fungus portion of the survey is still in progress.

Chemigation with Busan 1020 in Antrim County at 25 and 50 gallons per acre, provided increases in Superior tuber yields. Additional yield increases were not obtained at 100 gallons per acre (Table 2). No additional benefits were obtained at this site through the use of Temik 15G in addition to Busan 1020. Excellent root-lesion nematode control was obhtained (Table 3). Similar results were obtained with Russet Burbanks in Montcalm County (Table 4).

In 1985 it was possible to apply Busan 1020 and Vapam for potato early-die control through the use of spring chemigation (Table 5). In other years, however, the environment could result in either phytotoxicity or problems with planting at the optimum time.

Chemigation with Busan 1020 resulted in increased tuber yield of Superiors following rye, alfalfa or corn-wheat rotations (Table 6). The greatest yields were obtained after alfalfa. There was no indication that chemigation in 1983 had any beneficial impact on the 1985 potato crop (Table 7).

Not all sites responded to chemigation with Busan 1020 (Table 8). It appeared that the more times a site had been used for potato production, the lower the potential tuber yield. Two soil ammendment products were also evaluated (Table 9).

Table 1. 1985 Potato early-die disease complex survey summary.

Counties included in the survey (7)

Allegan	Antrim	Barry	Delta	Monroe
Montcalm	Presque Isle			

Varieties included in the survey (8)

Russet Burbank	Monona	Superior
Russet Sebago	Atlantic	Bellruss
Ontario	Shepoy	

Number of sites included in the survey (33)

Number of acres included in the survey (890)

% of sites infested with *Pratylenchus penetrans* (93.8%)

Mean *Pratylenchus penetrans* population density per 1.0 g root (63.4)

Verticillium dahalae analysis still in progress

Current research activities involve evaluation of the procedures for *Verticillium dahaliae* currently being used in Ohio, Wisconsin and North Dakota.

Table 2. Influence of Busan 1020 and Temik 15G on Superior tuber yields.

Busan 1020	Non-treated Control	Temik 15G (20 lb/A)
0 gal/A	300	349
25 gal/A	417	399
50 gal/A	490	465
100 gal/A	485	480

Table 3. Influence of Busan 1020 and Temik 15G on *Pratylenchus penetrans* control.

Busan 1020	Non-treated control	Temik 15G (20 lb ai/A)
0	0[1]	99
25	87	99
50	94	100
100	100	100

1 % control based on a cummulative (P_i, P_m, P_f) population density of 285 *Pratylenchus penetrans* per 100 cm^3 soil plus 1.0 g root tissue.

Table 4. Influence of Vapam on Russet Burbank tuber yields in Montcalm County.

Non-treated control	347 cwt/A
Vapam (50 gpa)	415 cwt/A

Table 5. Comparison of fall and spring Busan 1020 chemigation on Superior tuber yields.

Control	384 cwt/A
Fall Busan 1020 (54 gal/A)	448 cwt/A
Spring Busan 1020 (50 gal/A)	512 cwt/A

Table 6. Influence of rotation crops and chemigation on Superior tuber yields.

	Busan 1020 (50 gpa)	Control
Rye (2 years)	493 cwt/A	263 cwt/A
Alfalfa (2 years)	528 cwt/A	330 cwt/A
Corn/wheat	480 cwt/A	201 cwt/A

Table 7. 1985 Superior tuber yields following 1983 treatment with Vapam (50 gpa).

Treatment	Yield
Non-treated control	256 cwt/A
Temik 15G (3 lb ai/A)	447 cwt/A

Table 8. Influence of number of crops of potatoes ahd chemigation on tuber yield.

Site	Yield (cwt/A)	
	Superior	Russet Burbank
1st year potato land		
Non-treated control	639	-
Busan 1020 (50 gpa)	626	-
2nd year potato land		
Non-treated control	491	499
3rd - 4th year potato land		
Non-treated control	-	434
Vapam (50 gpa)	-	519
20th year potato land		
Non-treated control	305	-

Table 9. Influence of Vapam, nitrogen, and soil ammendments on Russet Burbanks tuber yields.

Treatment	Yield (cwt/A)	
	Vapam (50 gpa)	Control
Regular N		
Control	492	383
Bioplus	513	370
Agroculture	513	350
Double N		
Bioplus	547	-
Agroculture	550	-

FIELD COMPARISON OF THE EFFECTIVENESS OF THE MSU AIR CURTAIN SPRAYER VS. CONVENTIONAL BOOM SPRAYER WITH HYDRAULIC NOZZLES FOR VINE KILL IN POTATOES

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INTRODUCTION

During the last two years (1984 and 1985), the Agricultural Engineering Department at Michigan State University has been involved in developing the Air Curtain Chemical Application Technology (Air Assisted, Controlled Drop Atomization) for orchard spraying. Orchard performance data indicated approximately a two fold increase in chemical deposition efficiency. In 1985 a row-crop version of the Air Curtain concept was built and field tested. This vine kill study was designed to compare the performance of a standard hollow-cone brush type boom sprayer with the Air Curtain concept. Four different chemical treatments were studied. The experiments were on the V&G Farms, Stanton, MI. The treatments were applied to Russet Burbank potato vines on September 19, 1985.

OBJECTIVES

The purpose of this research is to investigate spray application systems, and obtain a method that effectively kills potato vines. More specific objectives were to increase the speed of foliar desiccation as well as decrease spray solution volume.

PROCEDURE

Application Methods

In the vine kill test, the spray systems used were:

1. Conventional brush type boom sprayer with hollow-cone (D4-25) nozzles applying 50 gal/A at 50 psi.

2. MSU Air Curtain sprayer with Micronair AU7000 applying 5 gal/A rotating at 7000 rpm.

Treatments

The four chemical treatments used are listed below. All treatments were applied on 0.195 acre plots with spray systems stated above:

1. Chevron Diquat at 1 pint/A, X-77 spreader at 4 oz/A.

2. Chevron Diquat (1 pint/A), STA-PUT drift retardant (0.64 oz/gal solution) and X-77 spreader (4 oz/A).

3. Chevron Diquat (1 pint/A), Copper Sulfate ($CuSO_4$) at 5 lbs/A and X-77 spreader (4 oz/A).

4. Copper Sulfate ($CuSO_4$) at 10 lbs/A with X-77 spreader (4 oz/A).

5. Check.

Application Time

The above treatments and methods were used on Russet Burbank potatoes on the V and G Farms, Stanton, MI. They were applied September 19, 1985.

EVALUATION

Data was compiled by means of subjective panel investigation. The vine kill-down (percent) was evaluated every other day following application for eight days, at which point most treated vines were no longer green. The treatments were applied September 19, and evaluated on September 21, 23, 25 and 27, 1985.

RESULTS AND DISCUSSION

The percent vine kill figures are presented in Table 1. Applications which included Diquat displayed increase kill-down efficiency over copper sulfate only. In the two to six day range, the Air Curtain exhibited an obvious visual increase in kill-down over the boom and check treatments.

Deposition studies performed on potato vines may explain the improved performance of the Air Curtain Sprayer. The volume applied in these studies was 5 gal/A for Air Curtain and 50 gal/A for boom applications, the tracer material used was soluable copper. Deposition of soluable copper was collected on horizontally-placed mylar targets located at the top and in the middle of the plant canopy. Two targets were held in a rigid frame to provide an upper and lower surface. The frames were supported by upright iron rods, (see Figure 1). Table 2 shows deposition recorded on both sides of the target[1]. These deposition tests indicate that the Air Curtain consistently deposited the copper more evenly throughout the plant canopy than did the boom application. The improvement of the Air Curtain desiccation correlates to this even distribution, particularly the underside coverage.

CONCLUSIONS

1. The use of Diquat increases the percent kill-down over copper sulfate in potato vine kill.

2. Air assisted rotary atomizers (MSU Air Curtain) greatly increases the rate of kill-down and percent desiccation over conventional boom sprayer with hydraulic nozzle spray equipment.

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[1]The values of Table 2 should be used for comparison between sprayers only. Both sprayers used the same 160 ppm copper solution; the only difference was that the boom applied 50 gal/A where the Air Curtain applied 5 gal/A.

Table 1. Potato Vine Kill-down Using a Conventional Boom Sprayer in Comparison With the MSU Curtain Sprayer on Russet Burbank Potatoes, 1985.

	DAYS AFTER APPLICATION[1]			
CHEMICAL/SPRAYER[3]	2[2]	4	6	8
	Percent desiccation			
Diquat				
MSU AC	27	72	96	99
Boom	19	56	86	96
Diquat + D.R.				
MSU AC	30	82	95	98
Boom	23	62	87	95
Diquat + $CuSO_4$				
MSU AC	29	72	93	98
Boom	22	56	85	97
$CuSO_4$				
MSU AC	8	42	68	93
Boom	8	28	64	92
Check[4]	2	4	21	24

[1]Application date, September 19, 1985.

[2]The first evaluation date was September 21, 1985.

[3]See page 2 for detailed description of treatments.

[4]Natural vine-kill.

Table 2. Soluable Copper Deposited on Mylar Targets Placed in the Potato Vine Canopy Using the Conventional Boom Sprayers in Comparison to the MSU Air Curtain Sprayer, 1985.

TARGET POSITION	NO ADJ.[1]		DRIFT RETARDANT[2]	
	BOOM[3] D4-25	MSU[4] AC	BOOM[3] D4-25	MSU[4] AC
Upper target				
Top surface	1.11[5]	.42[5]	1.80[5]	.30[5]
Bottom surface	.12	.19	.26	.15
Lower target				
Top surface	.55	.28	.92	.22
Bottom surface	.08	.20	.26	.13
Average				
Top surface	.83	.35	1.36	.26
Bottom surface	.10	.20	.26	.14
Grand Mean	.46	.28	.81	.20

[1]No adjuvant-water, chemical only

[2]Water, chemical, plus drift retardant

[3]Boom - 50 gal/Ac (160 ppm Cu. Solution)

[4]MSU Air Curtain - 5 gal/A (160 ppm Cu. Solution)

[5]For comparison of the boom and Air Curtain applications, multiply the Air Curtain deposition number by a factor of ten due to the one-tenth application volume.

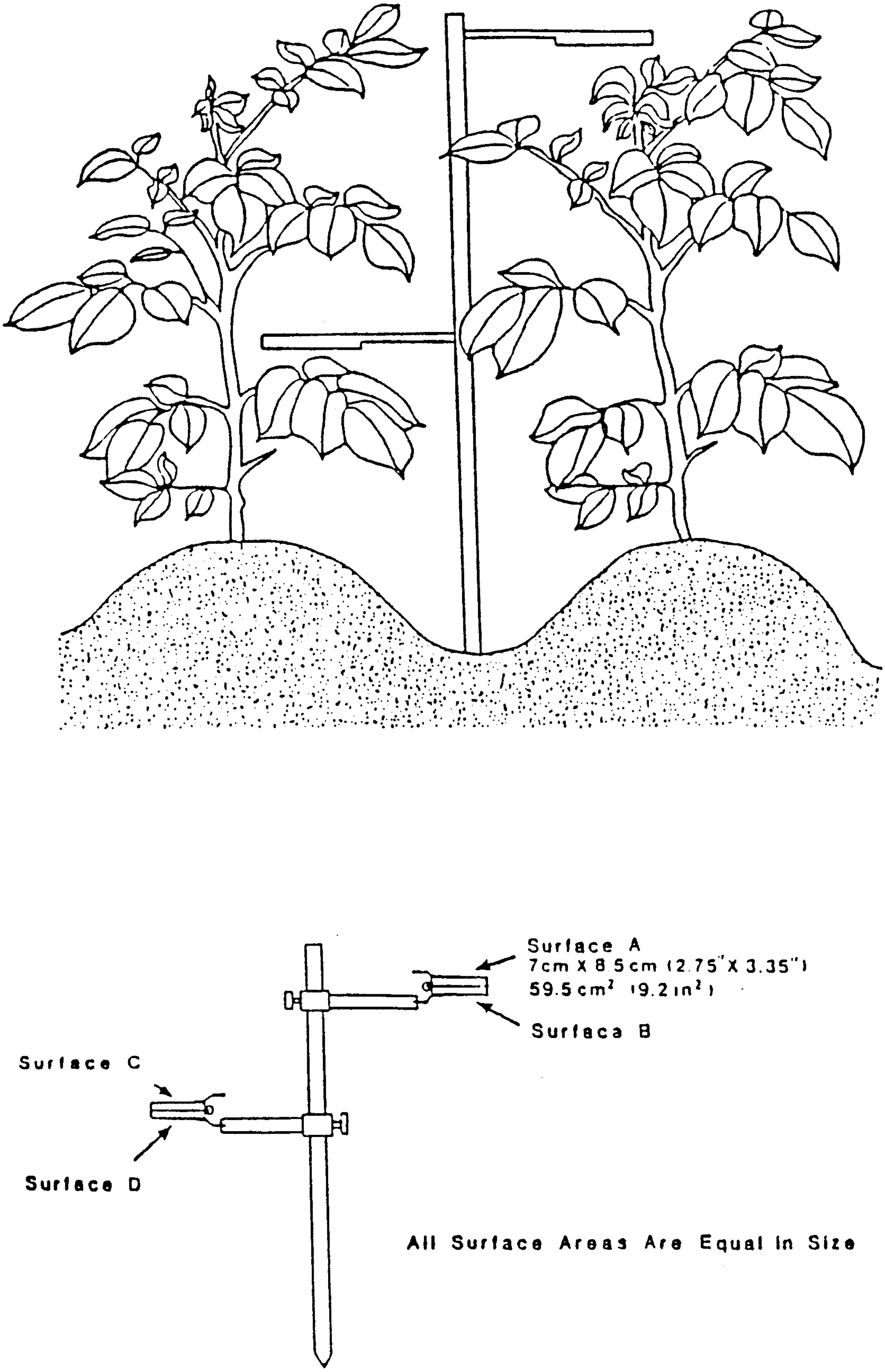

Fig. 1. Mylar target frames and location of targets in potato vine canopy.

DETERMINATION OF THE ROLE OF FRUCTOSE IN COLD STORED, IMMATURE POTATO TUBERS

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It has long been known that fructose and glucose, the major reducing sugars found in potatoes, are responsible for browning of potato products during chipping. The presence of these sugars after storage is generally thought to be the result of a breakdown of sucrose during storage. However, some preliminary work indicates that fructose alone is present in moderately high concentrations in immature tubers. If these immature tubers are stored at normal chip storage temperatures, the fructose levels do not decrease and may, in fact, increase. With this situation, the tubers coming out of storage cannot produce acceptable quality products. The most logical approach, therefore, is to determine concentrations of fructose under varying treatments, soil temperature and maturity prior to harvest and monitor changes during storage regimes to lower or eliminate fructose levels before the tubers are processed.

During the second year of this three year study, potatoes of the Atlantic cultivar were subjected to the following preharvest treatments: 1) control; 2) chemical top kill, and, 3) mechanical top kill. Potatoes were harvested biweekly from August 7 to October 15. Samples from each harvest were analyzed for sucrose, fructose and glucose. Samples from the last harvest were stored at 40^{o}, 45^{o} and 50^{o}F to be analyzed monthly for sugar content and chip quality.

Results from the first year work (1984) indicated that the treatments and climate conditions used did influence sugar accumulations. Sucrose and fructose concentrations in the control and top killed plants did not vary significantly but the potatoes from the cooling treatments showed greater concentrations of both sugars. During the first month of storage, samples at 40^{o}F accumulated fructose much more rapidly than sucrose or glucose. After one to two months, accumulations seemed to cease and the concentrations of sugar became relatively constant at a fairly high level. Pre-harvest treatments did not seem to influence accumulation rates but the soil cooled samples had higher fructose levels going into storage so the total fructose level of these samples was higher throughout the storage regimes.

In 1985, fructose concentrations did vary between the control and top killed samples (Table 1). Although differences were relatively small, there is good reason to believe that chip colors can be greatly influenced by these small variations. It has long been theorized that chip color is associated with changes in glucose content, however, glucose concentrations between samples is almost nonexistant but chip color differences can be seen. These differences must be in response to fructose concentrations present. Fructose reactions may be due to the involvement of free fructose in sucrose synthesis and if this pattern holds true during longer storage times at low temperature, long time storage, there could be some important implications for processing quality. This would involve not only temperature and variety but also cultural conditions and prestorage treatment.

Table 1. Sugar analysis (g/100g fresh weight) of Atlantic Potatoes, 1985.

	Treatments								
	Control			Chemical Top Kill			Mechanical Top Kill		
Harvest Date	Fru	Glu	Suc	Fru	Glu	Suc	Fru	Glu	Suc
August 7	.296	.009	.177	---	---	---	---	---	---
August 22	.384	.002	.125	---	---	---	---	---	---
August 29	.120	.005	.078	.144	.005	.086	.168	.006	.124
September 6	.128	.004	.086	.144	.005	.103	.120	.006	.102
September 19	.130	.010	.140	.144	.006	.100	.144	.011	.160
October 1	.080	.006	.123	.088	.006	.110	.092	.006	.117
October 15	.080	.005	.110	.088	.005	.100	.090	.006	.100

Table 2. Sugar analysis (g/100g fresh weight) potatoes from 1985 M.S.U. Variety Trials.

Variety	August 7			August 29			September 19		
	Fru	Glu	Suc	Fru	Glu	Suc	Fru	Glu	Suc
Yankee Chipper	.240	.006	.110	.184	.010	.112	.120	.009	.095
Shepody	.200	.036	.342	.232	.011	.229	.128	.009	.153
Yankee Supreme	.224	.020	.290	.114	.025	.219	.104	.019	.131
Conestoga	.336	.012	.193	.168	.010	.184	.104	.009	.109
Yukon Gold	.344	.016	.271	.200	.014	.194	.104	.009	.109
Alasclear	.288	.094	.554	.264	.018	.266	.176	.023	.225
716-15	.304	.010	.213	.136	.008	.107	.072	.009	.111
700-83	.424	.010	.146	.152	.012	.144	.064	.002	.055
700-79	.264	.012	.225	.208	.006	.159	.120	.007	.102
700-22	.216	.038	.340	.176	.010	.200	.088	.007	.133
B9140-32	.328	.004	.132	.160	.002	.071	.056	.002	.045
702-91	.272	.005	.187	.152	.006	.157	.072	.007	.107
Acadia Russet	.240	.082	.887	.288	.142	1.01	.064	.050	.501
Islander	.256	.014	.166	.136	.007	.138	.088	.005	.083
Atlantic	.368	.001	.137	.128	.006	.119	.144	.011	.160
Carlton	.288	.069	.403	.152	.038	.127	.088	.039	.228
702-80	.208	.006	.119	.120	.003	.081	.256	.005	.068
Onaway	.264	.201	.716	.304	.207	.837	.136	.181	.664
G670-11	.240	.236	1.00	.256	.114	.593	.136	.176	.200
704-10	.368	.014	.200	.208	.016	.163	.144	.010	.149
Russet Burbank	.440	.087	.525	.200	.029	.270	.152	.021	.200
Simcoe	.280	.066	.474	.112	.009	.120	.144	.010	.180

EFFECT OF PRESTORAGE HANDLING AND CHEMICAL TREATMENTS ON THE MARKETABLE QUALITY OF 1984 POTATOES OUT OF EXTENDED STORAGE

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INTRODUCTION

This paper is part of a continuing report on the influence of prestorage mechanical handling and chemical treatments on the market quality of potatoes out of extended storage. Mechanical systems for harvesting and handling result in tuber damage and the degree of this damage influences the storability and market quality of the potatoes coming out of storage.

Various prestorage chemical treatments have been shown to influence losses and market quality out of storage. The present practice is to treat mechanically handled potatoes going into storage with a solution containing 0.42 fl oz of a thiabendazole formulation Mertect 340F[1] containing 42.28% active [2-(4-Thiazolyl) benzimidazole]. The recommendation has been to apply Mertect 340F at the rate of 0.42 fl oz in 1 gal of water per ton of potatoes. A one gallon solution per ton of potatoes is considered excessive. It results in free surface water on the potatoes and presents a serious overload to the storage ventilation system.

Since 1983 prestorage chemical application research at Michigan State University has shifted emphasis toward the development of a commercial, low-volume, controlled droplet application system. The purpose of this research has been to develop a commercially acceptable application system, while maintaining or enhancing the market quality of potatoes being removed from storage.

OBJECTIVES

The objective of this research is to develop a commercially acceptable, low-volume, controlled droplet, prestorage application system. More specific objectives are: 1) enhance the out-of-storage market quality of the commercially harvested potatoes, 2) improve chemical deposition on the potatoes going into storage, and 3) reduce the carrier solution required to apply these chemicals.

PROCEDURE

Potato Samples

The 1984 Atlantic and Monona 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 Monona potatoes used in the commercial phase of this project were grown and harvested by Sackett Ranch, Inc., Stanton, MI; Sandyland Farms, Howard City, MI; and Wayne J. Lennard & Sons, Samaria, MI.

Equipment

Sandyland Farms Lockwood bin piler (with prestorage chemical application equipment) was used to treat all of the MSU grown Atlantic and Monona potatoes. The potato flow rate was controlled at 30 ton/hr. This piler was also used for the commercial phase at Sandyland Farms. The potato flow rate used for the commercial phase was approximately 60 ton/hr.

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[1] A product of Merck & Co., Rahway, NJ

The Lockwood bin piler and prestorage chemical application equipment at Sackett Ranch, Inc., Stanton, MI, was used to treat the potatoes during this commercial phase of the project. The potato flow rate over this bin piler was approximately 80 ton/hr. The Troyer bin piler and prestorage chemical application equipment at Wayne J. Lennard & Sons was used to treat the potatoes during this commercial phase of the project. The potato flow rate over this conveyor was approximately 60 ton/hr.

In 1984 two different chemical application systems were used. The first system was a Micronair AU7000 CDA nozzle without propeller blades mounted in a cross-flow fan (prototype II or MSU Air Curtain sprayer), see Fig. 1-4. This system was mounted at the boot where the cleaning bed empties onto the piling boom and was used for the MSU phase and the Sackett Ranch and Wayne J. Lennard & Sons commercial phase of the project.

The second system used a heavy duty shroud/mounting with a Micronair AU 7000 with propeller (prototype III). This system was located at the junction between the stationary and telescoping boom conveyors on Sandyland Farms Lockwood bin piler. This system was used for the MSU phase and for Sandyland Farms part in the commercial phase of the project. Both systems used stacked peristaltic pumps for metering the chemicals. All of the components used in the 1984 chemical application systems were powered by a 120v source.

Chemical Solution/Treatments

The chemical solution used in 1984 consisted of a fungicide, bactericide, and a chemical carrier. The MSU phase consisted of checks and chemical treatments with a total solution rate of 2.6 oz/ton. This 2.6 oz rate consisted of 0.42 oz of Mertect 340F and 2.18 oz of chemical carrier (water or soybean oil with 5% Rohm Hass food grade emulsifier). Chlorine dioxide was added at 200 ppm to control bacterial soft rot.

The commercial phase treatments at Sandyland Farms and Sackett Ranch consisted of check and 2.6 oz/ton (water carrier chemical treatments). Chlorine dioxide was added at 200 ppm to control bacterial soft rot. Prototype II was used at Sackett Ranch and prototype III was used at Sandyland Farms.

The total solution rate used at Wayne J. Lennard & Sons was 3.4 oz/ton. This solution consisted of 0.42 oz/ton of Mertect 340F and 2.98 oz/ton of water. Chlorine dioxide was also added at the rate of 200 ppm to control bacterial soft rot. Prototype II was used to apply the above treatment.

Table 1, page 7 (MSU Atlantic); Table 2, page 8 (MSU Monona); and Table 3, page 8 (commercial treatments) give a detailed description of the treatments used in this project.

Storage Environment

Immediately after treatment, bagging, tagging, etc., samples[1] of the Atlantic and Monona potatoes were placed in controlled environment cubicle storage on the MSU campus and in the center of a commercial potato storage at Sandyland

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[1]Samples weight approximately 25 lbs and are bagged in flat mesh plastic bags

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 these potatoes were lowered 5F/week until the desired storage temperatures of 45F and 50F were reached.

Samples stored (MSU and commercial phase) in a commercial bulk storage at Sandyland Farms received 24 hr ventilation and were lowered in storage temperature approximately 1F every 2 days until the desired storage temperature of 45F was reached. The potatoes at Sandyland Farms were stored in a 15,320 cwt uniformly ventilated storage.

Samples of the commercially produced and treated potatoes were stored in the MSU cubicles and in 1984 in the commercial bulk storage at Sackett Ranch, Inc., Stanton, MI. Samples in the MSU cubicle storage were suberized in the same manner as the Atlantic potatoes described above. The samples in the commercial storage were suberized at 55-60F with continuous ventilation for approximately 30 days. After suberization the potatoes stored at Sackett Ranch were gradually lowered to their storage temperature 45F over a 30 day period. The potatoes at Sackett Ranch Inc., were stored in a 14,000 cwt uniformly ventilated storage.

Samples of the commercial phase at Wayne J. Lennard & Sons were suberized at 60F and 24 hrs ventilation for 21 days. The potatoes were then lowered 5F/wk until the desired storage temperature of 50F was reached. Storage environment for Lennard potatoes stored in the MSU cubicles is described above.

Residue Analysis

Ten pounds of randomly selected tubers were removed from selected treatments and air shipped to New Jersey for evaluation of TBZ residue. The potato assay for thiabendazole was performed from opposite quarters of each tuber by the Ag Chem Division of the Merck Chemical Co., Rahway, NJ.

Evaluation

Bruise Analysis: A bruise analysis of the MSU grown Atlantic and Monona potatoes was performed. 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 the bruise evaluation[1]. The bruise-free percent for the 1984 MSU grown Atlantic and Monona potatoes is presented in Table 4.

Weight Loss: All bagged potato samples were weighed after treatment. The samples stored in the MSU cubicles were weighed after two weeks of suberization and at the market quality evaluation dates. Samples stored commercially were weighed upon removal from storage. Weight loss is represented by a percentage and is determined by:

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[1]Bruise evaluation includes shatter and blackspot bruise

$$\text{Weight loss \%} = \frac{Wi - We}{Wi} \times 100$$

Wi = initial weight
We = evaluation weight

Market Quality: Market quality evaluations of the potatoes in the MSU cubicles were made at various times during storage. Market quality evaluation of the commercially stored potatoes were made upon the removal of the samples from storage. These evaluations involved removal of the respective bag from storage, emptying the bag and cutting and examining each individual tuber.

Tubers were classified as follows:

A. Marketable*

This includes potatoes that have 0-5%, by weight, of dry rot

B. Non-Marketable

Dry rot	Soft rot
1. 5.1 - 10.0%	4. 0 - 5.0%
2. 10.1 - 25.0%	5. 5.1 - 10.0%
3. 25.1% and over	6. 10.1 - 25.0%
	7. 25.1% and over

*Non-storage related problems and defects (scab, nematodes, insects, sunburn, etc.)

After the potatoes were classified, the various categories of non-marketable potatoes were counted and weighed.

Market quality is represented by a percent and is determined by tuber weight and numbers. Market quality evaluation by weight and number are compared for potential variations due to potato size variations within the sample bags.

These two methods are as follows:

1. By number of tubers:

$$\text{Marketable quality (\%)} = \frac{Mn}{Tn} \times 100$$

Mn = number of marketable potatoes in each sample
Tn = total number of potatoes in each sample

2. By weight of tubers:

$$\text{Marketable quality (\%)} = \frac{Mw}{Tw} \times 100$$

Mw = weight of marketable potatoes in each sample
Tw = total weight of potatoes in each sample

RESULTS and DISCUSSION

Equipment

Two CDA[1] spray systems were used in 1984: a boom mounted Micronair AU7000 and a Micronair AU7000 fitted in a cross-flow fan and mounted at the boot between the boom and the cleaning table. Both systems used a 120v power source and stacked peristaltic pumps for metering each individual chemical.

The Micronair AU7000 unit (Prototype III with propeller fan) displayed good results. The Micronair nozzle handled the low-volume, viscous, materials with no clogging. Cleanup was fast and simple compared to the Microtec used in previous years. However, the prototype III was noisy, experienced a problem with chemical drift, and is subject to damage by operator error due to its location on the boom.

The Micronair AU7000 nozzle mounted in the cross flow fan (prototype II or MSU Air Curtain Sprayer) had several advantages over prototype III and the Microtec. First, due to its location, it is easily accessible for repairs and cleaning. The circular pattern of the CDA nozzle system is changed to a rectangular pattern, (see Fig. 4, page 13) which is more adaptable to the geometry on a bin piler conveyor. The straight stream air flow increased chemical impingement, nearly eliminated chemical drifting, and gave more consistent chemical deposition on the potatoes.

The stacked peristaltic pumps, driven by a DC motor with a 120v infinite voltage regulator, gave excellent control of the chemical application rate. The stacked peristaltic pumps allowed the chemicals to be pumped separately and directly from the commercial container. This eliminated the need for mixing and mechanical agitation of the chemical solution. Maintenance and cleanup of the pumping system was minimal. The 120v power source was not susceptible to the power fluctions as the 12v source used in previous years. All components of the power system are OEM parts and readily available.

Weight Loss

Weight loss for the 1984 Atlantic potatoes stored at 45F and 50F in the MSU cubicles is presented in Table 5, page 9. The statistical analysis showed the following:

1. A difference of 2.3% (at the 10% level of significance) between treatments 2 and 4 stored at 45F for 180 days.

2. A difference of 0.9% (at the 10% level of significance) between treatments 2 and 3 stored at 50F for 110 days.

3. A difference of 0.8% (at the 1% level of significance) between treatments 2 and 3 stored at 45F for 110 days.

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[1]Controlled Droplet Applicator

Market Quality

The market quality of the treated Atlantic potatoes stored at 45F and 50F in the MSU cubicles is presented in Table 6, page 9.

A statistical analysis of the 1984 Atlantic potatoes stored at 45F and 50F in the MSU cubicles showed the following results:

For Atlantic potatoes stored at 45F for 112 days there was a difference of 6.3% (2.5% level of significance) between treatments 2 (check) and 3 (treated, water carrier). There was also a difference of 6.8% (2.5% level of significance) between treatments 2 (check) and 4 (treated, soybean oil carrier).

For Atlantic potatoes stored at 45F for 187 days there was a difference of 10.9% (0.5% level of significance) between treatments 2 and 4. There was also a difference of 6.9% (20% level of significance) between treatments 3 and 4.

For Atlantic potatoes stored at 50F for 187 days there was a significant difference of 4.7% (15% level of significance) between treatments 2 and 3. There was also a difference of 6.6% (10% level of significance) between treatments 2 and 4.

The market quality data from the Atlantics suggest that a very significant increase in market quality will be obtained by treating the potatoes. The data also suggests an additional increase in market quality when an emulsified soybean oil is used as a chemical carrier.

The market quality and residue analysis of the Monona potatoes stored at 45F at Sandyland Farms is presented in Table 7, page 10.

A statistical analysis on the 1984 Monona potatoes showed a difference of 2.9% (10% level of significance) between treatments 2 (check, bruised) and 3 (treated, prototype II, water carrier). The analysis also showed a difference of 3% (20% level of significance) between treatments 1 and 2.

The market quality of the Monona potatoes treated in Sandyland Farms commercial phase is shown in Table 8, page 10. While statistical analysis show no significant difference, it is important to point out that treatment 2 had bruise levels 2.2% higher than treatment 1.

Table 9 presents the data for the low volume commercial prestorage treatment at Sackett Ranch, Inc., Stanton, MI. No significant difference was found for the potatoes stored at Sackett Ranch due to the large variability in the samples. However, the average suggest an improvement in market quality with chemical treating.

The market quality for the potatoes treated in the commercial phase at Wayne J. Lennard & Sons is shown in Table 10.

The statistical analysis showed no significant difference between the treatments, but confirms that market quality of high quality potatoes is not improved by prestorage chemical treatments.

CONCLUSIONS

The following conclusions can be drawn from this study:

1. The Micronair CDA nozzle is better suited to handle the solution used in this study than the spinning disk or rotary cup atomizers used in past studies.
2. For metering the chemical, peristaltic or "squeeze" pumps are superior to the diaphragm pump-orifice combination used in previous years.
3. The results suggest that using soybean oil as a chemical carrier may improve market quality.
4. Market quality of the potatoes can be improved from 0-11.4% using the MSU Air Curtain sprayer and low volume chemical solutions. Since the cost of the chemicals used is less than $0.02/cwt ($0.20/metric ton), only a small increase in market quality is necessary to cover application costs and provide a return for the producer.

ACKNOWLEDGEMENTS

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1. Michigan Potato Industry Commission, East Lansing, MI
2. Merck & Co. Chemical Corp., Ag Chemical Division, Rahway, NJ
3. Soybean Promotion Committee of Michigan, East Lansing, MI
4. Sackett Ranch, Edmore, MI
5. Sandyland Farms, Howard City, MI
6. Wayne J. Lennard and Sons, Samaria, MI
7. Ore-Ida Foods, Greenville, MI

Table 1. Prestorage Chemical and Mechanical Treatments of 1984 MSU Grown Atlantic Potatoes.

Treatment	Mechanical handling	Chemical applied[1] per ton (2000 lbs)
1	Plot harvester	None (check)
2	Plot harvester and bin piler	None (check)
3	Plot harvester and bin piler	0.42 oz Mertect 340-F 2.1 oz water[2]
4.	Plot harvester and bin piler	0.42 oz Mertect 340-F 2.1 oz emulsified soybean oil[3]

[1]The chemicals were all applied with the MSU Prototype II, see Equipment under PROCEDURE, page 2.
[2]Also contains 200 ppm of chlorine dioxide
[3]Contains 5% Rohm Haas food grade emulsifier and 200 ppm of chlorine dioxide

Table 2. Chemical and Mechanical Treatments of the 1984 MSU Grown Monona Potatoes.

Treat-ment	Mechanical handling	Chemical application system[1]	Chemical applied per ton (2000) lbs
1	Plot harvester	None	None
2	Plot harvester and bin piler	None	None
3	Plot harvester and bin piler	Prototype II[4]	0.42 oz Mertect 340-F 2.1 oz water[2]
4	Plot harvester	Prototype III	Same as Treatment 3
5	Plot harvester and bin piler	Prototype II	0.42 oz Mertect 340-F 2.1 oz emulsified soybean oil[3]
6	Plot harvester and bin piler	Prototype III	Same as Treatment 5

[1]See Equipment under PROCEDURE, page 2
[2]Also contains 200 ppm of chlorine dioxide
[3]Contains 5% Rhom Haas food grade emulsifier and 200 ppm of chlorine dioxide
[4]Prototype II is also referred to as the MSU Air Curtain Sprayer

Table 3. Prestorage Chemical Treatment used on 1984 Commercially Produced[1] and Handled Monona Potatoes.

Treatment	Chemical Applied[2] per ton (2000) lbs.
1	None (check)
2	0.42 oz Mertect 340F, 2.1 (2.98)[3] oz water[4]

[1]Sackett Ranch Inc., Stanton, MI; Sandyland Farms, Howard City, MI, Wayne J. Lennard & Sons, Samaria, MI.
[2]Chemical applied with Prototype II at Sackett Ranch and Wayne J. Lennard & Sons, Samaria, MI, and prototype III at Sandyland Farms
[3]Water volume used at Wayne J. Lennard & Sons
[4]Also contains 200 ppm of chlorine dioxide

Table 4. Bruise-Free Percentage of the 1984 MSU Grown Atlantic and Monona and Sandyland Grown Monona Potatoes at Various Stages in the Mechanical Handling System[1]

Variety	Samples location	Bruise-free percentage
Atlantic	Plot harvester	86.5%
Atlantic	After bin piler	82.6%
Monona	Plot harvester	92.4%
Monona	After bin piler	87.7%
Monona	Sandyland harvester	82.4%
Monona	Sandyland after bin piler	80.2%

[1]Bruise evaluations were performed by Ore-Ida Inc., Greenville, MI and includes both shatter and blackspot bruise

Table 5. Weight Loss for the 1984 Atlantic Potatoes Stored at 45F (7.72C) and 50F (10.0C) and 95% r.h. at the MSU Cubicles.

Treatment[1]	Storage Duration and Temperature			
	110 days		180 days	
	45F (7.2C)	50F (10.0C)	45F (7.2C)	50F (10.0)
2	5.38	4.16	9.10	9.87
3	4.56	3.27	7.45	7.82
4	4.94	3.82	6.78	9.32

[1]See Table 1 for a detailed description of the treatment

Table 6. Market Quality (% Marketable by Weight) for the 1984 Atlantic Potatoes Stored at 45F and 50F and 95% r.h. in the MSU Cubicles.

Treatment[1]	Storage Duration and Temperature			
	112 days		187 days	
	45F (7.2C)	50F (10.0C)	45F (7.2C)	50F (10.0)
2	86.7	91.5	79.7	73.6
3	93.0	92.4	83.7	78.3
4	93.5	93.2	90.6	80.2

[1]See Table 1 for a detailed description of the treatments

Table 7. Market Quality (% Marketable by Weight) and Chemical Residue for 1984 MSU Monona Potatoes Stored at 45F for 175 Days at Sandyland Farms Commercial Bulk Storages.

Treatment[1]	Market Quality	Chemical residue (ppm)
1	97.2	-
2	94.2	-
3	97.1	2.74 - 3.27
4	96.2	2.78 - 4.17
5	96.7	1.38 - 5.51
6	96.8	1.52 - 3.15

[1]See Table 2, page 8 for a detailed description of the treatment

Table 8. Market Quality (% by Weight) for Sandyland Farms Potatoes Stored at Sandyland Farms and in the MSU Cubicles at 45F.

	Market Quality	
Treatment[1]	MSU cubicles	Sandyland Farms storage
1	89.7	94.5
2	91.9	91.2[2]

[1]See Table 3 for a detailed description of the treatments
[2]Treatment 2 had a 2.2% higher bruise level than Treatment 1.

Table 9. Market Quality (% by Weight) and Deposition for Non-treated vs Low Volume Prestorage Chemically Treated Monona Potatoes (1984) stored at Sackett Ranch.

Treatment[1]	Market quality (% by weight)	Deposition ppm
1	81.8	-
2	88.5[2]	2.14-2.78

[1]See Table 3 for a detailed description of the treatments
[2]This market quality improvement represents approximately 1000 cwt more marketable potatoes from this bulk bin. At $6/cwt it represents $6000 and a chemical cost of approximately $280.

Table 10. Market Quality (% by Weight) for Potatoes Grown and Stored by Wayne J. Lennard and Sons and Stored in the MSU Cubicles.

Treatment[1]	Market Quality	
	MSU cubicles	Lennards storage
1	97.5	93.8
2[2]	95.9	90.3

[1]See Table 3 for a detailed description of the treatments
[2]Treatment 2 had bruise levels that were higher than Treatment 1.

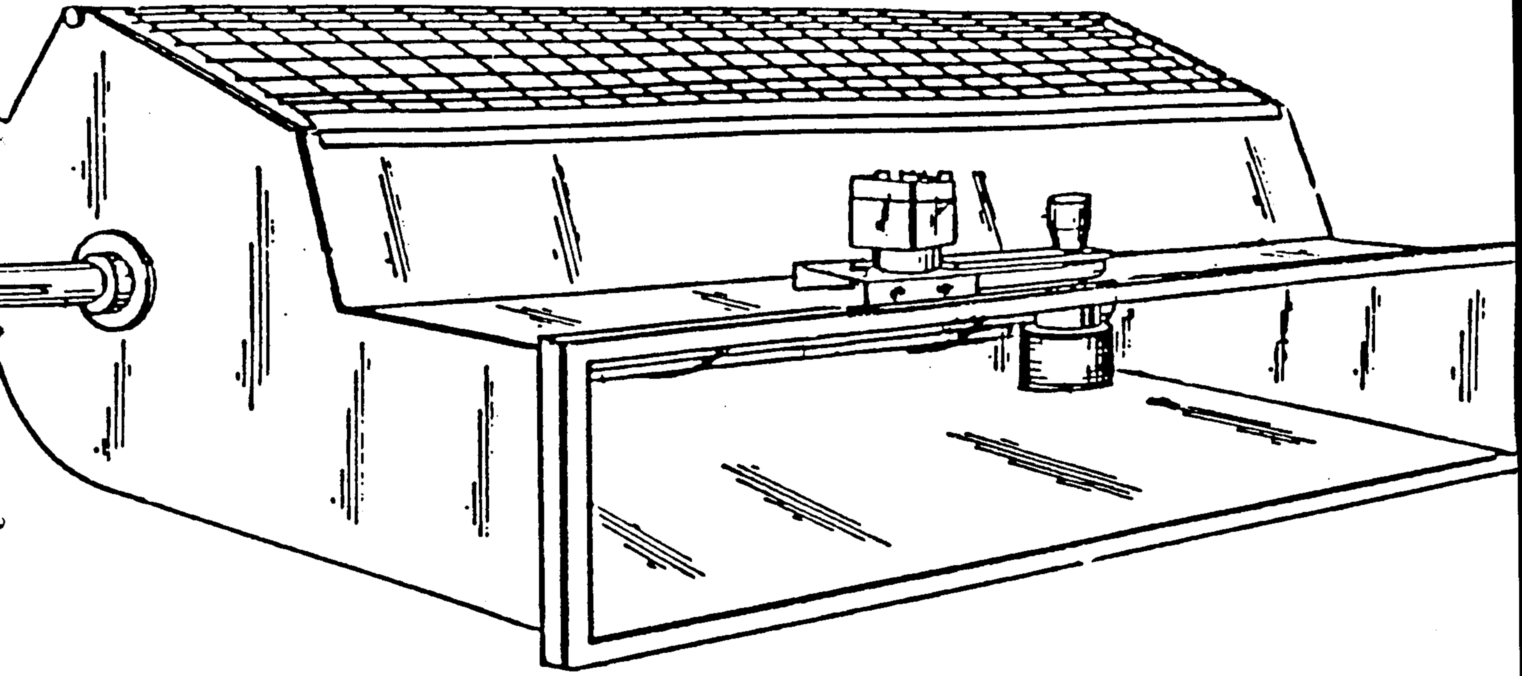

Fig 1. Overall Schematic of Prototype II (MSU Air Curtain Sprayer) used in the 1984 Chemical Application Research

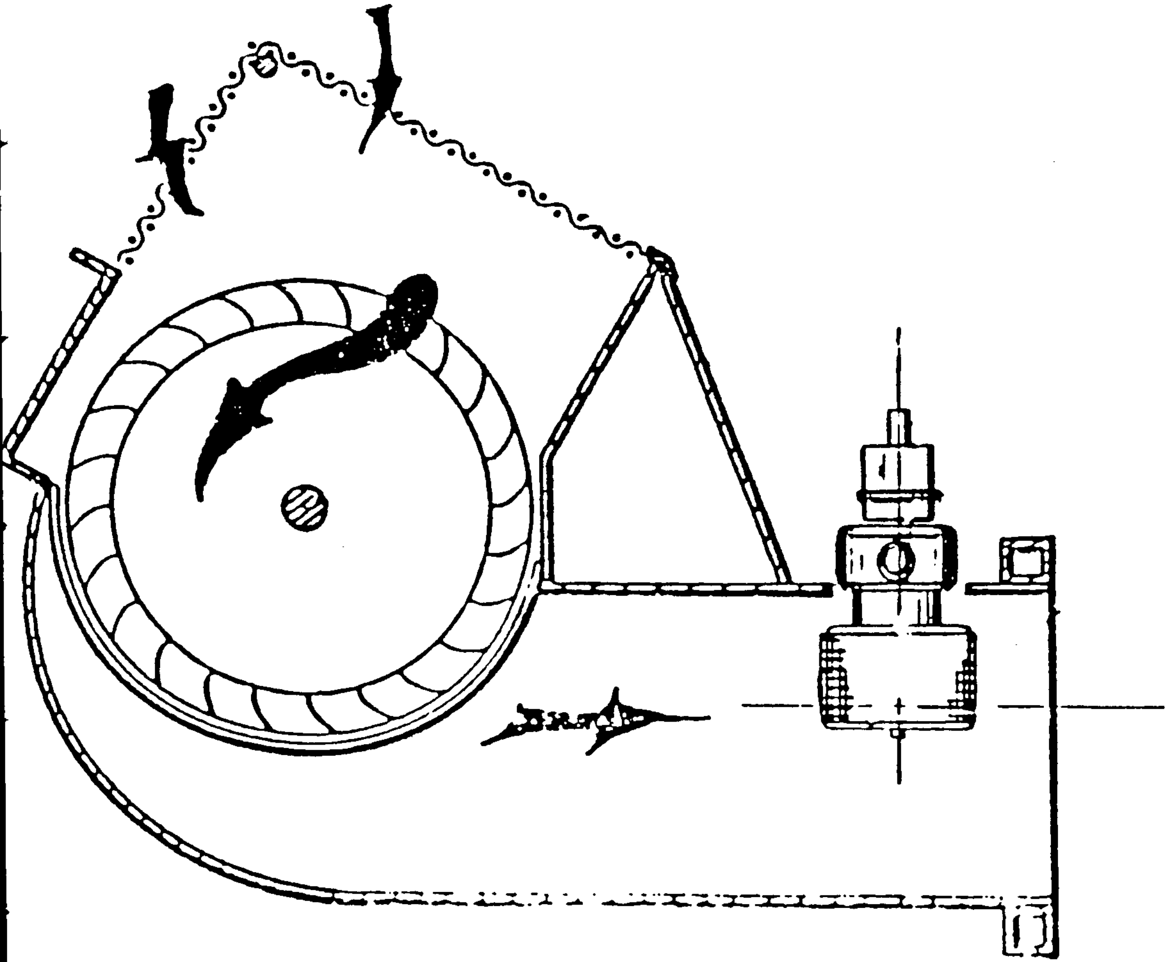

Fig. 2. Side View of the Prototype II Used in the 1984 Chemical Application Research

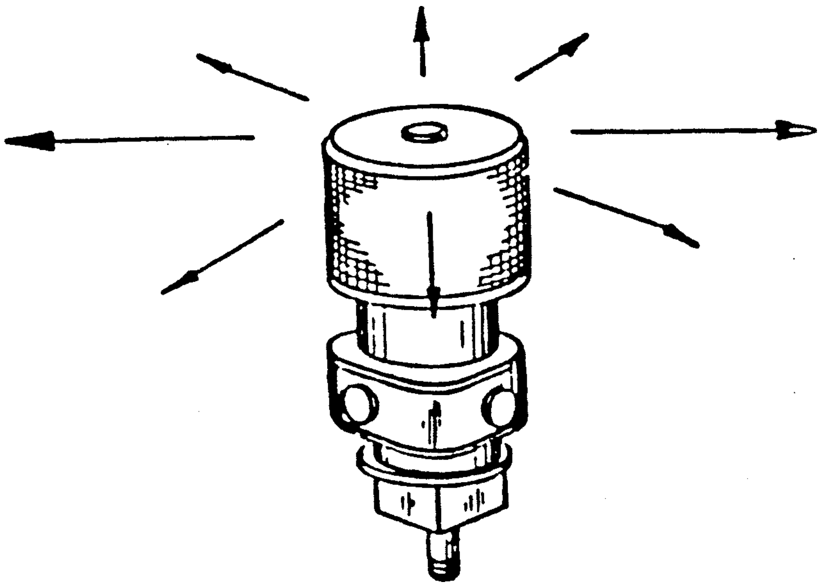

Fig. 3. Schematic of the Micronair AU 7000 Applicator Used in Prototype II and III in the 1984 Chemical Application Research

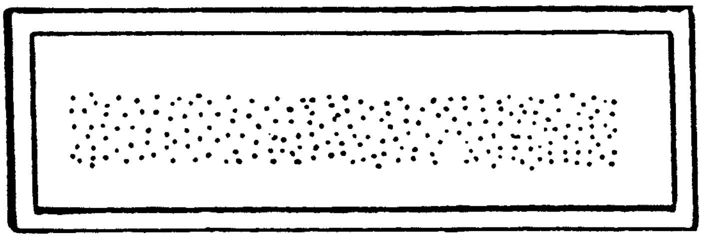

Fig. 4. Schematic (plan view) of the Spray Pattern of the Prototype II

THE EFFECT OF FIELD PRODUCTION TREATMENTS ON THE MARKET QUALITY AND STORABILITY OF POTATOES (1984 INTEGRATED PROJECT)

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INTRODUCTION

This report contains data on the effects of various 1984 field production treatments on the quality of MSU grown Atlantic potatoes out of extended storage (1984-85).

PROCEDURE

Potato Samples

For the storage phase of the 1984 integrated project, Atlantic potatoes were grown under controlled conditions at the Michigan State University Potato Research Farm at Entrican, Michigan. These potatoes were harvested with the one-row MSU research harvester on September 19 and 20, 1984.

Treatments

Six field production treatments were used in this phase of the integrated project, comparing the use of a soil fumigant, Vorlex, with a check, and the usage of foliar fertilizers. Treatments 1 through 3 received no Vorlex, and the fertilization was as follows: 1) check, 2) nitrogen, 3) nitrogen, phosphorus, and potassium. Treatments 4 through 6 received fertilizer applications similar to those described above, but also had an application of Vorlex. Each treatment received starter fertilizer, and an additional nitrogen application (see Table 1).

Table 1. Field Production Treatments for the Atlantic Potatoes used in the Storage Phase of the 1984 Integrated Project

Treatment[1] number	Fumigate treatment	Fertilizer treatment[2]
1	None	None
2	None	Nitrogen
3	None	N-P-K[3]
4	Vorlex	None
5	Vorlex	Nitrogen
6	Vorlex	N-P-K

[1]For a detailed discussion of the field production treatments used in this study refer to the 1985 MSU Montcalm Potato Research Report
[2]All treatments received 110 lbs/A of nitrogen
[3]Nitrogen, phosphorus, potassium

Storage Environment

After harvest all potato samples were bagged, tagged and placed into controlled environment cubicles on the MSU campus. The potatoes were suberized at 60F and 95% r.h. for one week and 55F and 95% r.h. for a second week. Following suberization the temperature was dropped in the cubicles 5F/wk until the desired storage environment of 40F and 95% r.h. was attained.

Evaluation

Weight loss: All bagged samples were weighed at harvest, after two weeks suberization and after 110 and 181 days in storage. The weight loss during storage is represented by a percent using the following equation:

$$\text{Weight Loss (\%)} = \frac{Wi - We}{Wi} \times 100$$

Wi = harvest weight
We = evaluation weight

The weight loss factor (WLF) is the weight loss percent per day and is found by:

$$WLF = \frac{\text{Weight loss (\%)}}{\text{Number of days in storage}}$$

This factor is an important "marketing tool" for the grower. The WLF can be used to help the grower determine the economics of when to market potatoes based only on the loss of weight during storage. Other factors such as loss in quality, market price, and storage operation costs influence when to market potatoes.

Market quality: Market quality evaluations were made after 110 and 181 days in storage. Market quality evaluations involved removing the respective bagged samples from storage, examining each individual tuber, and classifying them as follows:

A. Marketable

This includes potatoes that have 0-5%, by weight, of dry rot

B. Non-marketable

Dry rot	Soft rot
1. 5.1 - 10.0%	4. 0 - 5.0%
2. 10.1 - 25.0%	5. 5.1 - 10.0%
3. 25.1% and over	6. 10.1 - 25.0%
	7. 25.1% and over

8. Non-storage related problems and defects (scab, nematodes, insects, sunburn, etc.)

After potato classification, the non-marketable potatoes were counted and weighed.

Market quality is a percentage of the total sample and is determined by two methods:

1. By number of tubers: $\text{Market quality (\%)} = \frac{Mn}{Tn} \times 100$

Mn = number of marketable potatoes in each sample
Tn - total number of potatoes in each sample

2. By weight of tubers: Market quality (%) = $\frac{Mw}{Tw}$ x 100

Mw = weight of marketable potatoes in each sample
Tw = total weight of each sample

RESULTS AND DISCUSSION

Weight Loss

Table 2 shows the weight loss data for the Atlantic potatoes for the storage phase of the 1984 integrated project.

Table 2. Weight Loss Percentage for Atlantic Potatoes of the 1984 Integrated Project stored at 40F and 95% r.h.

	Days in storage					
	15		110		181	
Treatment[1]	% Weight loss[3]	WLF[2]	% Weight loss	WLF	% Weight loss	WLF
1	1.6	.113	4.1	.038	7.3	.041
2	2.2	.149	4.9	.045	7.8	.043
3	1.6	.112	4.5	.041	7.5	.042
Ave	1.8	.125	4.5	.041	7.5	.042
4	2.1	.141	4.4	.040	7.4	.041
5	2.1	.142	5.3	.049	7.9	.044
6	1.7	.117	4.5	.042	7.4	.041
Ave	1.9	.133	4.7	.043	7.5	.042

[1]See Table 1 for a detailed description of the field treatments
[2]Weight loss factor is percent weight lost per day
[3]% by weight

A statistical analysis of the data compiled in Table 2 (at 110 day storage duration) indicated the following: 1) there was an 0.8% difference at the 5% level of significance between treatments 1 (no fumigant or fertilizer) and 2 (no fumigant and nitrogen), 2) a 0.4% difference at the 10% level of significance between treatments 1 and 3 (no fumigant but NPK) was found, 3) there was also a difference of 0.9% at the 5% level of significance between treatments 4 (fumigant and no fertilizer) and 5 (fumigant plus nitrogen).

Market Quality

The market quality data (% by weight) of the Atlantic potatoes in the 1984 integrated project is shown in Table 3.

Table 3. Market Quality (% by Weight) of MSU Grown Atlantic Potatoes Stored at 40F and 95% r.h. for 110 and 181 Days.

Treatment[1]	Days in storage 110	181
1	93.1	91.9
2	89.8	91.3
3	93.3	89.6
Ave	92.0	90.9
4	92.6	96.0
5	91.7	91.5
6	89.3	93.0
Ave	91.2	93.5

[1]See Table 1 for a detailed description of the field treatments

A statistical analysis of the data compiled in Table 3 had the following results: 1) a 3.3% difference was found at the 25% level of significance between treatments 1 and 2 after 110 days of storage, 2) a difference of 3.5% at the 10% level of significance was found between treatments 2 and 3 after 110 storage days, 3) there was also a difference of 4.5% at the 1% level of significance found between treatments 4 and 5 after 181 days of storage.

CONCLUSIONS

The data suggests that the non-fertilized or check treatments have a slightly better storability than the fertilized treatments. However, past research has not shown a significance between these types of treatments.

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