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R.W. Chase

1982 MONTCALM FARM RESEARCH REPORT

MICHIGAN STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

IN COOPERATION WITH

THE MICHIGAN POTATO INDUSTRY COMMISSION

THE MICHIGAN POTATO INDUSTRY COMMISSION

To Michigan Potato Growers and Shippers:

This Potato Research Report is the result of the research that was carried on by Michigan State University at the Montcalm Research Farm, Entrican, Michigan as well as other potato research projects conducted during 1982.

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.

Sincerely,

Ray Kaschyk

R. H. Kaschyk
Executive Director

RHK:kk

enclosure

THE MICHIGAN POTATO INDUSTRY COMMISSION • 500 N. HOMER STREET • LANSING, MICHIGAN 48912 • (517) 373-3783

ACKNOWLEDGEMENTS

Research personnel working at the Montcalm Branch Experiment Station have received considerable assistance in various ways. The Michigan Potato Industry Commission has granted substantial research dollars to support many of the projects included in this report. A special thanks is given to the MPIC, private companies, and government agencies who have made this research possible. Many contributions in the way of fertilizers, chemicals, seed, equipment, technical assistance, personal services and monetary grants were also received and are hereby gratefully acknowledged. Contributions of Russet Burbank seed and the processing of samples for bruise determinations were provided by Ore-Ida Foods, Inc. and we gratefully acknowledge their continued support of MSU potato research.

Recognition is also given to Mr. Theron Comden for his dedicated cooperation and assistance in many of the day-to-day operations.

Special acknowledgement is also given to Mr. Art Wells, and Dr. Norm Thompson, both of who retired from MSU at the end of 1982. Art and Norm have a long history of working with MSU and the Michigan potato industry. They both will leave a real void in our MSU potato research team.

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1982 POTATO RESEARCH REPORT

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INTRODUCTION

The Montcalm Branch Experiment Station was established in 1967. This report marks the completion of 16 years of studies at this facility. This report is designed to summarize all of the research conducted at the Montcalm Research Farm during 1982 plus the potato research conducted at other locations. Much of the data herein reported represents projects in various stages of progress, so results and interpretations may not be final. RESULTS PRESENTED HERE SHOULD BE TREATED AS A PROGRESS REPORT ONLY as data from repeated trials are necessary before definite conclusions and recommendations can be made.

WEATHER

Tables 1 and 2 summarize the fifteen year temperature and rainfall data recorded at the Research Farm. Temperatures during 1982 were generally cooler than the 15 year average, particularly in June, August and September. Rainfall was approximately two inches above average and was reasonably well spaced throughout the growing season with monthly totals, except for August, above normal.

The irrigation system was also modified with solid set sprinklers spaced 30' X 30' to provide more uniform coverage. Irrigation applications of approximately one inch each were made 9 times on July 5, 8, 14, 24, Aug. 2, 9, 16, 20, and 24. Overall yields and quality were the best which have been obtained at the Research Farm and it may be the combination of cooler temperatures, above average rainfall and improved irrigation coverage which contributed to these favorable yield results.

SOIL TESTS

Soil test results for the general plot area were:

pH	P	K	Ca	Mg
6.2	445	216	960	203

FERTILIZERS USED

Except for the specific fertility studies where the fertilizers are specified in the report, the following fertilizers were used on the potato plot area:

previous crop - corn		
plow down	0-0-60	200 lbs/A
banded at planting	20-10-10	500 lbs/A
sidedress at hilling	46-0-0	150 lbs/A

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
1968	61	37	62	41	74	53	80	55	81	58	74	50	73	50
1969	56	35	67	43	70	50	80	59	82	56	73	49	74	49
1970	54	35	65	47	72	55	80	60	80	57	70	51	73	45
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
15-yr. avg.	54	33	67	43	74	52	81	57	79	55	71	49	72	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
1968	2.84	4.90	3.74	1.23	1.31	3.30	17.32
1969	3.33	3.65	6.18	2.63	1.79	0.58	18.16
1970	2.42	4.09	4.62	3.67	6.54	7.18	28.52
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
15-yr. avg.	2.64	2.84	3.88	2.42	4.22	3.36	19.36

HERBICIDES

Early preemergence alachlor (Lasso) at 2 1/2 lbs/A followed by a delayed preemergence application of metribuzin (Sencor) at 1/2 lb/A.

DISEASE AND INSECT CONTROL

Temik was applied at planting at 3 lbs/A. The foliar fungicide program was initiated on June 26 with Brevo. Insecticides used were Thiodan, Monitor and Pydrin.

On September 18, Diquat at 1 pint/A plus X77 at 8 ounces per 100 gal was applied as a topkiller.

Introduction of New Varieties into Michigan

R.W. Chase, R.B. Kitchen, N.R. Thompson, R. Hammerschmidt, Dennis Greenman

Some 22 named varieties, 14 selections from the MSU potato breeding program, 11 selections from the USDA-Beltsville program and 6 miscellaneous numbered selections were planted at the W.J. Lennard Farm in Levering. Ten varieties have originated from the virus free program of Dr. Bud Wright at British Columbia and these include Jemseg, Yukon Gold, Superior, Ontario, Katahdin, Atlantic, Denali, Onaway, Snowchip and Russet Burbank.

Prior to the field planting, mother plants of Denali, Atlantic, Onaway, Jemseg, Katahdin, Russet Burbank and Snowchip were greenhouse grown and tested for PVX, PVY and PVST and all were found to be free of these viruses. Cuttings of the tested mother plants were made and small seed tubers were produced and stored. Timing of the greenhouse tuber production was too late to allow any field planting in 1982. The procedure however did allow for a random testing of these seed stocks and also to establish a mechanism for the processing of mother plants, stem cuttings and subsequent tuber production. This procedure could serve as a model for developing an ongoing virus testing and stem cutting program as a part of the Michigan seed certification program.

All of the introduction selections were included in yield test plots as outlined in the Variety Evaluation report. Yield and performance data obtained from such plantings are used to determine the continuation of the selections in the program.

Each selection was also planted in a replicated plot to assess their relative susceptibility to scab. These evaluations plus a determination of their ability to suberize and their susceptibility to Fusariun dry rot were conducted by Dr. Hammerschmidt. These data will add considerably to the total variety introduction and evaluation program.

Requests of seed by seed growers of B8971-2 , (GoldRus), Onaway, Chipbelle Atlantic, Jemseg, Rideau, Snowchip and Yukon Gold were distributed for 1982 plantings.

A significant expansion of the variety evaluation and introduction program will be initiated in 1983. Some 65 selections from the USDA-Beltsville program consisting of both whites and russets will be screened for adaptability to Michigan. The most promising selections will then be added to the new seed introduction program. A similar program was initiated in 1982 for selections from the USDA-Aberdeen program in cooperation with Ore-Ida Foods.

1982 POTATO VARIETY EVALUATIONS

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A. DATES OF HARVEST

The 1982 dates-of-harvest study was conducted at the Montcalm Research Farm. Three complete plantings of all varieties were made on May 3 in replicated plots 10 feet X 34 inches. Plant spacings were 12 inches.

Harvests of each planting were made August 9, August 30 and September 22, respectively. The previous crop was corn and 250 lbs/A of 0-0-60 were plowed down, 500 lbs/A of 20-10-10 were applied with the planter and two sidedress applications of 46-0-0 at 160 lbs/A each were applied in June prior to hilling. Aldicarb (Temik 15G) was applied at 20 lbs/A at planting. Alachlor (Lasso) was applied at early pre-emergence at 3 lbs/A and metribuzin (Sencor) at 1/2 lb/A at delayed pre-emergence. The plots were irrigated and a foliar insecticide and fungicide were applied as needed.

Results: Table 1 summarizes the yields, specific gravity and chipping quality of the several varieties evaluated at each harvest. Yields were above the average of previous years which reflects a very desirable growing season and a new and more uniform sprinkler irrigation system. Average yields and specific gravity increased with the later harvests however certain varieties reached their optimum yields before the third harvest.

Table 2 summarizes the internal defects and percent size distribution of each variety. Generally speaking, the incidence of internal defects, except for vascular discolorations, was very minimal. Brown center was noted in six varieties and hollow heart in only two seedlings. The vascular discolorations were only slight and would not be considered severe enough to be of any economic concern.

The percent size distribution data was taken from the third harvest and provides evidence as to the potential concern for oversized tuber development. Varieties which produced a high percentage of tubers over 3 1/4 inch would likely perform better at a closer spacing than the 12 inch spacing used in these trials. Varieties with a high percentage of tubers over 3 1/4 inch were G 670-11, Atlantic, Shepody, Rideau, Monona, Katahdin and Lemhi.

Table 2 also summarizes the determinations of bruise susceptability. Approximately twenty five pound samples of each variety were collected from the August 29 and September 22 harvests. The samples were held for at least one week and were then processed by the Ore-Ida Foods, Inc. inspection line. Tubers with and without black spot damage were counted and the percent bruise-free was then determined.

Although black spot damage may occur on any tuber it is oftentimes most prevelent on the large tubers and the stem end is usually the most vulnerable. Overall the bruise damage was greater from the third harvest as compared to the second harvest. Lower pulp temperatures in late September may have contributed to this reaction. The relative values of one variety compared to another is still valid inasmuch as all samples were handled in the same manner.

Variety Observations:

Onaway included as a reference variety. Yielded well above average.

Crystal high yield of bright tubers. Appears susceptible to scab, particularly pitted scab which can be severe. An elongated potato which matures in mid-August. Would not suggest as a storage potato but could fit as a tablestock variety to follow Onaway for marketing out of the field.

Rosa a recent golden nematode resistant vareity released by New York. Medium-late maturity and tubers have red splashes on skin. Reported to have early blight resistance however, early blight was observed in foliage. Appears suitable for chipping.

Lemhi performed exceptionally well in 1982 with very high yields and good tuber type. Internal defects were minimal however in previous years hollow heart has been a serious problem. It also is very susceptible to black spot injury as evidenced by the low percentage of bruise free tubers. Specific gravity was very high but did decrease between the second and third harvest.

Atlantic yields were above average with high specific gravity and excellent chip quality. The bruising data suggests it to be susceptible to black spot injury.

Shepody a recent release from New Brunswick, Canada. A long, smooth, white tuber which seems suitable for frozen processing. Yields were well above average with higher specific gravity than Russet Burbank. Appears med-late in maturity and specific gravity did decrease with delayed harvest. Bruise susceptibility was comparable to Russet Burbank.

Katahdin included as a reference variety with exceptionally good yields.

C-13 a selection from the Campbell Soup Company which is an early maturing, attractive round white variety. It has good specific gravity and does chip out of the field.

B7805-1 an early maturing round white selection from the USDA-Beltsville. Yields have been below Onaway, however specific gravity and chip quality is slightly better.

Russet Burbank produced excellent yields and specific gravity. Appeared to set heavier than normal and tuber type was very good with a much lower percentage of off type tubers.

B7154-10 an oblong, early maturing USDA-Beltsville selection. Lower specific gravity than Onaway but does chip out of the field.

Chipbelle an oblong variety recently released from USDA-Beltsville. Exceptionally high specific gravity with excellent chip quality. Yields above average, however it may have some susceptibility to blackspot damage.

CA027 is a late maturing selection from Maine. Yields have been well above average at the late harvests and specific gravity is high and very good chip quality out of the field. Appeared to have some resistance to blackspot damage.

Yukon Gold a Canadian released golden flesh potato being marketed as "Michigan Golden Bake". Maturity is medium early and it does chip satisfactorily out of the field. Appears to have some resistance to blackspot however it does have some susceptibility to pitted scab. Eyes have a characteristic pink color.

Monona included as a check variety.

Rideau a smooth, round red variety released from Canada. Medium late maturity and a tendency to oversized tubers. Good red skin color and appears to have scab tolerance.

Jemseg an early maturing, oblong white skin variety which appears to have a small set, however tubers do size early. Yields were below average and were not comparable with Onaway.

MS402-1 an MSU seedling which is being discontinued. Early maturity however yields have not been consistently at or above average. It also appeared very susceptible to blackspot at the late harvest.

Superior included as a check variety.

B8972-1 has recently been named GoldRus and is a USDA-Beltsville release. Yields at the Research Farm have been low due to inadequate tuber sizing as evidenced by the high percentage of under 2 inch potatoes. Maturity is medium early and tubers have a light golden russet skin.

B8934-4, B8943-4 & B8833-6 are russets which have recently been deleted from the USDA-Beltsville program.

G670-11 is a high yielding round white selection from the University of Guelph in Ontario. Tubers have a light netting and a very high percentage of large tubers. It had a high percentage of tubers with blackspot and this may be related to the high percentage of large tubers. Specific gravity was very high.

Snowchip is a release from Alaska. It has a high yield potential, however it did have considerable blackspot damage.

B. *OBSERVATION TRIALS*

Five new selections from the USDA-Beltsville potato breeding program were evaluated in a 10 hill observation plot at the Montcalm Research Farm. These data are summarized as follows:

	cwt/A		Specific	Chip	After Cooking Darkening		
	Total	No. 1	Gravity	Score	0 hr.	1 hr.	24 hr.
B9540-29	424	362	1.079	2.0	1.0	1.5	2.0
B9540-53	377	262	1.075	1.5	1.5	1.5	2.0
B9540-55	431	393	1.064	2.0	1.0	1.5	1.5
B9540-62	439	385	1.073	2.0	1.5	3.0	3.5
B4553-6	470	408	1.069	3.0	1.0	1.0	1.5

Table 1. YIELD, SPECIFIC GRAVITY AND CHIP QUALITY OF SEVERAL POTATO VARIETIES HARVESTED AT 3 DIFFERENT DATES IN 1982.

	1st Aug. 9, (98 days) cwt/A				Aug. 30, (119 days) cwt/A				Sept. 22, (142 days) cwt/A			
Variety	Total	U.S. No. 1	S. G.	Chip* Score	Total	U.S. No. 1	S. G.	Chip* Score	Total	U.S. No. 1	S. G.	Chip* Score
Onaway	541	510	1.071	3.0	553	531	1.071	3.0	591	568	1.073	3.5
Crystal	535	473	1.074	2.0	645	574	1.077	1.5	641	583	1.078	2.5
Rosa	500	446	1.081	1.0	619	557	1.083	1.0	590	524	1.079	1.5
Lemhi	488	434	1.085	1.5	656	591	1.093	1.5	682	614	1.088	2.0
Atlantic	485	440	1.095	1.0	544	505	1.095	1.0	519	491	1.093	1.0
Shepody	470	445	1.088	1.5	579	548	1.092	1.5	594	521	1.087	1.5
Katahdin	455	415	1.076	2.0	581	544	1.078	1.5	630	587	1.077	2.0
C-13	451	434	1.080	1.5	451	430	1.079	1.0	482	424	1.083	1.5
B7805-1	444	427	1.077	2.0	504	460	1.075	2.0	494	451	1.078	2.5
R. Burbank	437	379	1.084	2.0	590	494	1.086	1.5	530	425	1.089	1.5
B7154-10	406	371	1.066	1.0	414	377	1.067	1.0	425	368	1.069	1.0
Chipbelle	395	354	1.099	1.0	485	444	1.101	1.0	502	445	1.102	1.0
CA027	390	346	1.086	1.0	484	444	1.091	1.0	582	542	1.096	1.5
Yukon Gold	384	363	1.082	1.5	377	360	1.085	1.5	433	398	1.084	1.5
Monona	383	354	1.070	1.0	400	379	1.072	1.0	380	339	1.073	1.5
Rideau	350	325	1.076	2.5	502	471	1.082	2.0	471	442	1.086	2.0
Jemseg	350	321	1.072	2.0	360	330	1.073	2.0	376	339	1.078	2.0
402-1	344	298	1.067	1.0	330	299	1.068	1.0	333	303	1.070	1.5
Superior	325	281	1.072	1.5	373	339	1.074	1.0	393	351	1.076	1.0
B8972-1	314	229	1.076	1.5	319	251	1.078	1.0	314	237	1.080	1.0
B8934-4	310	258	1.074	1.0	337	296	1.076	1.5	339	280	1.079	1.5
B8943-4	308	250	1.077	3.0	288	246	1.075	2.0	310	243	1.078	2.0
B8833-6	265	206	1.075	2.0	279	240	1.076	2.0	299	222	1.077	2.5
G670-11									700	668	1.097	2.0
Snowchip									625	573	1.091	1.0
Average	405	363	1.078		464	422	1.080		489	437	1.082	

*Based on 1-5 scale: 1=lightest, 5=darkest

Table 2. INTERNAL DEFECTS, PERCENT SIZE DISTRIBUTION AND BRUISING DAMAGE OF SEVERAL POTATO VARIETIES.

	Internal Defects*			Percent Size Distribution				Percent of Tubers** Bruise Free	
	Vas. Dis.	Internal Necrosis	hollow heart	Pick outs	under 2"	over 3¼	2"-3¼	Aug. 29	Sept. 22
Onaway	2sl	0	0	0	4	10	86	81.8	73.1
Crystal	2sl	3b.c.	0	2	7	5	86	87.0	68.6
Rosa	2sl	0	0	0	11	7	82	85.3	65.0
Lemhi	3sl	0	0	2	8	22	68	70.0	46.3
Atlantic	1sl	0	0	1	5	26	68	55.6	60.4
Shepody	6sl	0	0	3	10	24	63	81.8	64.6
Katahdin	3sl	1b.c.	0	0	7	22	71	69.1	55.6
C-13	1sl	0	0	0	12	13	75	93.3	48.8
B7805-1	2sl	1b.c.	0	3	6	15	76	75.0	47.2
R. Burbank	3sl	2b.c.	0	7	13	5	75	82.2	58.0
B7154-10	0	0	0	1	12	4	83	90.6	70.7
Chipbelle	6sl	0	0	0	11	6	83	69.2	29.2
CA027	10sl	2b.c.	0	1	6	13	80	95.7	76.7
Yukon Gold	4sl	0	0	1	7	15	77	84.8	78.4
Monona	3sl	0	0	3	8	22	67	77.6	64.4
Rideau	1sl	0	0	0	6	23	71	75.8	60.5
Jemseg	10	0	0	0	10	8	82	82.1	68.2
402-1	0	0	0	0	9	5	86	90.2	18.5
Superior	0	2b.c.	0	1	11	3	85	93.2	72.9
B8972-1	0	0	0	0	25	6	69	76.9	81.8
B8934-4	2sl	0	2	4	14	16	66	81.3	66.7
B8943-4	0	0	0	2	19	0	79	82.4	89.3
B8833-6	0	0	0	3	23	0	74	77.3	65.5
G670-11	0	0	1	1	4	34	61	---	24.4
Snowchip	3sl	0	0	0	8	12	80	---	36.0
								80.8	59.6

b.c. = brown center
sl = slight

* 25 tubers sampled from September 22 harvest

** samples collected from August 29 and September 22 harvests

Table 2A. The Chip Score and After Cooking Darkening of Several Potato Varieties After Three Months Storage at 53 F.[1]

	Chip Score[2]	After Cooking Darkening			Remarks
		0 hrs.	1 hr.	24 hrs.	
Onaway	4.5	1.0	3.0	3.0	dark over all
Crystal	2.0	1.0	1.5	1.5	
Rosa	1.5	1.5	3.0	3.5	very dark stem end
Lemhi	2.0	1.0	1.5	1.5	some sloughing
Atlantic	1.5	1.0	1.0	1.5	some sloughing
Shepody	2.5	1.0	1.0	1.0	some sloughing
Katahdin	2.5	1.0	1.5	2.0	
C-13	2.0	1.0	1.0	1.0	
B-7805-1	4.0	1.5	2.0	3.0	dark stem end
R. Burbank	3.0	1.0	1.0	1.0	
B7154-10	2.0	1.0	1.0	1.0	
Chipbelle	1.5	1.5	1.5	2.0	some sloughing
CA027	1.5	1.5	1.5	1.5	some sloughing
Yukon Gold	2.5	1.0	1.0	1.0	
Monona	1.0	1.0	1.5	1.5	
Rideau	2.5	1.5	3.0	3.0	very dark stem ends
Jemseg	3.0	1.0	1.0	1.5	discolored stem end
402-1	2.0	1.0	2.0	3.0	dark stem ends
Superior	2.0	1.0	2.0	2.5	dark over all
B8972-1	1.5	1.0	2.0	3.0	dark over all
B8934-4	2.0	1.0	1.0	1.5	
B8943-4	4.0	1.0	1.0	1.0	
B8833-6	3.5	1.0	1.0	1.0	very white
G670-11	2.0	1.0	1.0	1.0	some sloughing
Snowchip	2.5	1.5	2.0	2.5	some sloughing

[1]Tests conducted December 6, 1982.

[2]1-5 scale; 1=lightest; 5=darkest and not acceptable.

C. SEEDLING EVALUATION

Twelve seedlings from the MSU potato breeding program were planted May 3 in replicated plots and harvested on two dates, August 25 and September 29. Samples were collected to determine bruise susceptibility, after cooking darkening and chip quality.

Results: Yields, size distribution and specific gravity are summarized in Table 3. Overall there was no substantial yield increase between the two harvest dates suggesting that these selections are predominately in the medium-late category. The greatest change between the 2 harvest dates is shown in the percentage of tubers over 3 1/4". Table 4 summarizes the bruising, internal defects and cooking quality of these selections.

Onaway and Altantic were included as reference varieties and both yielded above the overall average and both increased substantially between the first and second harvests in the percentage of tubers over 3 1/4".

700-83 was the highest yielder on both harvest dates. Culinary quality was acceptable for both chips and aftercooking darkening. Tuber confirmation was acceptable, however some shatter bruise was noted on the September harvest.

701-22 produced average yields and very high specific gravity. It produced a high percentage of tubers over 3 1/4". It had no internal defects and culinary quality was good. Tuber type was very good at both harvests, except for a trace of growth cracks.

702-80 produced average yields of uniformly sized tubers. Culinary quality was very good with no after cooking darkening. There was some brown center noted and tuber quality was average with a medium-deep eye.

702-91 was a very high yielder. Internal defects were minimal, chip quality was acceptable however, there was a darkening of the tubers after boiling as the tubers cooled. Tuber type was rated as poor at both harvests with some pointed and pear shapped.

704-3 yielded well below average and has been discarded.

704-10 produced good yields of fairly uniform tubers and a high specific gravity. Internal defects were minimal and cooking quality was good.

704-17 had high yields and a very high percentage of tubers over 3 1/4". Tuber type was rated as poor, deep eyed and rough. It was also rated as susceptible to scab.

714-10 produced average yields. Chip quality was not acceptable after 3 months storage. Tuber conformation was acceptable at both harvests.

716-15 produced average yields with very high specific gravity. It appeared tolerant to black spot injury and chip and boiling quality was very good. Tuber type was acceptable.

718-6 had a high specific gravity and is the only selection which showed an increased yield on the second harvest. It had the highest percentage of tubers over 3 1/4" and tuber type was considered acceptable. Cooking quality was also acceptable.

718-11 and 719-38 are being discarded because of low yields.

Table 3. Yield, Size Distribution and Specific Gravity of Several MSU Seedlings at Two Harvest Dates, 1982.

Cultivar	Flesh* Color	cwt/A		Percent Size Distribution				Specific Gravity	cwt/A		Percent Size Distribution				Specific Gravity
		Total	No. 1	Pick Outs	Under 2"	Over 3 1/4"	2-3 1/4"		Total	No. 1	Pick Outs	Under 2"	Over 3 1/4"	2-3 1/4"	
Onaway	w	480	477	2	5	19	74	1.068	479	428	3	8	35	54	1.068
Atlantic	w	479	404	6	9	14	71	1.095	510	448	4	8	36	52	1.093
700-83	w	576	513	1	10	12	77	1.082	585	522	0	10	17	73	1.079
701-22	w	451	427	0	5	22	73	1.096	473	430	0	9	34	57	1.091
702-80	w	462	431	0	7	6	87	1.080	475	445	0	6	12	82	1.078
702-91	w	574	490	5	9	8	78	1.084	526	439	7	10	13	70	1.080
704-3	y	393	324	0	17	0	83	1.075	393	314	0	19	8	73	1.074
704-10	w	490	427	0	12	1	87	1.090	479	435	0	9	9	82	1.085
704-17	w	502	468	1	6	35	58	1.087	504	479	1	4	49	46	1.082
714-10	y	457	390	0	15	5	80	1.084	459	390	1	14	11	74	1.077
716-15	w	463	412	2	9	3	86	1.099	493	445	0	9	18	73	1.095
718-6	o/w	499	462	2	6	30	62	1.091	568	545	1	3	59	37	1.093
718-11	y	329	270	2	16	7	75	1.085	393	327	6	11	16	67	1.085
719-38	w	359	318	0	11	5	84	1.082	355	325	0	8	8	84	1.080
	AVERAGE	465	413					1.0856	478	427					1.0829

* w = white
y = yellow
o/w = offwhite

Table 4. The Bruising, Internal Defects and Culinary Quality of Several MSU Seedlings.

	Percent of Tubers Bruise Free [1]	Internal Defects [2]			Culinary Quality				
					Chip Score		After Cooking Darkening [3]		
		Vascular	Internal Necrosis	Hollow Heart	At Harvest	Dec. 13 [3]	0 hr.	1 hr.	24 hr.
Onaway	81.8	7 sl.	0	0	3.5	3.5	1.0	1.5	2.0
Atlantic	55.6	0	7 BC	1	1.0	1.5	1.0	1.5	1.5
700-83	81.8	0	2 BC	0	1.0	2.0	1.5	1.5	1.5
701-22	75.4	0	0	0	1.0	1.5	1.0	2.0	2.0
702-80	75.8	0	3 BC	1	1.0	1.5	1.0	1.0	1.0
702-91	82.9	2 sl 1 sev	0	0	1.0	1.5	1.5	3.0	3.0
704-3	---	0	0	0	2.0	---	---	---	---
704-10	86.5	2 sl	0	0	2.0	2.0	1.0	1.0	1.0
704-17	75.0	1 sl	0	0	1.0	2.5	1.0	3.0	3.5
714-10	84.4	0	2 JE	0	1.0	4.0	1.0	2.0	2.0
716-15	87.2	2 sl	2 BC	0	1.0	1.5	1.0	1.0	1.0
718-6	83.0	0	1 BC	1	1.0	1.5	1.0	2.0	2.0
718-11	---	2 sl	0	0	1.0	---	---	---	---
719-38	---	2 sl	0	0	1.0	---	---	---	---

(1) Approximately 25 lb sample collected from August 25 harvest

(2) 25 tubers sampled from August 25 harvest. sl = slight; sev = severe; BC = brown center; JE = jelly end rot

(3) Samples stored at 53°F since harvest

D. OVERSTATE POTATO VARIETY DEMONSTRATIONS

Overstate potato variety demonstrations were located at 6 locations in 1982. Two locations were established in Bay County in order to evaluate the early fresh market selections separately from the later maturing chipping varieties. Yields, specific gravity, planting and harvest dates are presented in Table 1.

At all locations, except in Monroe County, the seed was cut and planted with the cooperators equipment in order to incorporate the commercial handling component. The varieties for which there was only one location were included as reference or check varieties.

Yields: Generally speaking, yields were judged to be very good. As one would normally expect some varieties did better at some locations than others and this relates to the fact that most varieties respond differently to different management. Some selections, such as Jemseg, B7805-1 and Chipbelle did not consistently have good stands which seemed to be related to herbicides.

Specific gravity: Atlantic, Belchip, Chipbelle and Denali continue to have the highest dry matter. CA027, which is a later maturing, high yielding round-white also produced a med-high specific gravity.

Internal defects: Several tubers of each variety were cut at each location. Hollow heart was not a serious problem in any variety at any location. Atlantic did have hollow heart at 3 locations however it was less than 6% in the sample examined. Internal and/or heat necrosis was noted at only the Monroe location and it was most severe in Pioneer and Atlantic. There was no internal and/or heat necrosis at any other location.

A trace of brown center was noted at Presque Isle in Michimac and CA027 and at Monroe in Atlantic, Rosa and Jemseg. The brown center disorder is considered as the preliminary step in hollow heart development. Vascular discoloration appears to be the most common disorder noted, however the severe cases were limited. It was noted on Belchip, CA027, B7805-1 and Denali.

Chip quality: Chips were made from each variety at each location. Varieties which repeatedly produced the most desirable chips were Monona, Chipbelle, Atlantic, Belchip, Denali and Rosa. Jemseg and CA027 were also good but were slightly darker than the better varieties.

General comments: Scab seemed to be more apparent this year than in previous years and at the plot location in Presque Isle County it was very severe. The varieties there which exhibited the greatest tolerance were Rideau and Ontario followed by Atlantic. The other varieties had a heavy infestation and would have presented a grade problem. At other locations Denali and Rosa were the two which most frequently showed scab infestations. Jemseg is an early maturing variety which seems to have a small set however it does size well. It performed the best at the Bay and Monroe County locations with 15% of the yield with tubers over 3 1/4" at Bay and 40% over 3 1/4" at Monroe. Some growth crack was noted on Jemseg at two locations but this was not severe.

TABLE 5. The yield and specific gravity of several potato varieties planted as county demonstrations.

COUNTY:	Bay County		Monroe County		Allegan County		Presque Isle Co.		Washtenaw County		Bay County			
COOPERATOR:	Henry Mulders		W.J. Lennard & Sons		Pete Collier		Leroy & Louis Woloszyk		DuRussel Farms		Gordon Corrion			
Variety	U.S. No.1 cwt/A	Specific Gravity	U.S. No.1 cwt/A	Specific Gravity	U.S. No.1 cwt/A	Specific Gravity	U.S. No.1 cwt/A	Specific Gravity	U.S. No.1 cwt/A	Specific Gravity	U.S. No.1 cwt/A	Specific Gravity	Variety Average	
Atlantic	---	---	381	1.089	---	---	369	1.094	---	---	300	1.082	350	1.088
Jemseg	305	1.072	388	1.069	208	1.072	287	1.086	243	1.075	---	---	286	1.075
402-1	391	1.067	---	---	291	1.068	336	1.072	331	1.074	---	---	337	1.070
Crystal	302	1.076	---	---	---	---	---	---	406	1.074	---	---	354	1.075
Chipbelle	---	---	357	1.071	317	1.100	310	1.096	285	1.093	265	1.090	307	1.094
B7154-10	294	1.065	302	1.059	---	---	---	---	---	---	---	---	298	1.062
B7805-1	218	1.067	---	---	317	1.080	242	1.079	303	1.071	---	---	270	1.074
C-13	398	1.078	293	1.068	---	---	276	1.086	---	---	---	---	322	1.077
CA027	---	---	358	1.076	510	1.079	404	1.088	223	1.079	---	---	374	1.080
Denali	---	---	---	---	---	---	365	1.094	---	---	397	1.085	381	1.090
Rosa	---	---	468	1.082	356	1.075	---	---	305	1.072	387	1.084	379	1.078
Rideau	---	---	331	1.076	---	---	466	1.080	---	---	---	---	398	1.078
Monona	---	---	264	1.059	356	1.074	---	---	---	---	355	1.065	325	1.066
Belchip	---	---	---	---	406	1.089	---	---	413	1.084	423	1.087	414	1.086
B8972-1	---	---	309	1.067	---	---	---	---	---	---	---	---	309	1.067*
Yukon Gold	347	1.078	---	---	---	---	---	---	---	---	---	---	347	1.078*
Onaway	350	1.070	---	---	---	---	---	---	---	---	---	---	350	1.070*
Ontario	---	---	---	---	---	---	370	1.082	---	---	---	---	370	1.082*
Michimac	---	---	---	---	---	---	387	1.077	---	---	---	---	387	1.077*
Russette	---	---	---	---	---	---	344	1.088	---	---	---	---	344	1.088*
Average	326	1.072	345	1.074	345	1.080	346	1.085	314	1.078	354	1.082		
Planting Date	Apr. 21		May 12		May 18		May 19		May 25		May 13			
Harvest Date	July 30		Sept. 17		Oct. 4		Oct. 7		Oct. 12		Oct. 15			

* single observation only

1982 UPPER PENINSULA POTATO VARIETY EVALUATIONS

Richard Leep, Richard Chase, and Cliff Kahl

A date-of-harvest study was conducted on the Trepanier Farm in the Upper Peninsula in 1982. Two complete plantings were made for all varieties with the exception of A72685-2, which was evaluated in the second harvest date. All plots were planted on May 24, 1982 in replicated plots 20 feet by 34 inches. Plant spacings were 12 inches.

Harvests of each planting were on August 30 and October 4, respectively. The previous crop was barley which was seeded to mammoth red clover. The soil type was an Iron River loam which tested P=467, K=392, Mg=203, Ca=1813, and pH=5.9. A total of N-P_2O_5-K_2O-Mg (74-0-93-16) pounds of fertilizer was plowed down and (67-87-90-16) pounds applied in the row at planting. Temik 15G was applied at a rate of 20 lb/A at planting. Lorox was applied delayed preemergence at 1½ lbs/A. Fungicides were applied throughout the season as needed.

The results of each harvest are reported in Table 1. Most of the varieties resulted in increased yields with the later date of harvest. The following varieties did not differ significantly in yield with the later harvest and specific gravity decreased slightly: B8833-6, B8943-4, BelRus and GoldRus. Those varieties could be considered as having early marketable yields. Internal defects are noted in Table 1.

Table 1. The yield and specific gravity of several potato varieties harvested on two different dates in the Upper Peninsula - 1982.

VARIETY	AUGUST 30				OCTOBER 4				
	TOTAL CWT/A	NO. 1 CWT/A	% NO. 1	SPECIFIC GRAVITY	TOTAL CWT/A	NO. 1 CWT/A	% NO. 1	% OVER 10 OZ.	SPECIFIC GRAVITY
Atlantic	433	393	90.8	1.085	584	532	91.1	1.7	1.098
Superior	403	380	94.3	1.073	566	518	91.5	3.7	1.073
MS402-1	387	360	93.0	1.075	534	493	92.4	9.1	1.074
Chipbelle	390	339	86.9	1.089	468	436	93	5.6	1.099
Denali	362	331	91.4	1.090	551	518	94	2.5	1.096
A69657-4	312	295	94.6	1.076	482	435	90.[illegible]	6.2	1.080
B8833-6*	333	287	86.2	1.079[3]	220	209	95	8.4	1.076[3]
Russet Burbank	358	277	77.4	1.076	492	401	81.5	5.7	1.080
B8943-4	303	271	89.4	1.089[3]	308	269	86.9	5.9	1.087[3]
B8972-1 (GoldRus)	300	269	89.7	1.074[2]	312	273	87.6	3.9	1.072[2]
Lemhi	304	267	87.8	1.082[1]	454	405	89	9.6	1.079[1]
BelRus	277	260	93.9	1.080	301	268	89	5.2	1.078
A68599-1	273	248	90.8	1.073[3]	439	412	93.8	4.6	1.099[3]
Russette	253	224	88.5	1.079[1]	430	419	97	2.0	1.082[1]
Rideau	221	210	95.0	1.069	488	450	92.2	12.3	1.070
Shepody	192	184	95.8	1.075	477	386	81	36.4	1.071
B8934-4	163	143	87.7	1.075[2]	261	228	87.4	7.7	1.073[2]
A72685-2					583	514	88.2	9.5	1.082
Average	310	279	91.2	1.079	442	398	90	7.8	1.082

[1]Severe Hollow Heart

[2]Moderate Hollow Heart

[3]Little Hollow Heart

*Deer damage caused some yield reduction on October 4 harvest.

CONSERVATION TILLAGE IN POTATO PRODUCTION MANAGEMENT

R.W. Chase, R.B. Kitchen, Henry Mulders, Warren Schauer (EAA)
and Lynn Sampson (SCS)

This study has been conducted for two years at the farm of Henry Mulders of Munger. As a means of reducing wind erosion damage, which frequently occurs soon after planting and before the potatoes have fully emerged, the concept of a reduced tillage program was initiated. The objective has been to establish a winter cover crop which would provide sufficient residue and to then plant the potatoes with a minimum of spring tillage leaving the cover crop residue to prevent wind erosion.

The winter cover crops of oats, spring barley and winter rye were planted September 14, 1981. The plot area was plowed and disked prior to planting of the cover crops. The growth of any of the cover crops was poor and very little residue was present at planting time.

One half of the field was plowed and prepared for planting the conventional way on April 19, 1982. The entire area was planted on April 21 with the growers cut and treated Onaway seed. The field received 400 lbs/A of 4-10-32 plow down and 1000 lbs/A of 9-18-18-2Mn-2Zn in the planter. Aldicarb (Temik) was applied at 3 lbs/A with the planter.

The no-tillage area was planted with the MSU two-row Lockwood planter using sweeps in place of the opening disks. After planting the no-tillage area, the sweeps were removed and the opening disks were re-attached for planting the conventionally tilled area. Comparisons were also made in both plantings between conventional seed covering with and without a zero pressure press wheel.

Soil temperatures of the no tilled area at 8 inch and 4 inch depths were 44^{o} and 48^{o} F, respectively and in the area prepared conventionally, they were 40^{o} and 44^{o} F, respectively. The area which received no spring tillage was 4^{o} warmer than the tilled soil. About one week following planting the plots planted to rye were divided and treated with either paraquat at 1 1/2 pints/A + X77 at 8 ounces/100 gallons or glyphosate (Roundup) at 1 1/2 quarts/A. Both treatments provided satisfactory control of the rye.

The spring tilled area was dragged off after planting and linuron (Lorox) was applied pre-emergence. In the no-tillage area, their was no drag-off and the linuron was applied pre-emergence. Both areas were hilled in early June.

Results

Plant emergence and stands were substantially better in the area prepared and planted conventionally. Although the exact reason is unknown, it may be that the depth of seed piece placement and the depth of the sweep in relation to the planting shoe in the no-till area may have been factors. The effect of this difference is shown in the yields in Table 1. The yields from the conventional planting were over 100 cwt/A greater than the no-till area.

Table 1. The yields of Onaway potatoes grown on two tillage systems (Cwt/A)

	No-Tillage		Conventional		
	Press wheel	No press wheel	Press wheel	No press wheel	Average
barley	284	238	375	338	308
oats	244	224	354	324	286
rye	278	*	387	337	334
Average	268	231	372	333	

*plot area deleted

In terms of the difference between the individual cover crops, rye produced the best results whereas oats produced the lowest yields. Oats and spring barley were selected because they would winter-kill and there would be no need for any chemical or tillage control in the spring. The rate of growth of any winter cover crop would be dependant on the fall weather however a severe early freeze would be very harmful to oats or spring barley whereas rye would continue to grow.

Also of interest is the apparent difference between the use of a press wheel. In both the no-till and conventional area the yields obtained from the plots where the press wheel was used were greater. Earlier emergence was also noted on these plots. It was these responses which suggested that the difference in stands may have been influenced by the depth of planting and the resulting seed-soil contact. An attempt to evaluate these factors will be the objectives of the 1983 study.

Foliar Insecticide Evaluation on Potatoes

Arthur L. Wells, Dept. of Entomology

Twenty-two insecticide treatments including foliar and soil systemic materials were evaluated against the foliar insect complex on potatoes in 1982. The plots consisted of paired 50 foot rows randomized in three replications using Russet Burbank variety of seed. At the time of planting on May 6, the rows to be treated with the systemics were left open so band applications could be made in the seed furrow before covering. Space for one row was left between each plot to allow access to the plots for spraying and sampling. Recommended fertilizer, herbicide, fungicide and irrigation programs were followed during the study.

A CO_2 sprayer with 3 nozzles per row delivering 70 gallons per acre at 75 psi was used to apply the foliar insecticides. Applications were made on July 1, 13, 23, August 3 and 13. The foliar insects were sampled with an insect net on July 13, 23 and August 3 prior to the insecticide application on the corresponding days. The plots were rated on August 18 for apparent differences in insect control and plot damage. These data are presented in Tables 1-3. A vine killer was applied in early September and the plots were harvested on September 13. The potato yields, size distribution and specific gravity from the plots are presented in Table 4.

Results

The principal foliar insect in the evaluation plots was the Colorado Potato Beetle. Since this insect has become of increased importance in the Eastern United States most candidate insecticides have been selected and developed for their control. Most of the foliar materials especially the synthetic pyrethroids and Monitor were effective in controling the beetles. The insect growth regulator materials, Bay Sir 8514 and Larvadex reduced the larval counts more than the adults due to the mode of action of the materials. The soil systemics continued to show their all around effectiveness for this use on potatoes. By recording the adult and larval count separately the life cycle and periods of activity can be determined to help time sprays. The other insects were in such low population pressure that the evaluation of the materials were inconclusive.

The plot ratings (Table 3) also gave a good check on beetle control between the new materials. The systemics and the treatments receiving Monitor provided the best protection of the plots and the highest tuber yields. There appeared to be no major effect on the grade size or specific gravity of the tuber samples from the plots. It is important that the new materials be evaluated against all of the major insect pests on potatoes to determine their specificity in overall control programs.

Table 1. Potato flea beetle and potato leafhoppers control in the spray plots

	Insects per 30 sweeps							
	Potato Flea Bettle				Potato Leafhoppers			
Material & Rate/A*	July 13	July 23	Aug. 3	Total	July 13	July 23	Aug. 3	Total
Foliar Applications								
Pay Off 0.04 lb	0	9	11	20	0	0	0	0
Pay Off 0.08 lb	0	16	16	32	2	0	0	2
Pydrin 0.1 lb	0	33	38	71	4	4	2	10
Ammo 0.05 lb	0	19	19	38	0	4	1	5
Pounce 0.10 lb	0	3	13	16	5	0	0	5
Ambush 0.10 lb	0	4	17	21	0	3	0	3
FCR 1272 0.04 lb	0	17	11	28	0	0	1	1
Bay Sir W 0.50 lb	0	16	141	157	7	12	6	25
Bay Sir W 0.25 lb + Monitor .50 lb	0	16	61	77	12	14	10	36
Bay Sir F 0.50 lb	0	19	62	81	11	3	7	21
Bay Sir F 0.25 lb + Monitor 0.50 lb	0	39	38	77	5	9	10	24
Monitor 0.75 lb	0	4	12	16	0	4	3	7
SN-72129 0.05 lb	1	21	85	106	0	12	3	15
SN-72129 0.05 lb + Monitor 0.50 lb	0	12	34	46	0	20	4	24
Larvadex 0.50 lb	0	5	37	42	3	2	4	9
Larvadex 1.0 lb	0	11	75	86	6	17	0	23
Soil Systemics								
Vydate 2.0 lb	0	1	14	15	5	18	1	24
Counter 24 oz/th	0	4	3	7	2	4	3	9
BASF 263 3 lb	0	2	6	8	1	1	4	6
Temik 3 lb	0	23	21	44	1	6	1	8
Untreated --	0	14	77	91	0	2	1	3
Untreated --	0	0	41	41	2	1	12	15

*Refer to Table 4 for formulations used in the trial.

Table 2. Colorado potato beetle control in the spray plots

Material & Rate/A*	Insects per 30 Sweeps July 13 Ad	 La	 July 23 Ad	 La	 August 3 Ad	 La	Total Insects Ad	 La
Foliar								
Pay Off 0.04 lb	0	77	49	12	71	15	120	104
Pay Off 0.08	0	27	33	25	72	50	105	102
Pydrin 0.10	2	21	29	3	66	49	97	73
Ammo 0.05	1	42	9	15	54	14	64	71
Pounce 0.10	0	70	69	9	81	33	150	112
Ambush 0.10	2	149	77	91	75	24	154	264
FCR 1272 0.04	0	31	14	14	63	45	77	90
Bay Sir W 0.50	1	37	80	9	75	4	156	50
Bay Sir W 0.25 + Monitor 0.50	0	9	27	0	22	9	49	18
Bay Sir F 0.50	0	7	53	5	44	0	97	12
Bay Sir F 0.25 + Monitor 0.50	1	4	14	0	19	4	34	8
Monitor 0.75	0	121	36	7	55	49	91	177
SN-72129 0.05	0	128	33	3	53	13	86	144
SN-72129 0.05 + Monitor 0.50	0	82	11	12	36	13	47	107
Larvadex 0.50	0	122	116	39	80	17	196	178
Larvadex 1.0	1	56	29	5	47	8	77	69
Soil Systemics								
Vydate 2 lb	0	26	13	6	58	24	71	56
Counter 24 oz/th	0	32	10	4	24	7	24	43
BASF 263 3 lb	0	21	3	8	26	6	29	35
Temik 3 lb	0	0	2	0	24	2	26	2
Untreated --	1	125	101	2	74	7	176	134
Untreated --	0	82	119	33	50	15	169	130
Total of each form.	9	1269	927	302	1169	408	2095	1979
Totals	1278		1229		1577		4074	
Percent of Total	1%	99%	75%	25%	74%	26%	51%	49%

*Refer to Table 4 for formulations used in the trial.

Table 3. Predators and parasite populations in the spray plots and plot rating on August 18 nearing maturity

Material & Rate/A*	July 13	July 23	Aug. 3	Total	Plot Rating**
Foliar Applications					
Pay Off 0.04 lb	2	2	0	4	4.3
Pay Off 0.08 lb	1	2	0	3	4.0
Pydrin 0.10 lb	1	3	0	4	4.3
Ammo 0.05 lb	3	2	1	6	4.0
Pounce 0.10 lb	1	1	0	2	4.7
Ambush 0.10 lb	2	0	0	2	4.7
FCR 1272 0.04 lb	2	1	0	3	4.0
Bay Sir W 0.50 lb	5	1	1	7	5.0
Bay Sir W 0.25 lb + Monitor 0.50 lb	1	1	1	3	3.3
Bay Sir F 0.50	4	6	1	11	4.3
Bay Sir F 0.25 lb + Monitor 0.50 lb	3	2	0	5	3.3
Monitor 0.75 lb	0	0	0	0	4.0
SN-72129 0.05 lb	7	2	0	9	4.3
SN-72129 0.05 lb + Monitor 0.50 lb	2	1	1	4	3.3
Larvadex 0.50 lb	2	4	0	6	4.3
Larvadex 1.0 lb	1	1	1	3	4.3
Soil Systemics					
Vydate 2 lb	7	3	2	12	2.0
Counter 24 oz/th	2	1	1	4	4.3
BASF 263 3 lb	2	1	1	4	3.3
Temik 3 lb	2	4	0	6	2.3
Untreated --	5	2	0	7	5.0
Untreated --	3	0	0	3	5.0

*Refer to Table 4 for formulations used in the trial.

**Plot ratings made on August 18 for apparent insect damage: 1--no apparent insect damage, plots thrifty to 5--most of plants dead or nearly mature.

Table 4. Yields and specific gravity of tubers from the spray plots

Material and Formulation	Rate (ai) per A	Yield per A	Percent by Grade Size B's	A's	10oz	Off Type	Specific Gravity
Foliar Applications							
Pay Off 2.5EC	0.04 lb	377 cwt	17%	76%	3%	4%	1.087
Pay Off 2.5EC	0.08	392	18	76	1	5	1.086
Pydrin 2.4EC	0.10	404	16	76	6	3	1.090
Ammo 2.5EC	0.05	399	15	76	4	5	1.088
Pounce 3.2EC	0.10	386	19	73	3	5	1.087
Ambush 20EC	0.10	373	19	75	2	4	1.086
FCR 1272 240EC	0.04	402	16	76	4	4	1.087
Bay SIR8514 25WP	0.50	339	22	71	1	6	1.085
Bay SIR8514 25WP	0.25						
+Monitor 4L	+0.50	407	15	75	4	6	1.093
Bay SIR 8514 4F	0.50	364	18	73	3	6	1.087
Bay SIR 8514 4F	0.25						
+ Monitor 4L	+0.50	413	16	73	6	5	1.085
Monitor 4L	0.75	401	16	73	6	5	1.090
SN-72129 50WP	0.05	355	19	73	4	4	1.085
SN-72129 50WP	0.05						
+ Monitor 4L	+0.50	409	16	77	4	3	1.086
Larvadex 5SC	0.50	317	24	70	2	4	1.083
Larvadex 5SC	1.00	351	21	72	2	5	1.087
Soil Systemics							
Vydate 2L	2.0	362	18	73	1	8	1.088
Counter 15G	24oz/1000 ft	369	19	73	3	5	1.085
BASF 263 20G	3 lb	433	13	76	5	6	1.087
Temik 15G	3 lb	470	11	78	5	6	1.088
Untreated	--	350	19	76	1	4	1.087
Untreated	--	280	31	65	1	3	1.079

Etiology of Common & Deep Pitted Scab

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In the present investigation of potato scab in Michigan we are particularly interested in determining: 1) the cause(s) of deep-pitted scab, stem and stolon cankering and aerial tuber production; and 2) determining why these disorders are increasing in prevalence. The filamentous bacterium Streptomyces scabies has classically been considered the pathogen causing common and pitted potato scab, cut some recent investigators have isolated other Streptomyces species from scabby potatoes. However, other organisms also play a role. For example, Rhizoctonia solani has been suggested to be the causative agent for the condition known as russet scab and has also been shown to cause tuber pitting. In addition, both Rhizoctonia and Streptomyces have been shown to cause stem and stolon cankers and aerial tuber formation under certain conditions. Therefore, as a prelude to further studies, we have isolated a number of organisms from potato scabs and done some partial characterizations of these isolates. We have investigated several systems that might serve as bioassays for pathogenicity of isolates and we have begun preliminary expeirments with stem cankers caused by scab organisms and Rhizoctonia.

METHODS

Isolations of Streptomyces:

Tubers were washed in running water and a block containing the lesion was cut from the tuber and surface sterilized in 10% Clorox. Tissue from beneath the lesion was ground in physiological saline and plated at several dilutions on chitin agar and water agar. Bacteria in the actinomycete group, which includes Streptomyces, form distinctive colonies on these media. After four to seven days incubation, actinomycete colonies were transferred to potato dextrose agar and fresh water agar. Characteristics observed for each isolate were colony morphology, spore chain morphology, colors of substrate mass and aerial mycelia, and production of diffusing pigments on potato dextrose agar. Each isolate was also tested for pigment production on autoclaved potato disks. Isolates were stored on potato dextrose agar slants at 4°C.

Isolations of other organisms:

Although some fungal isolates were obtained from the actinomycete isolation plates, the majority came from sections across lesions which were placed on water agar and on potato dextrose agar acidified with lactic acid, which inhibits bacterial growth. Debris from deep pits was plated on water agar and on both acidified and unacidified potato dextrose agar. Sclerotia from tuber surfaces were grown out on acidified potato dextrose agar. An attempt was made to identify as many fungal isolates obtained from scab sections and pit debris as possible. Fungal isolates were stored on potato dextrose agar slants at 4°C.

Attempts to find a bioassay for pathogenicity of actinomycete and Rhizoctonia isolates:

Potato sprouts were grown from surface-sterilized seed pieces in vermiculite in a dark cabinet. Apical segments of sprouts were excised and laid on water agar plates. For tests with Rhizoctonia, four mm plugs cut from potato dextrose agar cultures of the isolate were placed next to or on the sprout. For tests with actinomycete isolates, the test plate was inoculated with the isolate prior to the addition of the excised sprout tip.

Small tubers (diameter one cm and less) produced at the base of the same sprouts used in the above experiments were excised (leaving a short length of stolon attached where possible) and placed on potato dextrose agar and water agar plates. Four mm plugs from actinomycete cultures were placed against tubers. Some tubers were wounded and the plug placed against the wound. Some seed pieces with small tubers still attached were replanted with the tuber exposed and suspensions of an actinomycete isolate were dropped on both wounded and unwounded tubers.

Researchers at Washington State University have used sugar beet seedlings as an assay of pathogenicity of isolates from potato scabs. Several modifications of their technique were tried. Sugar beet seeds were surface sterilized and placed in large test tubes on several cm of either water agar or Czapek's agar with a plug from a potato dextrose agar culture of an actinomycete isolate. Seeds were also placed on plates of these media that had been inoculated with actinomycete isolates just prior to the addition of seeds. Seeds that had been germinated in damp germination paper were placed on water agar plates containing cultures of isoltes which were already sporulating.

Stem cankers:

In a preliminary investigation of the cuase of stem cankers, seed pieces cut from diseased tubers of six varieties of potatoes and having on their surfaces various combinations of scab and *Rhizoctonia* sclerotia were planted in the greenhouse in steam sterilized soil. Three to four weeks after planting, the young plants were unpotted and examined for stem and stolon cankers.

RESULTS

Isolations of *Streptomyces*:

To date we have isolated approximately eighty actinomycetes from scabby potato tubers from four counties. Many of these may prove to be identical upon further characterization. Although there is considerable variation among the isolates, the majority have tan to brown substrate masses, produce a grey aerial mass when mature, have a spiraling spore chain, and produce a dark pigment.

Isolation of other organisms:

Rhizoctonia was fequently isolated from potato scabs. Other fungi associated with pitted scabs include several species of *Fusarium*, an *Alternaria* sp., *Colletotrichum atramentarium*, *Botrytis cinerea*, *Trichoderma* sp., and *Doratomyces microsporus*.

Pathogenicity assays:

In tests with excised potato sprout tips and *Rhizoctonia* some isolates produced cankers while some produced only sclerotia, which did not seem to damage the sprout tissue. Tests with potato sprouts and actinomycete isolates were inconclusive and will be repeated using slightly different techniques.

The tests with small tubers weer not successful because of a high degree of fungal contamination. These will also be tried again.

Pathogenicity of actinomycete isolates to sugar beet seedlings was evidenced in all variations of technique by varying degrees of necrosis of the radicle and in some cases of the entire shoot. Germination was also reduced. The reliability of this assay will be further investigated by repeated experiments and by comparison with results on potato and with results on sugar beets grown in soil.

Stem cankers:

Although the experiment with diseased seed pieces planted in the greenhouse is ongoing, first observations of the growing stems revealed formation of stem cankers on several plants. This suggests that seed borne inoculum may contribute to the development of disease symptoms. We are currently determining the relative contribution of actinomycetes and *Rhizoctonia* in the development of these symptoms.

REPRESENTATIVE ACTINOMYCETE ISOLATES FROM SCABBY POTATOS

Source	Isolate	Colony size and shape on PDA	Color of substrate mass; color of mature aerial mass.	Pigment on PDA	Pigment on potato	Spiral spore chain	Pathogenicity tests 1 not pathogenic 2 mildly pathogenic 3 markedly pathogenic
Crystal pitted scab	#33	large, conical	tan-yellow; light grey	+	+	+	3 on sugar beet 2 on potato sprout
	#43C	Small, convex	bright yellow; dark grey	-	-	-	2 on sugar beet
Monona pitted scab	M15	large, conical	very dark brown; light grey	+	+	+	2 on sugar beet
Monona surface scab	M24	large, conical	tan-yellow; light grey	+	+	+	3 on sugar beet
Atlantic pitted scab	Atl-R/P4	large, conical	tan-yellow; light grey	+	+	+	3 on sugar beet
B8943-4 pitted scab	B8943-4-P2	large, conical	tan-yellow; light grey	+	+	+	3 on sugar beet 2 on sugar beet
B8972-1 (GoldRus) pitted scab	B8972-1-P1	large, conical	tan-yellow; light grey	+	+	+	2 on sugar beet
Denali surface scab	Den-S1	small, convex	bright yellow; dark grey	-	-	-	1 on sugar beet
	Den-S7	large, conical	bright yellow; light grey	yellow	-	+	
Monona pitted scab	Mon-P2	large, conical	tan-yellow; light grey	+	+	+	2 on sugar beet
Onaway pitted scab	On-P5	large, conical	tan-yellow; light grey	+	+	+	1 on sugar beet 3 on sugar beet
Onaway raised scab	On-R3	large, conical	pale yellow; light grey	+	+	+	3 on sugar beet
Onaway surface scab	On-S1	large, conical	tan-yellow; light grey	+	+	+	3 on sugar beet
Pioneer surface scab	Pio-S2	large, conical	tan-yellow light grey	+	+	+	2 on sugar beet

Source	Isolate	Colony size and shape on PDA	Color of substrate mass; color of mature aerial mass.	Pigment on PDA	Pigment on potato	Spiral spore chain	Pathogenicity tests 1 not pathogenic 2 mildly pathogenic 3 markedly pathogenic
Russet Burbank surface scab	RB-S1	small, convex	yellow-green; dark grey	-	-	-	1 on sugar beet
	RB-S4	large, conical	tan-yellow; light grey	+	+	+	
Rosa pitted scab	Rosa-R/P3	large, conical	yellow; light grey	+	+	+	2 on sugar beet
Russette raised scab	Russ-R2	large, conical	tan-yellow; light grey	+	+	+	3 on sugar beet
702-80 pitted scab	36-P1	large, conical	tan-yellow; light grey	+	+	+	2 on sugar beet
700-83 surface scab	700-83-S2	large, conical	pale tan-yellow; light grey	+	+	+	1 on sugar beet
702-80 pitted scab	702-80-P1	large, conical	pale tan; light grey	+	+	+	3 on sugar beet
Sebago raised scab	Seb-R3	small, convex	yellow; dark grey	-	+	+	
	Seb-R6	large, conical	yellow-green; dark grey	-	+	-	
	Seb-R8	large, conical	tan-yellow; light grey	-	-	-	
	Seb-R9	large, conical	light tan; light grey	+	+	+	
Sebago pitted scab	Seb-P4	large, conical	light tan; light grey	+	+	+	
Sebago small surface scab	Seb-T1	small, convex	yellow-green; dark grey	-	-	-	

Weed Control in Potatoes

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Herbicide treatments for control of annual weeds are shown in the table.I. The major weed species present were redroot pigweed, common lambsquarter and barnyardgrass. All soil applied herbicides either preplant incorporated (EPTAM) or preemergence provided excellent (97-100%) control of all weeds. Plots that were weed-free at time of early billing (treatments 31-34) and sprayed pre-emergence remained weed-free throughout the season. Any early weeds were covered by the early hilling and then herbicides killed weeds as they germinated. There was no further cultivation after early hilling so no additional was brought up and put in a position for germination as happens when the hilling is carried out later in season after potatoes are 8 inches or greater tall.

Postemergence herbicides for control of barnyardgrass gave excellent control in combination with sencor/lexone for broadleaved weeds. The postemergence grass herbicides offer an excellent approach to complete control of barnyardgrass without potato injury. None of the treatments in this study produced any injury on the potatoes. Oil concentrates was added to the postemergence grass herbicides to increase absorption and effectiveness.

Potato yields were quite variable and showed no significant reduction.

Research in the Upper Peninsula on herbicides for control of annual grasses, broadleaved weeds and quackgrass are presented in Table II. The major weed species present were barnyardgrass, common lambsquarters, redroot pigweed, and quackgrass. Treatments 1 and 3-7 provided good control of quackgrass (80 to 95%) and excellent control of annual weeds (90 to 100%). The pre-plow dalapon treatment resulted in only 55% quackgrass control. A split application of the postemergence herbicides increased quackgrass control slightly compared to a single application.

Delayed preemergence treatments of sencor/lexone and lorox provided excellent annual broadleave control. Early preemergence treatment with the above herbicides resulted in poor weed control. Postemergence treatments of sencor/lexone resulted in excellent broadleaved weed control.

Soil applied herbicides, Dual, Lasso, and Prowl, gave good barnyardgrass control when applied with a delayed preemergence treatment of lexone/sencor or lorox. The only exception to this was the combination of prowl-lorox. The soil applied grass herbicides ranged in overall barnyardgrass control as follows from best to least control dual $>$ lasso $>$ prowl.

Plots 23-25 were applied preemergence after early hilling. No further cultivation was done after spraying. These treatments resulted in barnyardgrass control from 65% with the prowl-lexone/sencor treatment to 100% with the dual-lexone/sencor treatment.

Potato yields were variable, however, treatments which resulted in poor weed control of grasses or broadleaved weeds were generally lower in yield than those treatments with good control.

Table I.

Weed Control in Potatoes, Montcalm County, Michigan 1982

Date Planted: May 6, 1982
Variety: Russett Burbanks
Row Spacing: 34"
Plot Size: 102" x 50'
No. of Replications: 3
Incorporation Equipment: Springtooth Drag x 2

Date Treated: PPI - 5/6/82
Pre - 5/8/82
Delayed Pre - 5/21/82
POST - 6/28/82
Potatoes - 20", 5% flowering
Date Rated: 6/18/82
Soil Texture: Loamy Sand
Organic Matter: 2.0%
Soil pH: 6.2

*Treatments 31-34 hilled prior to preemergence treatments.

Weeds Present: Redroot pigweed, Common lambsquarters, Barnyardgrass

Trt. No.	Treatment	Rate lbs/A	Rrpw	Colq	Bygr	Injury	Yield cwt/A
1.	Lasso + Lexone/Sencor (Pre)	2 + 1/2	10.0	10.0	10.0	0	403
2.	Lasso + Lexone/Sencor (Pre)	1/2 + 1/2	10.0	10.0	10.0	0	392
3.	Dual + Lexone/Sencor (Pre)	2 + 1/2	10.0	10.0	10.0	0	379
4.	Dual + Lexone/Sencor (Pre)	1/2 + 1/2	10.0	10.0	10.0	0	370
5.	Lasso (Pre) + [Lexone/Sencor (D. Pre)]	2 + [1/2]	10.0	10.0	10.0	0	355
6.	Dual (Pre) + [Lexone/Sencor (D. Pre)]	2 + [1/2]	10.0	10.0	10.0	0	350
7.	Prowl + Lexone/Sencor (Pre)	3/4 + 1/2	10.0	10.0	10.0	0	391
8.	Prowl + Lexone/Sencor (Pre)	1 + 1/2	10.0	10.0	9.7	0	362
9.	Prowl (Pre) + [Lexone/Sencor (D. Pre)]	3/4 + [1/2]	10.0	10.0	10.0	0	350
10.	S-734 (Pre) + [Lexone/Sencor (D. Pre)]	1/2 + [1/2]	10.0	10.0	10.0	0	374
11.	S-734 (Pre) + [Lexone/Sencor (D. Pre)]	3/4 + [1/2]	10.0	10.0	10.0	0	345
12.	S-734 (Pre) + [Lexone/Sencor (D. Pre)]	1 + [1/2]	10.0	10.0	10.0	0	334

Weed Control in Potatoes, Montcalm County, Michigan 1982
(continued)

Trt. No.	Treatment	Rate lbs/A	Rrpw	Colq	Bygr	Injury	Yield cwt/A
13.	S-734 + Lexone/Sencor (Pre)	3/4 + 1/2	10.0	10.0	10.0	0	355
14.	Lexone/Sencor (D. Pre) + [Poast + OC (POST)]	1/4 + [1/8 + 1 qt]	10.0	10.0	10.0	0	338
15.	Lexone/Sencor (D. Pre) + [Poast + OC (POST)]	1/4 + [1/4 + 1 qt]	10.0	10.0	10.0	0	336
16.	Lexone/Sencor (D. Pre) + [Poast + OC (POST)]	1/4 + [1/2 + 1 qt]	10.0	10.0	10.0	0	340
17.	Lexone/Sencor (D. Pre) + [Fusilade + OC (POST)]	1/4 + [1/4 + 1 qt]	10.0	10.0	10.0	0	343
18.	Lexone/Sencor (D. Pre) + [Fusilade + OC (POST)]	1/4 + [3/8 + 1 qt]	10.0	10.0	10.0	0	410
19.	Lexone/Sencor (D. Pre) + [DOWCO 453 + OC (POST)]	1/4 + [1/8 + 1 qt]	10.0	10.0	10.0	0	339
20.	Lexone/Sencor (D. Pre) + [DOWCO 453 + OC (POST)]	1/4 + [1/4 + 1 qt]	10.0	10.0	10.0	0	344
21.	Lexone/Sencor (D. Pre) + [CGA 82725 + OC (POST)]	1/4 + [1/4 + 1 qt]	10.0	10.0	10.0	0	310
22.	Lexone/Sencor (D. Pre) + [Lexone/Sencor + Poast + OC (POST)]	1/4 + [1/4 + 1/4 + 1 qt]	10.0	10.0	10.0	0	333
23.	No Treatment	-	0	0	0	0	237
24.	Eptam (PPI) + [Lexone/Sencor (D. Pre)]	4 + [1/2]	10.0	10.0	10.0	0	395
25.	Eptam + Prowl (PPI)	3 + 1	10.0	10.0	10.0	0	385
26.	Eptam + Prowl (PPI)	4 + 1	9.7	9.0	9.7	0	344

Table I.

leed Control in Potatoes, Montcalm County, Michigan 1982
continued)

Trt. No.	Treatment	Rate lbs/A	Rrpw	Colq	Bygr	Injury	Yield cwt/A
27.	Eptam + Extender (PPI) + [Lexone/ Sencor (D. Pre)]	3 + [1/2]	10.0	10.0	10.0	0	381
28.	S-734 (PPI) + [Lexone/Sencor (D. Pre)]	1/2 + [1/2]	10.0	10.0	10.0	0	343
29.	S-734 (PPI) + [Lexone/Sencor (D. Pre)]	3/4 + [1/2]	10.0	10.0	10.0	0	402
30.	S-734 (PPI) + [Lexone/Sencor (D. Pre)]	1 + [1/2]	10.0	10.0	10.0	0	379
31.	Lasso + Lexone/Sencor*	2 + 1/2	10.0	10.0	10.0	0	356
32.	Lasso + Lexone/Sencor*	2 1/2 + 1/2	10.0	10.0	10.0	0	394
33.	Dual + Lexone/Sencor*	2 + 1/2	10.0	10.0	10.0	0	373
34.	Dual + Lexone/Sencor*	2 1/2 + 1/2	10.0	10.0	10.0	0	301
35.	Dual + Lexone/Sencor (Pre)	1 1/2 + 1/2	10.0	10.0	10.0	0	324
36.	S-734 + Lexone/Sencor (Pre)	1 + 1/2	10.0	10.0	10.0	0	327
37	Prowl + Lexone/Sencor (Pre)	1 + 1/2	10.0	10.0	10.0	0	381

Table II - POTATO YIELD AND WEED CONTROL RATINGS IN THE UPPER PENINSULA - 1982

TREATMENT	RATE LB/A	TOTAL CWT/A	NO. 1 CWT/A	% NO. 1	% OVER 10 OZ.	WEED CONTROL[1]			
						QG	BG	PW	LQ
1. Roundup (PPI) + Lasso (Pre) + Sencor (Delay Pre)	1.5 + 2 + .5	318	210	66	1.6	9.5	10	10	10
2. Dalapon (PPI) + Lasso (Pre) + Sencor (Delay Pre)	10 + 2 + .5	261	208	79.8	1.5	5.5	9	10	10
3. Eptam (PPI) + Sencor (Delay Pre)	6 + .5	343	291	84.8	8.2	8.5	10	10	10
4. Poast (Post) + Sencor (Delay Pre)	.5 + .5	326	218	66.9	4.6	8	10	10	10
5. Poast (Sp Post) + Sencor (Delay Pre)	.25/.25 + .5	268	171	63.8	11.6	8.5	10	10	10
6. Fusilade (Post) + Sencor (Delay Pre)	.5 + .5	291	213	73.2	2.7	9	10	10	10
7. Fusilade (Sp Post) + Sencor (Delay Pre)	.25/.25 + .5	296	195	65.9	3.0	9.5	10	10	10
8. Lasso (Pre) + Sencor (Delay Pre)	2 + .5	326	255	78.2	3.1	0	8	9.5	10
9. Lasso (Pre) + Lorox (Delay Pre)	2 + 1	248	208	83.9	4	0	8	9.5	10
10. Dual (Pre) + Sencor (Delay Pre)	2 + .5	306	211	68.9	3.3	0	10	10	10
11. Dual (Pre) + Lorox (Delay Pre)	2 + 1	305	248	81.3	4.3	0	9.5	10	10

[1] QG = Quackgrass, BG = Barnyard Grass, PW = Pigweed, LQ = Lambsquarter.

Table II. (continued)

TREATMENT	RATE LB/A	TOTAL CWT/A	NO. 1 CWT/A	% NO. 1	% OVER 10 OZ.	WEED CONTROL QG	BG	PW	LQ
12. Prowl (Pre) + Sencor (Delay Pre)	.75 + .5	274	190	69.3	1.5	0	8.5	10	10
13. Prowl (Pre) + Lorox (Delay Pre)	.75 + 1	140	105	75	0	0	5	9.5	10
14. Lasso (Pre) + Sencor (Pre)	2 + .5	233	182	78.1	0	0	5.5	8	9
15. Lasso (Pre) + Lorox (Pre)	2 + 1	193	148	76.7	0	0	6.5	7.5	8.5
16. Dual (Pre) + Sencor (Pre)	2 + .5	256	192	75	3.1	0	8.5	8	9.5
17. Dual (Pre) + Lorox (Pre)	2 + 1	173	94	54.3	1.7	0	8	5.5	6
18. Prowl (Pre) + Sencor (Pre)	.75 + .5	145	99	68.3	0	0	3.5	5	6.5
19. Prowl (Pre) + Lorox (Pre)	.75 + 1	231	173	74.9	0	0	5	3.5	9
20. Lasso (Pre) + Sencor (Pre) + Sencor (Post)	2 + .5 + .25	250	190	76	1.6	3	5.5	10	10
21. Dual (Pre) + Sencor (Pre) + Sencor (Post)	2 + .5 + .25	343	269	78.4	6.4	3.5	9	10	10
22. Prowl (Pre) + Sencor (Pre) + Sencor (Post)	.75 + .5 + .25	204	164	80.4	0	3	7	10	10

Table II. (continued)

23. Lasso + Sencor (After E. Hilling)	2 + .5	280	211	75.3	0	0	8.5	10	9.5
24. Dual + Sencor (After E. Hilling)	2 + .5	332	284	85.5	2.1	0	10	9	10
25. Prowl + Sencor (After E. Hilling)	.75 + .5	244	175	71.7	2.5	0	6.5	8	10

Date Planted: June 3, 1982

Variety: Russet Burbank

Row Spacing: 36"

Plot Size: 108" x 50'

No. of Replications: 3

Incorporation Equipment: Finishing disc IX

Date Treated: PrePlow - 5/17/82
PPI - 6/3/82
Delayed Pre - 6/10/82
& Early Hilling
Post - 7/7/82
Post - 7/13/82

Date Rated: 7/16/82

Soil Texture: Sandy loam

INFLUENCE OF MOCAP 6EC ON THE CONTROL OF PRATYLENCHUS PENETRANS (ROOT-LESION NEMATODE) IN MICHIGAN POTATO (VARIETY SUPERIOR) PRODUCTION

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Mocap 6EC was evaluated for control of the root-lesion nematode (Pratylenchus penetrans) associated with potato (variety Superior) production at the Michigan State University Montacam Potato Research Farm in Entrican, Michigan in 1982. A randomized design was used with four-row plots. Two rows of each plot were treated with the nematicide and two served as non-treated controls. The rows were 34 inches apart and 50 feet in length. Each treatment was replicated three times. Temik 15G was included as a standard nematicide. The treatments were made on May 28, 1982. Temik was applied at-planting in the fertilizer furrow. Mocap 6EC was applied immediately before planting on a broadcast basis and incorporated. There were no significant (P=0.05) differences among the P. penetrans population densities associated with the experimental units at the time of planting. The plots were maintained throughout the growing season under commecial fertilizer, irrigation, and disease and insect management procedures. Nematode samples were taken immediately before treatment, at mid-season and at harvest. The tubers were harvested on September 7, 1982.

Both Mocap 6EC and Temik 15G provided excellent control of P. penetrans (see attached Table). Population densities on July 15, 1982 were significantly lower in the plots treated with the non-fumigant nematicides compared to the non-treated controls. All of the treatments resulted in significantly increased total tuber yields. Under these experimental conditions, however, Temik did not significantly increase the weight of US No. 1 tubers. The rate and method of application of Mocab 6EC appears to be very important in obtaining control of P. penetrans. The results obtained in 1982 were similar to those of 1981. Prior to 1981 the Michigan State University nematology research with Mocap had been done using the procedures commercially used for Temik application. Under these conditions nematode control was poor and tuber yields were not increased.

Influence of three nematicides on potato (cv Superior) yield and root-lesion nematode (*Pratylenchus pentrans*) control.

Treatment	*P. penetrans* per 100 cm^3 soil (5/28/82)	*P. penetrans* per 1.0 g root (7/15/82)	Tuber yield (cwt)			
			A	B	Jumbo	Total
Non-treated control	16a	47a	177a	11a	7a	195a
Mocap 6EC(6.0lb a.i./A)	6a	5b	206b	12a	8a	226b
Mocap 6EC(9.0lb a.i./A)	6a	0b	205b	13a	8a	226b
Temik 15G(3.0lb a.i./A)	12a	4b	193ab	11a	13a	217b

[1]Column means followed by the same letter are not significantly different (P=0.05) according to the Student-Newman-Kuels Multiple Range Test.

INFLUENCE OF NON-FUMIGANT NEMATICIDES ON THE CONTROL OF PRATYLENCHUS PENETRANS (ROOT-LESION NEMATODE) IN MICHIGAN PORATO (VARIETY SUPERIOR) PRODUCTION

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Temik 15G, Oxamyl 10G, Vydate 2L and Mocap 10G were evaluated for control of the root-lesion nematode (Pratylenchus penetrans) associated with potato (variety Superior) production at the Michigan State University Montcalm Potato Research Farm in Entrican, Michigan in 1982. A complete randomized block design was used with five replications of each treatment. Seed pieces were planted May, 10, 1982 in rows 34 inches apart and 50 feet in length. Each experimental unit consisted of a four-row plot. The nematicides were applied in-furrow at planting or on a broadcast basis and incorporated immediately before planting. A total of eight treatments were included in the test. Commercial fertilizer, irrigation and insect and disease procedures were used throughout the growing season. Nematode samples were taken before treatment, at mid-season and at harvest. The tubers were harvested on September 7, 1982.

All of the nematicide treatment resulted in significantly (P=0.05) greater yields than the non-treated control (see attached Table). There was a similar increase in the productivity of US No. 1 tubers. Temik 15G and the high rate of Oxamyl 10G resulted in an increase in the productivity of oversize tubers. There were no significant differences in the population densities of P. penetrans among the plots at the time of treatment and planting. All of the nematicide treatments significantly reduced the number of P. penetrans recovered from potato root tissue on July 15, 1982. The treatments had no influence on tuber specific gravity.

All of the non-fumigant nematicides evaluated in this trial provided excellent nematode control and resulted in improved potato tuber yields. The method of application and rate of nematicide used were very important factors. In many previous nematicide trials with Mocap, Vydate and Oxamyl the results have not been as good as those obtained with Temik. It is now possible to use each of these materials in a specifc manner that will provide similar nematode control and yield response.

Influence of non-fumigant nematicides on the control of Pratylenchus penetrans and yield of Solarum tuberosum (cv Superior)

Treatment, forumulation, lbs a.i. per acre and method of application	Yield (cwt/A)				P. pentrans per 100 cm^3 soil (5/10/82)	P. penetrans per 1.0g root (7/15/82)	Specific gravity
	Total	A	B	Jumbo			
Temik 15G, 3.0 (in-furrow)	231b[1]	205b	18a	9b	14a	3a	1.0716a
Oxamyl 10G, 4.0 (in-furrow)	229b	206b	18a	5ab	10a	8a	1.0732a
Oxamyl 10G, 6.0 (broadcast)	285d	254c	20a	9b	5a	1a	1.0736a
Vydate 2L, 6.0 (broadcast)	252bcd	227bc	19a	7ab	16a	10a	1.0760a
Mocap 10G, 6.0 (broadcast)	242bc	219bc	18a	4ab	17a	2a	1.0758a
Mocap 10G, 9.0 (broadcast)	257bcd	235bc	19a	4ab	17a	0a	1.0742a
Mocap 10G,12.0 (broadcast)	272cd	249c	18a	5ab	13a	0a	1.0756a
Non-treated control	185a	163a	19a	3a	7a	94b	1.0758a

[1]Column means followed by the same letter are not significantly (P=0.05) different according to the Student-Newman-Kuels Multiple Range Test.

1982 Potato Survey Report

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A nematode surevey of Michigan potato production was conducted in 1982. The objective of the study to determine the impact of Temik on potato production in Michigan from 1975-1982 in relation to the long-term potential of this product as a nematicide-insecticide. The procedure and sites used in the survey were similar to those of the survey sponsored by the Michigan potato Industry commission in 1975. The data were used to conduct a nematode crop loss-benefit assessment analysis of Michigan potato production.

The 1982 survey consisted of 96 sites in fifteen different potato growing regions (Table 1). Each site represented five acres. Approximately 1.2% of the 1982 Michigan potato acreage was surveyed for plant parasitic nematodes. In most cases it was possible to sample the same locations as surveyed in 1975. The number of sites per acre surveyed depended on the all potato acreage of the region.

Eighty-nine percent of the sites in the 1982 survey were treated with at-planting systemic nematicides-insecticides (Table 2). This was an increase of 4% compared with 1975. Five different materials were used for pre-plant or at-planting nematode and insect control. Temik 15G was by far the most common. Temik use increased 18% between 1975 and 1982. The use of DiSyston decreased 26%. There was in increase in the use of Furadan. Vorlex and Thimet remained constant. The nematicide-insecticide useage pattern varied among the regions (Table 3).

Seveteen potato varies were grown in the sites sampled in the nematode survey. Eight varieties represented 69% of the acreage (Table 4). Superior, Onaway, Russet Burbank and Monona were the most commonly grown varieties. Between 1975 and 1982 there was a decrease in the use of Norchip. The variety Atlantic was encountered in 2% of the acreage surveyed in 1982. There appeared to be an increase in the diversity of potato cultivars grown in Michigan between 1975 and 1982.

Thirty-one different types of crop rotations were identified in the 1982 nematode survey. Potatoes were grown on a continuous basis in 21% of the sites. Forty-four percent of the locations were in a 2-year rotation, and 30% of the sites were in a three-year or longer rotation (Table 5). There were numerous minor variations in the rotation systems used. In general they included small grains, corn, beans and various legumes (Table 6).

The root-lesion nematode was recovered from 92% of the sites sampled in the 1982 nematode survey (Table 7). This was a slight increase over 1975. Root-knot nematodes were recovered from 66 and 42% of the sites surveyed in 1975 and 1982, respectively. There was extensive variation in root-lesion nematode occurrence among the various regions (Table 8). In general, however, there was excellent correlation between the 1975 and 1982 survey results. As with the 1975 survey, nematode control with both Temik and Vorlex was observed from an anlysis of the survey data. Relatively high nematode population densities were associated with the Furadan, DiSyston, and sites not receiving an at-planting insecticide-nematicide treatment (Table 9).

Using an initial root-lesion nematode population density pathogenicity threshold of 100 nematodes per 100 cm^3 of soil, and a predisposition agent threshold of 10 per 100 cm^3 of soil, this nematode was estimated to be a pathogen in 18% of the sites sampled and a predisposition agent in 71% of the sites (Table 10). Compared with 1975, this was a slight decrease in the role of this nematode as a pathogen, and an increase in its role as a predisposition agent.

The survey data made it possible to conduct a comprehensive crop loss-benefit analysis associated with the root-lesion nematode in Michigan potato production. The potential estimated loss was 18%; however, the actual estimated loss was only 4% (Table 11). Nematicide treatments cost a total of $1,256,000. Approximately 37% of this was unnecessary. Management of the root-lesion nematode resulted in an 11% benefit to Michigan potato producers. Only 56% of the sites were properly managed for control of the root-lesion nematode. Twenty-nine percent of the sites were treated with the nematicide when it was not needed. Fifteen percent of the sites required additional nematode management.

Although research data are not available for a comprehensive analysis of the root-knot nematode associated with Michigan potato production, population information about this nematode was recorded throughout the survey. There appeared to be a slight increase in the average root-knot nematode population density associated with Michigan potato production (Table 12). At this time, the Columbia root-knot nematode has not been found in Michigan.

Table 1. Michigan potato producing regions by estimated acreage and number of fields sampled during the 1975 and 1982 nematode surveys.

Estimated potato acreage and regions	Sites sampled[1] 1975	1982
Over 5,000 acres		
Montcalm-Kent-Mecosta-Gratiot-Ionia Region	39	17
Bay-Arenac-Saginaw-Tuscola Region	36	13
1,000-5,000 acres		
Monroe-Lenawee Region	9	8
Jackson-Calhoun-Eaton-Ingham Region	9	5
Allegan County	12	7
Antrim County	10	6
Presque Isle-Alpena Region	10	6
Iron-Dickinson Region	10	8
Less than 1,000 acres		
Van Buren County	5	3
Lapeer County	3	0
Manistee County	3	3
Emmet County	3	3
Delta-Marquette Region	6	5
Houghton County	10	4

[1]Each field represented 5 acres. *Circa* 2% of the Michigan potato acreage was included in the survey in 1975 and 1.2% in 1982.

Table 2. At-planting nematicide-insecticide use in potato production in Michigan in 1975 and 1982.[1]

Chemical	Acreage treated (%) 1975	1982
At-planting systemic nematicides-insecticides	85	89
Temik	46	64
DiSyston	35	9
Vorlex	2	3
Furadan	1	12
Thimet	1	3
Non-treated	15	11

[1]Based on a survey of *circa* 2% of the potato acreage in 1975 and 1.2% in 1982.

Table 3. At-planting systemic nematicide-insecticide use pattern in Michigan in 1982.[1]

Areas	Pesticide use (%)					
	Temik	Vorlex	Thimet	Furadan	DiSyston	No Systemic
Montcalm (14)	100	21	0	0	0	0
Presque Isle (6)	33	0	50	0	0	17
Van Buren (3)	0	0	0	100	0	0
Manistee (3)	0	0	0	100	0	0
Emmet (5)	100	0	0	0	0	0
Delta (8)	0	0	0	0	100	0
Monroe (6)	100	0	0	0	0	0
Antrim (7)	83	0	0	0	0	17
Allegan (13)	14	0	0	42	0	42
Bay (4)	62	0	0	0	0	38
Houghton (4)	0	0	0	50	50	0
Dickinson (4)	100	0	0	0	0	0
Iron (4)	75	0	0	0	25	0
Luce (4)	100	0	0	0	0	0
Jackson (5)	100	0	0	0	0	0

[1]Each field represented 5 acres. Circa 2% of the Michigan potato acreage was included in the survey in 1975 and 1.2% in 1982.

Table 4. Michigan potato varieties on farms surveyed for nematodes in 1975 and 1982.

Variety	Occurrence (%)	
	1975	1982
Superior	12	11
Katahdin	7	7
Onaway	13	16
Russet Burbank	13	13
Atlantic	0	2
Norchip	19	5
Monona	10	13
Sabago	6	2
Other	22	31

[1]Each field represented 5 acres. Circa 2% of the Michigan potato acreage was included in the survey in 1975 and 1.2% in 1982.

[2]17 varieties grown.

Table 5. Rotations and crops encountered in the 1975 and 1982 Michigan potato nematode surveys.

Rotation type	Number of systems used	Occurrence (%) 1975	Occurrence (%) 1982
Continuous potatoes	17 (varieties)	27	21
Potatoes for 2 years	1	5	1
Potatoes every other year	14 (rotations)	48	44
Potatoes less than every other year	16 (rotations)	9	30
Unknown		11	4

Table 6. Michigan potato production system rotation identified in the 1982 nematicide survey.

System	Occurrence (%)
Continuous potatoes	21
Two-year rotation	44
Small grains	
Corn	
Beans	
Small grain-legume mixtures	
Other	
Three-year rotations	16
Fallow/small grain or legume	
Small grain/legume	
Small grain or corn	
Four-year or more rotations	15
Hay	
Corn	
Small Grain	
Beans	
Unknown	4

Table 7. Root-lesion and root-knot nematodes recovered during the 1975 and 1982 Michigan potato nematode surveys.

Nematode	Number per 100 cm^3 soil[1]	
	1975	1982
Root-lesion (<u>Pratylenchus</u> spp.)	88	92
Root-knot (<u>Meloidogyne</u> spp.)	66	42

[1]Based on an analysis of <u>ca</u> 2 and 1.2% of Michigan potato acreage in 1975 and 1982, respectively.

Table 8. Occurrence of <u>Pratylenchus</u> (root-lesion nematode) in Michigan potato production.

Area	Nematodes per 100 cm^3 soil	
	1975	1982
Montcalm	11	36
Bay	214	25
Allegan	26	23
Antrim	106	113
Dickinson-Iron	142	72
Monroe	4	27
Presque Isle	33	53
Delta	101	367
Emmet	17	3
Houghton	30	37
Jackson	18	2
Luce	-	34
Manistee	525	875
Van Buren	12	136
Total	88	92

Table 9. Root-lesion and root-knot nematodes in relation to nematicides-insecticides used in Michigan potato production.

Treatment (Sites surveyed)	Nematodes per 100 cm^3 soil[1]	
	Root-lesion	Root-knot
Total (86)	92	42
Temik (57)	35	36
Vorlex (3)	0	0
Furadan (11)	294	32
Thimet (3)	38	4
DiSyston (8)	237	75
No treatment (7)	95	89

[1]Mid-season sampling of five area portions of potato fields.

Table 10. Estimated impact of the root-lesion nematode on Michigan potato production.

Area	Root-lesion nematode problem sites (%)[1]			
	Pathogen		Predisposition agent	
	1975	1982	1975	1982
Montcalm	0	14	49	79
Bay	8	8	42	54
Allegan	8	0	75	71
Antrim	80	33	100	83
Dickinson-Iron	70	13	70	50
Monroe	0	0	10	75
Presque Isle	10	33	70	100
Delta	67	60	100	100
Emmet	0	0	100	0
Houghton	100	0	100	100
Jackson	11	0	44	0
Luce	-	25	-	75
Manistee	100	100	100	100
Van Buren	0	33	60	100
Total	23	18	60	71

[1]Analysis based on a pathogenicity threshold of P_i = 100 *Pratylenchus* per 100 cm^3 soil and a predisposition agent threshold of P_i = 10 *Pratylenchus* per 100 cm^3 soil.

Table 11. Influence of the root-lesion nematode on Michigan potato production in 1982.

Loss-Benefit Analysis		
Estimated potential loss	$7,838,400	(18%)
1982 Unnecessary treatment cost	464,000	(37%)
1982 Crop loss estimate	1,870,000	(4%)
1982 Treatment cost	1,256,000	(3%)
1982 Total cost	3,126,000	(7%)
Management system benefit	$4,712,400	(11%)
Management System Analysis		
Sites properly managed	56%	
Sites over-treated	29%	
Sites needing additional management	15%	

Table 12. Occurrence of Meloidogyne (root-knot nematode) in Michigan potato production.

Area	Nematodes per 100 cm^3 soil	
	1975	1982
Montcalm	0	6
Bay	7	48
Allegan	26	99
Antrim	621	3
Dickinson-Iron	175	88
Montroe	17	64
Presque Isle	161	82
Delta	22	114
Emmet	4	0
Houghton	18	0
Jackson	0	109
Luce	-	8
Manist.	0	0
Van Buren	1	0
Total	66	42

Irrigation Management for Potatoes

by

M.L. Vitosh, T. Louden and D. Warncke

This project consisted of three separate studies (1) irrigation scheduling on growers farms; (2) measurement of evapotranspiration for potatoes and (3) an evaluation of methods of measuring soil moisture and irrigation scheduling for potatoes grown on organic soils. These studies will be presented individually in the order presented above.

ON-FARM IRRIGATION SCHEDULING

An irrigation scheduling program was set up on 13 sites in Montcalm County and one in Berrien County. In addition, tensiometers were provided for several growers in Cass, Otsego and Dickinson Counties. The irrigation scheduling program in Montcalm and Berrien Counties was implemented through the pest management scouting program. The other locations were assisted through the County Extension Service Offices.

At each of the locations 4-6 tensiometers were installed at 12 and 18 inch depths during June prior to irrigation. Pest scouts were instructed to visit the field twice a week to make tensiometer readings and leave a record of the soil moisture content, the current estimate of daily crop water use and an estimate of how soon irrigation would be required if rain did not occur.

At seasons end an evaluation form was given to each cooperator to evaluate the program.

RESULTS

Results varied from being highly successful to being of little value where the information provided to the irrigator was not used. Most cooperators rated the program as good, although some did not understand how the information was calculated or how to use it. Most cooperators indicated that they did not always use the information provided but did use it some of the time.

All cooperators felt that irrigation scheduling was very important to their operation and deserved the attention and time necessary to make the readings and to do the calculations. One of the most surprising comments of the survey was that several irrigators did not understand how to use tensiometers to schedule irrigation water. This comment may have been made because there were some problems at several locations with the proper functioning of the tensiometers. Early in the season most tensiometers functioned very good but as the season progressed, more and more failures occurred. One possible reason for this is that as the soil dries out, it does not rewet uniformly around the poreous ceramic tip with added rainfall or irrigation. The only solution at this point is to reestablish the tensiometers after the soil has been thoroughly rewetted. In some locations this was done, however there were other locations where it was not done due to lack of time and competition for reporting other pest information.

All cooperators indicated an interest in an educational program concerning the benefits and "How to's" of irrigation scheduling for potatoes. This will be a continuing effort for my Extension activities.

A summary of each location's irrigation and soil moisture record was not attempted because accurate data was not always on rainfall, amount of irrigation water applied, date or time of application with respect to date and time of tensiometer readings. Getting accurate information to be able to use the water balance approach to irrigation scheduling is crucial to this procedure. Because many irrigators do not have good records of this information or are not willing to take the time to get it, some method of measuring soil moisture is the next best alternative. The use of tensiometers for determining when to irrigate are excellent if they can be kept in proper functioning order throughout the season.

From a general review of the tensiometer charts and soil moisture calculations many growers are overly concerned about keeping the soil wet. As a result, some are wasting water and leaching nitrogen below the root zone. At several locations, tensiometers rarely get above 20 centibars. My research would indicate no advantage of keeping the soil that wet. If soil moisture is maintained below 50 centibars, one can expect optimum yields and better control of leaching. Such a practice should improve the nitrogen and water use efficiency, possibly lowering the amount of nitrogen fertilizer required and improve the net return per acre.

MEASUREMENT OF TRANSPIRATION

During the summer of 1982, a team in the Agricultural Engineering Department, consisting of Eric Harmsen, Gary Peterson, Graduate Assistants; George E. Merva, Professor; and Ted Loudon, Associate Professor were involved in the development of a portable plastic chamber for directly measuring evapotranspiration in the field.

The chamber is a metal framed box with a film plastic cover and a top which opens and closes. Dimensions in the box are 4' x 4' x 5' high. Within the chamber paired termisters measure wet and dry bulb temperature many times over a short measurement interval.

In use, the chamber is lowered down over selected plants in the field using a boom structure mounted on the three point hitch of a tractor. The chamber is lowered with the top open so that the air profile in the crop canopy and just above it is not disturbed as the chamber is put in place. Ninety-six values of wet and dry bulb temperature are logged over 36 second period of time into a small computer mounted on the tractor.

This process allows us to determine the rate of vapor density increase within the chamber over the short measurement interval. With this chamber we can directly compare evapotranspiration rates for different varieties, different management schemes, or different crops under the same environmental conditions. Measurements made approximately once an hour can be summed over the day to determine the total daily evapotranspiration.

Measurements were made over potatoes on the MSU farm for several days this summer. In addition, the chamber was used at the Montcalm Research Farm potato field day on August 18, 1982.

We believe this method has great potential for future use. We are still in the process of analyzing data and determining whether our first runs this year actually yielded useful data. Several ideas have been generated for improving both the chamber and the instrumentation used.

IRRIGATION SCHEDULING FOR ORGANIC SOILS

Potatoes were grown at the Muck Experimental Farm for purposes of evaluating methods of irrigation scheduling. Tensiometers were installed and water evaporation was measured with the use of a 30 gallon plastic pail. Evaporation of water from the plastic pail was assumed to be equivalent to the evapotranspiration (crop water use) of potatoes. A plastic pail was also installed at the Jim Shoemaker farm in Allegan County.

RESULTS

Tensiometers were found to be in general unsatisfactory on organic soils. Water is held at such low tension that tensiometers did not respond sufficiently to changes in soil moisture so that they could be used reliably for determining when to irrigate.

The plastic pail for estimating crop water use tends to overestimate crop water use. More work is needed on this method to determine the appropriate correction factor. Meanwhile irrigation management for organic soils lack the state of the art that has been developed for mineral soils. Experience is still the best teacher.

Climatilogical methods of estimating evapotranspiration of potatoes grown on organic soils still needs to be evaluated. The use of the neutron electron probe for measuring soil moisture was considered but determined unuseable on organic soils because of the large amount of hydrogen ions associated with the organic matter.

Biology & Control Strategies for Insect Pests of Potatoes

E. Grafius and M.A. Otto
Department of Entomology

Research in 1982 emphasized:

1. Evaluation of insecticide resistance in Colorado potato beetles in Michigan

and

2. Assessment of control strategies and aphid economic thresholds

Colorado Potato Beetle Insecticide Resistance

Trials were conducted on field collected or laboratory reared beetles from 5 locations, including fields where resistance was suspected and fields representing other regions in the state. Beetles were treated with technical grade parathion or Temik, dissolved in absolute alcohol and diluted with acetone. Treatments were applied directly to the abdomen of each beetle with a micro-syringe. 40 adults per dose were used in most of the trials. After treatment, beetles were kept in the laboratory, fed untreated potato leaves, and checked for survival daily for five days.

Results clearly indicate difference in susceptibility to parathion and Temik. Monroe field 1 beetles (suspected resistant) commonly survived doses of parathion that were 100 x the dose that killed all beetles from Montcalm Co. or Imlay City (Table 1). Results with Temik were less dramatic, but still showed decreased susceptibility of the Monroe field 1 beetles.

The dosages required to kill 50% or 90% of the population (LD_{50} or LD_{90}) were calculated for accurate comparisons between the beetle populations. LD_{50} values for parathion were 100 x greater for Monroe field 1 beetles than other populations and LD_{90}'s were 500 x or more greater (Table 2). Temik LD_{50} and LD_{90} values were 3 - 7 x greater for the Monroe field 1 beetles (Table 3).

The results clearly indicate that beetles from Monroe field 1 are much less susceptible, apparently to the point where field control is difficult. Future studies will evaluate other insecticides and will include beetles from Antrim Co., probably highly susceptible.

Resistance problems on the East Coast, especially Long Island, are extreme. Michigan is apparently heading in the same direction. However, we can deal with this problem if we act now to:

1) identify problem beetle populations
2) initiate strong educational programs toward chemical management
3) begin investigation of biological control as a possible aid to chemical control programs

Assessment of Control Strategies

Insect Pest Management and Insecticide Resistance Managemnt are both based on using insecticides only when needed. Growers need to gain more confidence in their ability to assess insect populations and to use this information to protect their potatoes from economic losses due to insects. Thus, this demonstration was designed.

One range of potatoes at the Montcalm Experimental Farm was used, to get fairly large areas per treatment. Treatment consisted of: the varieties Onaway and Russet Burbank; Temik and Furadan; and two different foliar insecticide schedules (Table 4). These treatments were designed to create a range of insect populations at different potato growth stages. Insect population levels were assessed by the Montcalm County Integrated Pest Management scouts, using their normal sampling procedures. Foliar treatment schedule 1, attempted to keep insects from being a problem. Foliar schedule 2 allowed insect populations to rise above MSU action threshold recommendations.

Aphids, primarily green peach, were the only insects to rise above the action threshold. Their numbers varied widely between treatments (Table 5). However, there were no significant yield differences between treatments, despite the fact that aphid numbers rose to 606/100 leaves (more than 20 times the action threshold) in one treatment. This demonstrates the inherently conservative nature of our action threshold recommendations.

In the 1980's in Michigan, Colorado potato beetle insecticide resistance management is going to become increasingly important. Slowing the rate of resistance development will be a primary concern. A key to this will be using insecticides only when needed to reduce the selection pressure on the population.

Table 1. Mortality of Colorado potato beetles treated with parathion or Temik, 48 hours after treatment.

	Dose (µl/beetle)	% Mortality (48 hrs.)				
		Monroe Co. Field 1	Monroe Co. Field 2	East Lansing	Mont-calm Co.	Imlay City
Parathion	.001	-	18	8	-	-
	.01	0	40	88	100	100
	.1	38	92	100	100	100
	1.0	67	-	-	100	100
	10.0	100	-	-	-	-
Temik	1	0	20	35	-	-
	10	55	65	93	-	-
	30	88	100	98	-	-
	50	98	100	100	-	-
	70	100	100	-	-	-

Table 2. 50 and 90% lethal dose values for Colorado potato beetles treated with parathion (µl active ingredient per beetle).

PARATHION

Topical LD (µl/beetle)

	50%	90%
Monroe Co.		
Field 1	0.33	5.27
Field 2	0.003	0.01
East Lansing	0.003	0.01
Montcalm Co.	<<0.01	<<0.01
Imlay City	<<0.01	<<0.01

Table 3. 50 and 90% lethal dose values for Colorado potato beetles treated with Temik (µl active ingredient per beetle).

TEMIK

Topical LD (µg/beetle)

	50%	90%
Monroe Co.		
Field 1	8.4	26.0
Field 2	2.0	11.1
East Lansing	1.4	8.1

Table 4. Foliar Insecticide Treatments

Treatment	Date	Chemical and Rate lbs AI/A	
1	7/9	Thiodan	1.0
	7/28	Monitor	.75
	8/4	Pydrin	.1
2	7/9	Thiodan	1.0
	8/4	Pydrin	.1
	8/11	Monitor	.75

Table 5. Effects of Selected Treatments on Peak Aphid Populations and Yield

Variety	Systemic[1]	Foliar[2]	Peak Aphid Population[3] (#/100 leaves) and Date		Yield (lbs/50 ft ± S.E.)[4]					
					A	SE	Over	SE	A+0	SE
Onaway	Temik	1	0		118.2	2.0	9.9	1.6	128.1	3.1
		2	76	July 30	115.3	3.1	13.3	1.5	127.7	4.0
	Furadan	1	28	July 30	120.1	1.8	15.6	1.6	120.1	3.0
		2	156	Aug. 13[5]	119.7	2.6	17.5	1.7	119.7	3.1
Russet Burbank	Temik	1	0		81.3	2.4	20.4	1.3	101.8	2.4
		2	6	Aug. 6	87.7	4.0	20.3	2.3	108.1	3.7
	Furadan	1	39	July 23	75.5	3.0	20.0	2.0	95.6	2.8
		2	606	Aug. 6	81.0	2.9	21.2	1.3	102.3	2.1

1. Rate of application 3 lbs A.I. per acre

2. See Table 4 for spray schedule

3. Action threshold estimated to be 30/100 leaves

4. 100 lbs/50 ft = 307.5 cwt/acre

5. Very late - most vines were dead or dying

THE INFLUENCE OF SELECTED PRODUCTION MANAGEMENT PRACTICES ON POTATO YIELD, QUALITY AND NUTRITION

M.L. Vitosh, G.W. Bird, R. Hammerschmidt, R.W. Chase, E. Grafius and M. Otto

Departments of Crop and Soil Sciences, Entomology, and Botany-Plant Pathology

The objective of the 1982 study was to optimize the inputs necessary for maximum tuber yield and excellent quality. From 1977 to 1980 a series of experiments were conducted to examine various nutrient-nematicide interactions. The 1981 and 1982 experiments are a culmination of this information plus an additional component, crop rotation. Superior, Russet Burbank, Atlantic and Denali varieties were evaluated in corn and alfalfa rotations.

METHODS

In the spring of 1980 and again in 1981 one range of corn and one range of alfalfa were planted side by side. The alfalfa was cut periodically and the top growth was left for soil organic matter accumulation. The corn was harvested for grain and the stalks left in the field. Both plots were plowed the last week of April, 1982. The plots that required fumigation received 10 gallons of Vorlex per acre chiseled in at an eight-inch depth on April 26th. All other plots received the same tillage but no Vorlex was added. Treatment applications and planting were completed on May 10th. Each plot consisted of four rows 50 feet long having 34 inch row width and 8 to 12 inches between seed pieces.

Russet Burbank was evaluated using a 2 by 3 factorial design with 5 replications. Atlantic and Denali received only the highest rate of nitrogen (225 lb/A). Temik 15G at 3.0 lb active ingredient per acre was applied at planting, in a band beside the seed furrow. Fertilizer was banded two inches to the side and below the seed pieces. All plots received 150 lbs K_2O per acre and 150 lbs P_2O_5 per acre. There were two nitrogen treatments, 75 and 225 lb N per acre. All plots received 75 lbs N at planting but the high N (225 lb N/A) plots received two sidedressings of 75 lbs N per acre. The nitrogen form was urea.

Soil tests were obtained from random samples in both ranges prior to planting. Plant nutrient composition was determined on potato petioles sampled on June 22.

RESULTS

All plots were vine killed on September 18 and harvested on September 23 and 24. The yield data are shown in tables 1 and 2.

Tubers were graded on the harvestor into four categories, off-type, over size, under size and U.S. No. 1's. The U.S. No. 1 category includes all tubers greater than two inches in diameter having no signs of rot. The undersize category includes all tubers under two inches in diameter. The over size category for the Russet Burbank variety includes all tubers weighing 10 ounces or more. For the other varieties over size tubers were those tubers greater than 3 1/4 inches in diameter. Off-type tubers are representative of knobby tubers found in the Russet Burbank variety only.

The maximum yield of U.S. No. 1 tubers for each variety was obtained with the highest level of the treatments (225 lb N/A and Temik and Vorlex). Yield increases due to Vorlex were largest in the alfalfa rotation. Although small yield increases were observed for Vorlex in the corn rotation, the differences were not statistically significant (P = .05). Temik increased the yield of U.S. No. 1 tubers over the check (no nematicide) in nearly all comparisons at both nitrogen levels and in both rotations.

Temik significantly reduced the amount of small Russet Burbank tubers at the low nitrogen rate while having little or no affect on small tuber yield at the higher nitrogen rate.

Both higher nitrogen level and Temik increased the yield of large tubers. Vorlex increased the yield of large Atlantic tubers only in the alfalfa rotation otherwise Vorlex had little affect on large tuber size.

Off-type tubers observed only in the Russet Burbank variety were significantly affected by the nitrogen and nematicide treatments. The specific gravity of Atlantic and Denali tubers was significantly higher than Russet Burbank.

Nutrient Composition of Potato Petioles

The nutrient composition of potato petioles samples on June 23 are shown in tables 3 and 4. Nitrate nitrogen levels were below the normal sufficiency levels at the time of sampling however the amount found in the potato petioles was directly related to the rate of nitrogen fertilizer application. Slightly higher nitrate levels were observed in the alfalfa rotation, particularly at the low rate of nitrogen fertilizer (75 lb N/A). We cannot explain the below normal NO_3-nitrogen values found in 1982.

All other nutrients determined were found to be within the sufficiency ranges. Phosphorus values appeared to be higher than in previous years. The higher rate of nitrogen also decreased the phosphate levels present. Vorlex as in previous years tended to decrease the level of manganese found in potato petioles in both rotations and four both varieties. The lowest levels of manganese however were still well above the critical level of 30 parts per million (ppm). Other nutrients which were found to be significantly affected by the treatments were calcium, magnesium, zinc, iron and boron but the differences were not consistent for similar comparisons in both rotations or within each nitrogen level and can only be explained as usual variation.

Root-lesion Nematode Control

Excellent root-lesion nematode (*Pratylenchus penetrans*) control was obtained with both Temik 15G and the Temik plus vorlex treatment (Tables 8-9). As in previous trials, Temik provided season-long control of the root-lesion nematode following both the corn and alfalfa rotations. The response to nematode control was observed for both Russet Burbank and Atlantic and with Russet Burbank at both nitrogen levels. Denali yields were high and nematode control appeared to be good. In a number of cases the highest population densities were associated with the low nitrogen treatment. Initial nematode population densities were greater after alfalfa than following corn.

FOLIAR DISEASE RATINGS

Observations on the development of foliar disease symptoms (primarily early blight) were made during the growing season. Early blight was chosen for these observations since general health of the plant is known to be related to disease severity and the fact the farm was under high early blight pressure the previous year. In general, high nitrogen combined with temik or temik + vorlex gave the best protection against the development of early blight. Wilt and early dying were observed throughout the plot. However, no major visual differences were observed within or among the treatments. No late blight was observed in the plots and only a few plants exhibited botrytis blight.

EARLY BLIGHT RATINGS

Treatment	N	Variety	Disease Ratings[1] 7/14	7/28	8/18	8/25
Check	75	RB	1.0	2.0	4.0	4.0
Temik	75	RB	0.0	1.8	2.2	3.2
Temik + Vorlex	75	RB	0.0	2.2	2.8	3.4
Check	225	RB	0.0	0.8	1.4	2.0
Temik	225	RB	0.0	0.8	1.2	2.0
Temik + Vorlex	225	RB	0.0	0.2	0.4	0.6
Check	225	AT	0.0	2.0	3.6	4.0
Temik	225	AT	0.0	1.6	2.6	3.0
Temik + Vorlex	225	AT	0.0	1.4	2.4	3.0
Temik + Vorlex	225	DE	0.0	0.2	0.4	0.6

[1]Rated on a scale of 0-4, based on per cent leaf coverage by lesions.

0 = no symptoms
1 = 1-10% coverage
2 = 11-20% coverage
3 = 21-40% coverage
4 = over 41% coverage

Economics

Compared with the 75 lb N non-treated control, net returns from the various management systems at five market values ranged from $116 to $1,096 per acre following corn, and $-85 to $1,222 per acre following alfalfa (Tables 5 and 6). The data illustrate the need for accurate information about the system and specific objectives prior to making management decisions. Projected returns were generally greater for Atlantic and Denali than for Russet Burbank. At the lower management levels the projected returns were generally greater with the corn rotation than for the alfalfa system (Table 7). The alfalfa system, however, was necessary for maximum returns.

Table 1

Influence of nematicides and nitrogen on the tuber yield and specific gravity of three potato cultivars grown after rotation with corn.

Treatment	Yield (cwt/A)					Specific gravity
	Total	US #1	Under-size	Over-size	Off-type	
75 lb N						
Russet Burbank						
Control	274	166a	99d	3a	6a	1.083a
Temik	343	231b	88c	8a	16bc	1.083a
Temik & Vorlex	366	259b	80c	13ab	14b	1.082a
225 lb N						
Russet Burbank						
Control	394	287c	67b	27bc	14b	1.082a
Temik	428	313d	63b	38cd	24c	1.081a
Temik & Vorlex	449	315de	59b	52de	23cd	1.083a
Atlantic						
Control	406	348d	30a	28bc	--	1.091b
Temik	455	360e	34a	61e	--	1.092b
Temik & Vorlex	480	384f	33a	63ef	--	1.092b
Denali						
Temik & Vorlex	489	382f	26a	81f	--	1.095c
LSD (P=0.05)	(32)	(31)	(9)	(18)	N.S.	(0.003)

Table 2

Influence of nematicides and nitrogen on the tuber yield and specific gravity of three potato cultivars grown after rotation with alfalfa.

Treatment	Yield (cwt/A)					Specific gravity
	Total	US #1	Over-size	Under-size	Off-type	
75 lb N						
Russet Burbank						
Control	293	193a	1a	95f	4a	1.081ab
Temik	318	216ab	5ab	76cde	20bc	1.078a
Temik & Vorlex	391	285cd	7ab	82de	18f	1.082b
225 lb N						
Russet Burbank						
Control	347	254bc	12ab	71bcd	10a	1.078a
Temik	405	293cde	21bc	64b	27c	1.081ab
Temik & Vorlex	448	329e	29cd	66bc	24bc	1.080ab
Atlantic						
Control	375	326de	18bc	31a	--	1.090cd
Temik	432	354e	42d	36a	--	1.092d
Temik & Vorlex	514	393f	85e	37a	--	1.088e
Denali						
Temik & Vorlex	529	388f	114f	26a	--	1.091cd
LSD (P=0.05)	(59)	(57)	(17)	(11)	(7)	(0.004)

Table 3. Effect of Temik, Vorlex and nitrogen on elemental composition of potato petioles of Russet Burbank, Atlantic and Denali varieties grown in the alfalfa rotation (sampled 6-22-82)

Treatments			Elemental Composition									
Variety	N Rate	Nematicide	NO_3	P	K	Ca	Mg	Mn	Zn	Cu	Fe	B
	lb/A		PPM	------%------				----------PPM----------				
R. Burbank	75	Check	11,583 abc[1]	.75 d	10.9	.42 b	.24 ab	157 d	45 a	7	190 bc	24 bc
R. Burbank	75	Temik	10,049 a	.73 cd	10.8	.43 b	.23 a	133 abcd	50 ab	14	187 bc	23 ab
R. Burbank	75	Temik + Vorlex	11,364 ab	.75 d	10.7	.40 ab	.24 ab	126 abcd	48 ab	6	180 bc	24 b
R. Burbank	225	Check	14,224 cd	.64 ab	11.7	.50 c	.32 c	133 ab	48 a	8	200 c	22 a
R. Burbank	225	Temik	13,148 bcd	.60 a	10.7	.44 b	.28 bc	134 abcd	55 abc	9	187 bc	23 ab
R. Burbank	225	Temik + Vorlex	13,723 bc	.60 bc	10.7	.40 ab	.28 bc	108 ab	52 ab	10	200 b	24 bc
Atlantic	225	Check	14,654 d	.67 abc	11.0	.43 b	.26 ab	142 cd	56 bc	10	154 ab	25 c
Atlantic	225	Temik	12,785 abcd	.65 ab	11.1	.43 b	.26 ab	139 bcd	47 ab	7	133 a	25 c
Atlantic	225	Temik + Vorlex	14,113 bcd	.66 abc	11.0	.41 ab	.27 ab	103 ab	52 ab	8	136 a	24 bc
Denali	225	Temik + Vorlex	13,677 bcd	.66 abc	10.8	.37 a	.28 bc	121 abc	64 c	29	201 c	25 c
LSD (.05)			(2766)	(.08)	(NS)	(.06)	(.05)	(32)	(11)	(NS)	(38)	(2)
Sufficiency Levels			16,000 20,000	.18 - .22	6.0 - 9.0	.36 - .50	.17 - .22	30 - 200	30 - 100	7 - 30	30 +	14 - 40

[1]Column mean followed by the same letter are not statistically different as determined by the Least Significant Difference Test (P = .05).

Table 4. Effect of Temik, Vorlex and nitrogen on elemental composition of potato petioles of Russet Burbank, Atlantic and Denali varieties grown in the corn rotation (sampled 6-22-82).

Treatments Variety	N Rate	Nematicide	Elemental Composition NO_3	P	K	Ca	Mg	Mn	Zn	Cu	Fe	B
	lb/A		PPM	-%-				-PPM-				
R. Burbank	75	Check	9,208 a[1]	.78 d	10.9	.40	.22 a	251 d	50 ab	10	174 bc	25 b
R. Burbank	75	Temik	8,116 a	.74 c	10.9	.40	.22 a	215 cd	51 ab	9	197 cde	24 a
R. Burbank	75	Temik + Vorlex	10,126 a	.76 cd	10.9	.40	.23 ab	165 ab	54 bc	10	214 de	24 a
R. Burbank	225	Check	13,491 b	.69 b	10.9	.42	.23 ab	174 abc	46 a	8	178 bc	24 a
R. Burbank	225	Temik	13,911 b	.66 ab	10.9	.43	.26 bc	173 abc	51 ab	11	214 de	24 a
R. Burbank	225	Temik + Vorlex	14,071 b	.68 ab	10.9	.38	.25 ab	149 ab	54 bc	10	220 e	24 a
Atlantic	225	Check	13,833 b	.69 b	10.7	.40	.23 ab	196 bc	53 bc	8	143 a	26 c
Atlantic	225	Temik	14,349 b	.68 ab	10.8	.41	.24 ab	173 abc	55 bc	8	152 bc	27 c
Atlantic	225	Temik + Vorlex	14,201 b	.67 ab	10.9	.40	.25 ab	144 a	59 c	8	155 b	27 d
Denali	225	Temik + Vorlex	13,114 b	.65 a	10.6	.44	.29 c	141 a	54 bc	9	167 bc	27 d
LSD (.05)			(2421)	(.04)	(NS)	(NS)	(.04)	(51)	(7)	(NS)	(29)	(1)
Sufficiency Levels			16,000 - 22,000	.18 - .22	6.0 - 9.0	.36 - .50	.17 - .22	30 - 200	30 - 100	7 - 30	30 +	14 - 40

[1]Column means followed by the same letter are not statistically different as determined by the Least Significant Difference Test (P = .05).

Table 5

Influence of three management systems on the economics associated with three potato cultivars grown after a corn rotation.

Management System	Net return at five market values ($).[1]			
	3.00	4.00	5.00	6.00
75 lb N				
Russet Burbank				
Nontreated-Control	--	--	--	--
Temik 15G	167	236	305	374
Temik & Vorlex	116	208	300	392
225 lb N				
Russet				
Nontreated Control	326	446	566	686
Temik 15G	418	582	746	910
Temik & Vorlex	331	506	681	856
Atlantic				
Nontreated Control	362	494	626	758
Temik 15G	469	650	831	1,012
Temik & Vorlex	424	630	836	1,042
Denali				
Temik & Vorlex	451	666	881	1,096

[1]Based on net returns above the 75 lb N non-treated control (274 cwt/A) less additional costs (Temik 15G = $40/A, Vorlex=$120/A, and 150 lb N = $34/A).

Table 6

Influence of three management systems on the economics associated with three potato cultivars grown after an alfalfa rotation.

Management system	Net return at five market values ($).[1]			
	3.00	4.00	5.00	6.00
75 lb N				
Russet Burbank				
Nontreated Control	--	--	--	--
Temik 15G	35	60	85	110
Temik & Vorlex	-85	-60	-35	-10
225 lb N				
Russet Burbank				
Nontreated Control	128	182	236	290
Temik 15G	253	362	471	580
Temik & Vorlex	271	426	581	736
Atlantic				
Nontreated Control	212	294	376	458
Temik 15G	343	482	621	760
Temik & Vorlex	469	690	911	1,132
Denali				
Temik & Vorlex	514	750	986	1,222

[1]Based on net returns above the 75 lb N nontreated control (293 cwt/A) less additional costs (Temik 15G = $40/A, Vorlex = $120/A, and 150 lb N = $34/A).

Table 7

Economics of three potato managment systems following rotations with alfalfa and corn.

Management System	Net return at $5.00/cwt[1]	
	Corn	Alfalfa
75 lb N		
Russet Burbank		
Nontreated Control	--	25
Temik 15G	305	110
Temik & Vorlex	300	355
225 lb N		
Russet Burbank		
Nontreated Control	566	261
Temik 15G	746	511
Temik & Vorlex	681	606
Atlantic		
Nontreated Control	626	401
Temik 15G	831	646
Temik & Vorlex	836	946
Denali		
Temik & Vorlex	881	1,011

[1]Based on net returns above the 75 lb N nontreated control (274 cwt/A) following corn less additional costs (Temik 15G = $40/A, Vorlex = $120/A, 150 lb N = $34/A, alfalfa production = $ 20 /A) and adjusted for $50/A profit from the rotation crop of corn.

Table 8

Influence of nematicides and nitrogen on the control of Pratylechus penetrans associated with three potato cultivars following rotation with corn.

Treatment	P. penetrans/100 cm^3 soil			P. Pentrans per 1.0 g root and 100 cm^3 soil (7/15/82)
	4/26/82	5/10/82	9/22/82	
75 lb N				
Russet Burbank				
Control	7a[1]	6ab	132b	70c
Temik	17a	16b	31a	1a
Temik & Vorlex	13a	4ab	10a	2a
225 lb N				
Russet Burbank				
Control	11a	7ab	104b	36b
Temik	24a	4ab	10a	1a
Temik & Vorlex	11a	0a	0a	1a
Atlantic				
Control	23a	5ab	132b	34b
Temik	11a	14b	19a	2a
Temik & Vorlex	13a	0a	5a	1a
Denali				
Temik & Vorlex	16a	0a	6a	0a

[1]Column means followed by the same letter are not significantly different (P=0.05) according to the Student Newman Kuels Multiple Range Test.

Table 9

Influence of nematicides and nitrogen on the control of Pratylenchus penetrans associated with their potato cultivars following rotation with alfalfa.

Treatment	P. pentrans per 100 cm^3 soil			P. penetrans per 1.0 g root	
	4/26/82	5/10/82	9/22/82	5/10/82	7/15/82
75 lb N					
Russet Burbank					
Control	45a[1]	16a	268c		50b
Temik	29a	22a	14a		2a
Temik & Vorlex	62a	8a	8a		1a
225 lb N					
Russet Burbank					
Control	67a	8a	150b		35b
Temik	54a	4a	13a		2a
Temik & Vorlex	62a	11a	6a		0a
Atlantic					
Control	51a	12a	237bc		37b
Temik	57a	13a	12a		0a
Temik & Vorlex	66a	7a	17a		1a
Denali					
Temik & Vorlex	80a	14a	2a		1a

[1]Column nemas followed by the same letter are not significantly different (P=0.05) according to the Student Newman Kuets Multiple Range Test.

THE 1981 MSU INTEGRATED POTATO PROJECT (STORAGE PHASE)

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The 1981 MSU Integrated Potato project at the MSU Montcalm Potato Research Station involved three varieties: Superior, Russet Burbank and Denali. These three varieties were grown following a corn rotation on one range and following an alfalfa rotation on a second range. Various production treatments were used as shown in Table 1.

Table 1. Description of production treatments used on the ten treatments checked during the 1981 MSU Integrated Potato project at the Montcalm Potato Research farm were as follows:

Treatment No.	Variety	Treatment
1	Superior	N_1 PK T V
2	Superior	N_1 PK T
3	Superior	N_1 PK V
4	Superior	N_1 PK
5	Superior	N_2 PK TV
6	Superior	N_2 PK T
7	Superior	N_2 PK V
8	Superior	N_2 PK
9	Russet Burbank	N_2 PK TV
10	Denali	N_2 TV

*Code:

N_1 = 75 lbs N/A K = 150 lbs K_2O/A

N_2 = 225 lbs N/A T = Temik

P = 150 lbs P_2O_5/A V = Vorlex

*For detailed production practices including times and methods of application consult the 1981 Montcalm Potato Report published in 1982.

The Superior and Denali potatoes were used for the storage project. These varieties were harvested with the MSU plot harvester on September 18, 1981. The Superior potatoes were stored in the MSU Food Science cubicles at 50°F until January 12, 1982 and then lowered to 45°F. The Denali potatoes were stored at 40, 45 and 50°F and 95% RH.

Superior potato storage phase procedure.

Superior potatoes for the storage phase were taken from treatments #5 and #6; treatment #5 received Temik and Vorlex whereas #6 received Vorlex only (Table 1).

Thirty 25 lb bagged and tagged samples of treatments #5 and #6 were stored in the MSU Food Science cubicles (60 bags). After the suberization period at 60°F the potatoes were reduced in storage temperature 5° per week to 50°F. The storage cubicles were maintained at 50°F and 95% RH until January 12, 1982. During this week the temperature was lowered to 45° to extend the storage life until May 1982. No sprout inhibitors are used in the MSU cubicles, therefore, the only control for sprouting is storage temperature.

Representative bagged samples of Superior potatoes were removed from storage and examined for market quality and checked for weight loss at three intervals of storage (77, 138 and 246 days; approximately 2, 4, and 8 months).

Discussion and results (Superior).

Market Quality. Market quality and storability are influenced by the extent of mechanical handling and storage environment. Mechanical handling (prestorage bruising) wounds the potatoes and influences soft and dry rots in storage. Sixty lots of Superior potatoes were tagged and bagged with very minimal handling other than harvesting with the MSU plot harvester.

Market quality was determined after storage by an examination of individual tubers by a plant pathologist (Dr. H.S. Potter). The potato tubers were divided into two catagories of market quality: good (marketable) and bad (not acceptable). The tubers in the bad catagory were divided into eight catagories, Table 2.

Table 2. Non-marketable tubers were divided into four levels of dry rot and four levels of soft rot*[1].

Dry Rot:		Soft Rot:	
	0.0 to 5.0%		0.0 to 5.0%
	5.1 to 10.0%		5.1 to 10.0%
	10.1 to 25.0%		10.1 to 25.0%
	over 25%		over 25%

*Miscellaneous

Tubers with disorders not attributable to storage disorders were included in the marketable catagory. Potatoes in this catagory include deformity, scab, insect chewing, etc.

Superior potatoes for the market quality evaluation were removed from storage and each tuber examined for dry and/or soft rot.

The market quality evaluation destroys the potatoes; therefore, no market quality evaluated potatoes are returned to the storage cubicles. On each market quality evaluation date twenty 25 lb bags of potatoes were examined (10 bags of treatment 5 and 10 bags for treatment 6).

In the past years the production practices used for the integrated project have not influenced the storability of potatoes. The 1981 market quality data further confirms this past data for Superior potatoes. The data shown in Table 3 illustrates that non-bruised Superior potatoes store very well. The data is presented as market quality (percent good) in two catagories; by weight and by numbers. In a 25 lb bagged sample potato size can influence the results; therefore, the potato data is recorded as to potato weight and potato numbers. The market quality for the three storage evaluation dates and two production treatments are shown in Table 3. It appears that there is no difference in storability of Superior potatoes grown with the application of Temek and Vorlex or Vorlex alone, see Table 3.

Table 3. Market quality of 1981 Superior potatoes after storage invervals (77, 138, and 246 days). These potatoes were grown for the MSU Integrated project as treatment #5 (Temek and Vorlex) and treatment #6 (Vorlex only).

Production Treatment	Market Quality Percent Good					
	By tuber wt. storage period, days			By tuber no. storage period, days		
	77	138	246	77	138	246
#5 (Temek & Vorlex)	94.3	96.5	96.1	94.8	95.2	95.9
#6 (Vorlex only)	94.5	94.6	97.1	95.4	95.5	97.1
# 5 & #6 (averaged)	94.4	95.5	96.6	95.1	95.3	96.5

Weight loss during storage was determined from 1981 Superior potatoes produced in the MSU Integrated Potato plots at the Montcalm Potato Research Station. Potatoes for this storage phase were taken from the Integrated project treatments #5 and #6 where Temek and Vorlex were used as production variables (Table 1.) Bruising for this phase was held to a minimum. The only handling prior to storage was harvesting with the MSU plot potato harvester.

Sixty samples were bagged, tagged, and weighed. Weight loss was determined by weighing after suberization and at three intervals during storage (77, 138 and 246 days).

These potatoes were stored for 138 days at 50°F and then gradually lowered to 45° and held for a total of 245 storage days. Weight loss data are shown separately for treatment #5 (Temek and Vorlex) and treatment #6 (Vorlex alone). The data for the two treatments are also averaged, the weight loss results are shown in Table 4.

Table 4. Weight loss from 1981 Superior potatoes during four intervals of storage. Potatoes were suberized for two weeks (65° and then 60°F) and then stored at 50° for 138 days. After 138 days the storage environment was gradually lowered to 45°F.

Production Treatment	Weight Loss Storage Period, Days			
	During Suberization	77 days	138 days	246 days
Treatment #5				
Weight loss, %	2.2	4.9	5.3	7.7
Range in wt loss	1.3 - 4.7	4.1 - 5.8	4.2 - 6.2	6.7 - 8.1
Wt loss factor*	0.169	0.064	0.038	0.031
Treatment #6				
Weight loss, %	2.1	4.2	5.1	7.1
Range in wt loss	1.6 - 3.8	3.5 - 5.1	4.3 - 6.2	6.3 - 8.0
Wt loss factor*	0.161	0.054	0.036	0.029
Treatment 5 & 6 (Averaged)				
Weight loss, %	2.2	4.6	5.2	7.4
Wt loss factor*	0.0165	0.059	0.037	0.030

*Weight loss % per day in storage.

Weight loss appears not to be influenced by the production treatments using Temek or Vorlex. It is important to observe in Table 4 that weight loss during suberization is an important factor. Weight loss in the nature of two percent occurs even from potatoes that are gently handled (non-bruised catagory). After suberization weight loss is greatly reduced in a properly designed storage. Weight loss factor (weight loss per day in storage) is an important factor which can help a grower determine the economics of selling or holding potatoes. Many other factors help a grower to decide to sell or hold (market quality deterioration, price, etc.) The weight loss factor predicts only the weight loss.

For example, if a grower placed 10,000 cwt of Superior potatoes in a bin at harvest, how many cwt could he predict to lose due to weight loss at the end of 60 days and 240 days storage:

10,000 cwt x 60 days x 0.59 WLF x 100 = 354 cwt

10,000 cwt x 240 days x .030 WLF x 100 = 720 cwt

If potatoes contracted for $5 out of storage at the end of 60 days (2 months); should he hold for 240 days (8 months) and take the excess weight loss. At 40¢ per month in the storage the 8 month old potatoes should sell for $7.80 or

9646 cwt @ $5.00 = $48,230
9280 cwt @ $7.80 = $72,384

This case is weight loss alone and of course weight loss is not the sole consideration but it is one of the many variables of potato storage.

Denali potato storage phase.

The 1981 Denali potatoes were harvested from the MSU Integrated Potato project plot at the MSU Potato Research Farm at Entrican, Michigan. These potatoes were harvested on September 18, 1981.

The potatoes were divided into two lots. One lot was controlled bruised by rerunning the potatoes three times over a PTO operated stationary windrower (PTO 700 rpm). This lot was designated as the 3x bruised lot. The second lot was taken directly off the MSU plot harvester and run over the conveyor used to apply the Mertect solutions. This lot was designated as the non-bruised lot.

One group of bruised and non-bruised potatoes was treated with a Mertect solution (applied with standard Delevan nozzles). Another group of bruised and non-bruised potatoes was treated with a solution of water only. Check lots of Denali potatoes were obtained from the alfalfa range (check A) and the corn range (check C). These check lots were obtained directly off the plot harvester and not run over the Mertect application conveyor. These check lots were bagged, tagged, and stored with the bruised and non-bruised lots described above. In total there were six treatments. Each treatment was stored at 40, 45, 50° for 55 and 116 days in the MSU cubicles, Table 5.

Table 5. Pre mechanically bruised and chemically treated 1981 Denali potatoes from the MSU Integrated potato project.

Code Designation	Mechanical Treatment	Chemical Treatment
A[1]	Check	Check
C[1]	Check	Check
NBW	Non Bruised	1 gal HQ/ton[2]
NBT	Non Bruised	1 gal Mertect solution/ton[3]
BW	Bruised (3x)	1 gal H_2O/ton[2]
BT	Bruised (3x)	1 gal Mertect solution/ton[3]

[1]Check lots from the alfalfa and corn rotation plots.
[2]Potatoes run over conveyor, however, only water applied.
[3]Potatoes run over conveyor and Mertect solution of 0.42 oz 340F per gallon solution was applied using the standard Delevan nozzle.

Discussion and Results

Seventy two lots of 1981 Denali potatoes were treated, bagged, tagged and stored at three temperatures 40, 45 and 50°F and 95% RH. Prior to storage all bagged samples were suberized at 60° from September 18 to October 12 and 55° from October 12 to 19. The history of these potatoes is shown in Table 6.

Table 6. History data for 1981 Denali potatoes after harvesting.

Harvested:	September 18, 1981
Method:	MSU plot harvester
Suberization at 60°	September 18 - October 5
Suberization at 55°	October 5 - October 12
Storage temperature 50°	October 12 - 19
50° environment	October 20
Storage temperature 45°	October 19 - October 27
45° environment	October 27
Storage temperature 40°	October 27

Programmed bagged lots were examined and evaluated for market quality after 55 and 116 days storage. Each storage evaluation period for market quality consisted of the individual tuber examination from two 25 lb bags per treatment for each storage temperature (36 bags).

Market quality of the six treatments is compared for the two storage duration periods in Figures 1 and 2 and Table 7. These figures and table show the importance of minimized bruising. The non-bruised treatments have a higher market quality than the controlled mechanically bruised and treated potatoes. The potatoes that were chemically treated with Mertect 340F solution have a higher market quality than equivalent potatoes that were treated with water only.

Figures 1 and 2 and Table 7 show that the highest market quality is for non-bruised chemically treated potatoes and the poorest market quality is for the bruised water treated potaotes. The figures show that market quality deteriorates with an increase in storage life.

The 1931 storage project was the first year of MSU storage research for the Denali potato. The optimum storage temperature for highest market quality is not known However, the 1981 data for the short term storage (55 days) shows that 45 and 50°F temperatures produced a higher fresh market potato quality than 40°F. The 40°F temperature produced the higher market quality for the 116 day storage period.

Table 7. Market quality (good quality %) vs. storage temperature for treated 1981 Denali potatoes stored for 55 days in MSU cubicles at 50, 45, and 40°F.

Treatment*	50° Good Quality %		45° Good Quality %		40° Good Quality %	
	Wt.**	No.**	Wt.	No.	Wt.	No.
Check	71.4	74.7	73.9	79.7	80.3	80.9
NBT	90.3	92.5	86.8	89.5	71.5	69.0
NBW	76.8	79.0	77.2	80.5	74.0	74.5
BT	57.5	69.7	62.5	67.0	49.0	53.5
BW	34.3	39.3	42.6	56.0	42.8	43.5
Average	66.1		68.6		63.5	

Market quality (good quality) vs. storage temperature for treated 1981 Denali potatoes stored for 116 days in MSU cubicles at 50, 45, and 40°F.

Check[1]	84.8	87.6	81.9	83.5	43.1	42.8
NBT	63.8	68.9	75.1	69.2	71.5	74.1
NBW	65.1	67.4	63.8	67.2	67.1	68.5
BT	23.4	23.8	26.8	33.0	34.8	40.4
BW	27.5	49.6	26.9	33.3	31.8	33.5
Average	52.9		54.9		49.7	

*See Table 1 for treatment code information.
**Due to size variation of potatoes in a bagged sample the evaluated tubers classified as marketable are reported by weight and numbers of tubers.
[1]Check A and C were combined for this table.

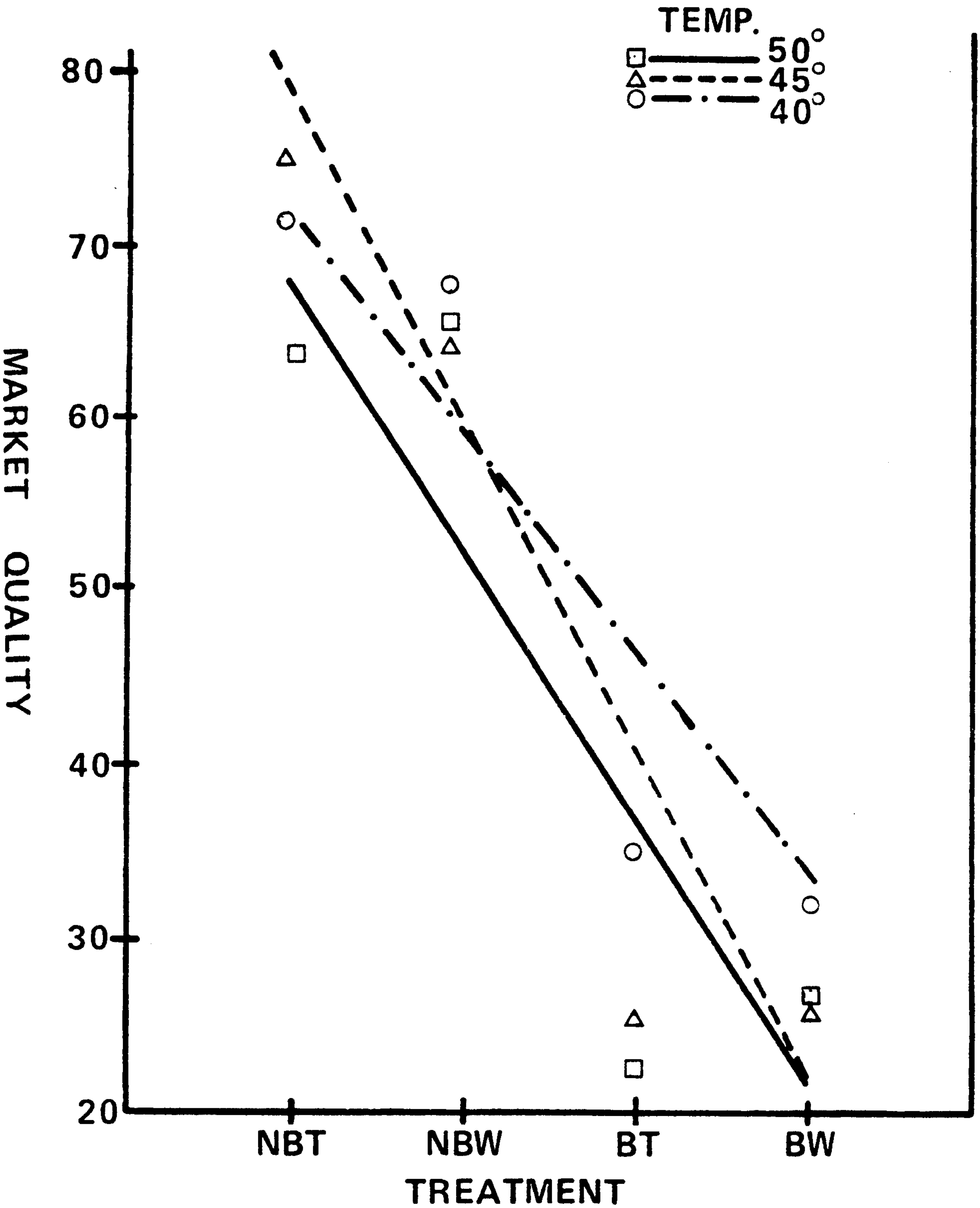


Fig. 1. Market quality of chemically and mechanically treated 1981 Denali potatoes stored for 55 days at three temperatures. The data points are calculated based on potato weights. See Table 1 for detailed description of treatments.

*See Table 1 for treatment information.

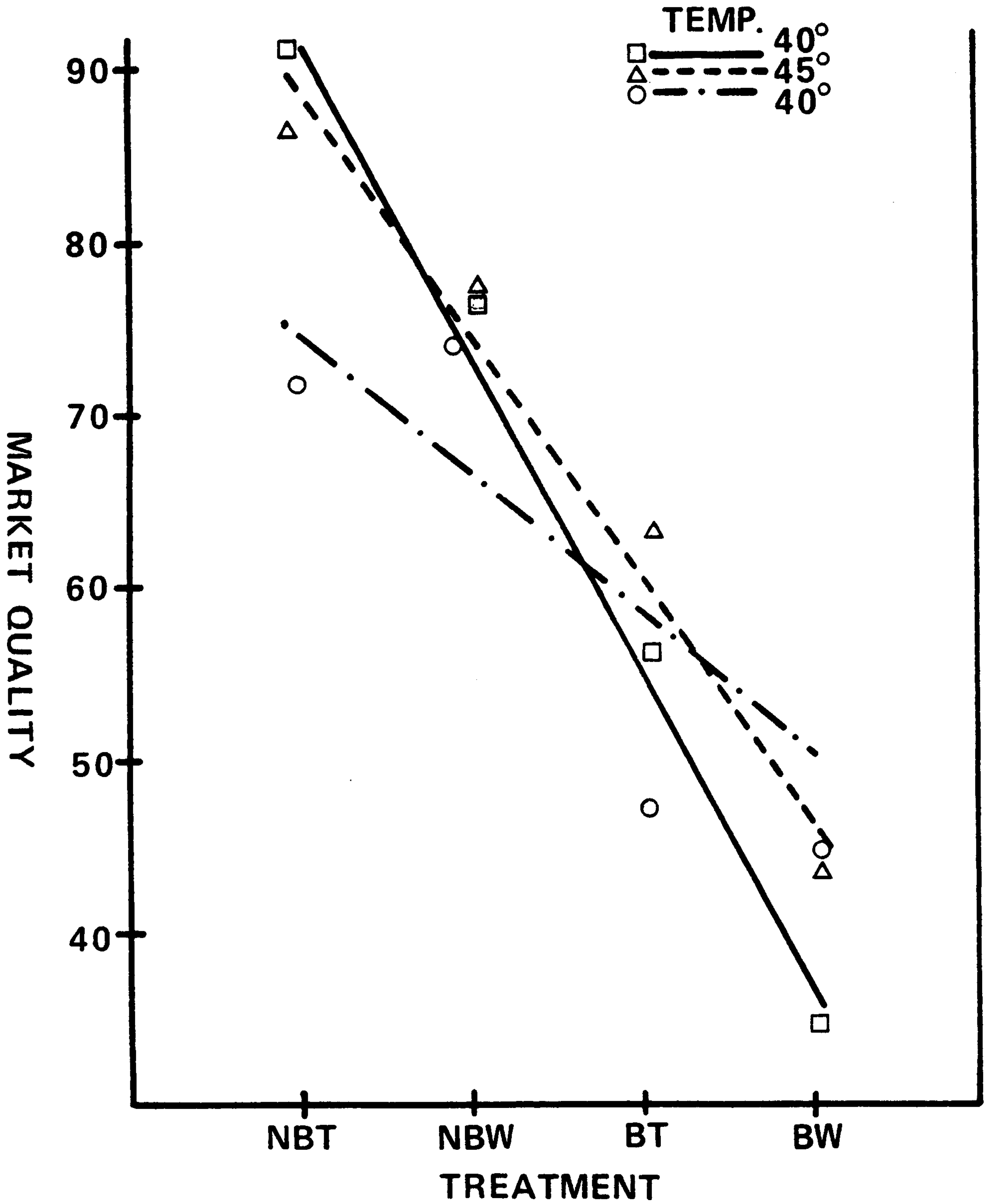


Fig. 2. Market quality of chemically and mechanically treated 1981 Denali potatoes stored for 116 days at three temperatures. The data points are calculated based on potato weights. See Table 1 for detailed description of treatments.

The 1981 Denali potatoes stored at 40, 45 and 50°F were checked for fry color directly out of the respective storage environment and after reconditioning 5° per week. Denali potatoes stored at 40° and 45° and reconditioned for four weeks did not respond to an acceptable fry color. The Denali potatoes stored at 50° had a fry color of 2.5 out of storage; 2.0 after reconditioning 1 week at 55° and 1.5 after reconditioning second week at 60°, Table 8.

Table 8. Fry color for 1981 Denali potatoes stored at 40, 45 and 50°.

Storage Temperature	Chipping Date	Fry Color*
40°	May 6, 1982	4.5
Reconditioned 1st wk. at 45°	May 13, 1982	4.5
Reconditioned 2nd wk. at 50°	May 20, 1982	4.5
Reconditioned 3rd wk. at 55°	May 27, 1982	4.5
Reconditioned 4th wk. at 60°	June 3, 1982	3.5
45°	May 6, 1982	3.5
Reconditioned 1st wk. at 50°	May 13, 1982	3.5
Reconditioned 2nd wk. at 55°	May 20, 1982	3.5
Reconditioned 3rd wk. at 60°	May 27, 1982	-
	June 3, 1982	2.5
50°	May 6, 1982	2.5
Reconditioned 1st wk. at 55°		2.5
Reconditioned 2nd wk. at 60°		1.5
	June 3, 1982	1.5

*Based on fry color standard chart 1-5 for potatoes for chipping.

The 1981 Denali potatoes were checked for weight loss during suberization and at three intervals during storage (53, 114, and 177 days). Tables 9, 10 and 11 show the weight loss at the three storage temperatures 40, 45, and 50°F.

Tables 9, 10, and 11 show that in general the weight loss for the non-bruised checks A and C is less than the non-bruised treated. An apparent reason is that the non-bruised treated potatoes did receive additional handling over the Mertect application conveyor. In general it is also shown that the bruised potatoes have higher weight loss than the non-bruised potatoes.

The weight loss data also shows that in general weight loss is less for the bruised potatoes treated with Mertect than the lots treated with water only.

Table 9. Weight loss from 1981 Denali potatoes during four intervals of storage. The potatoes were suberized for three weeks at 60 and 55°F then lowered at the rate of 5° per week to the storage environment of 40°F.

Production Treatment	Weight Loss Storage Period, Days			
	During Suberization	53 days	114 days	177 days
A				
Weight loss, %	2.0	3.9	4.4	5.7
Range in wt loss	1.4 - 2.5	3.7 - 4.4	4.4 - 4.4	
Wt loss factor %	0.12	0.074	0.038	0.032
C				
Weight loss, %	1.9	4.1	5.2	6.0
Range in wt loss	1.5 - 2.7	3.3 - 5.0	4.7 - 5.8	
Wt loss factor %	0.11	0.077	0.046	0.034
BT				
Weight loss, %	3.6	5.1	5.0	
Range in wt loss	2.5 - 4.1	1.8 - 6.9	2.3 - 6.3	
Wt loss factor %	0.21	0.097	0.044	
BW				
Weight loss, %	3.9	5.7	6.1	9.0
Range in wt loss	2.8 - 4.2	2.5 - 7.2	2.1 - 7.6	
Wt loss factor %	0.23	0.107	0.054	0.051
NBT				
Weight loss, %	2.8	4.8	5.1	6.1
Range in wt loss	2.4 - 3.8	3.7 - 5.5	4.1 - 5.6	
Wt loss factor %	0.16	0.091	0.045	0.034
NBW				
Weight loss, %	2.4	3.7	4.4	5.2
Range in wt loss	2.0 - 2.9	1.6 - 4.4	3.9 - 4.6	
Wt loss factor %	0.14	0.069	0.038	0.029

Table 10. Weight loss from 1981 Denali potatoes during four intervals of storage. The potatoes were suberized for three weeks at 60 and 55°F then lowered at the rate of 5° per week to the storage envi: ment of 45°F.

Production Treatment	Weight Loss Storage Period, Days			
	During Suberization	53 days	114 days	177 days
A				
Weight loss, %	2.5	4.2	5.1	8.1
Range in wt loss	2.3 - 2.6	3.5 - 4.7	4.7 - 5.6	
Wt loss factor %	0.15	0.079	0.045	0.046
C				
Weight loss, %	2.2	3.8	4.8	6.0
Range in wt loss	2.2 - 2.3	3.7 - 3.8	4.7 - 4.9	
Wt loss factor %	0.13	0.071	0.042	0.034
BT				
Weight loss, %	3.9	5.8	6.6	7.9
Range in wt loss	3.3 - 4.9	4.7 - 7.0	6.8 - 7.1	7.6 - 8.2
Wt loss factor %	0.23	0.109	0.058	0.045
BW				
Weight loss, %	3.7	5.9	7.2	8.5
Range in wt loss	2.8 - 4.6	5.1 - 6.7	5.9 - 8.6	7.9 - 9.8
Wt loss factor %	0.22	0.111	0.063	0.05
NBT				
Weight loss, %	2.7	4.4	5.1	6.4
Range in wt loss	2.4 - 3.1	3.7 - 4.8	4.5 - 5.6	5.9 - 6.9
Wt loss factor %	0.16	0.083	0.045	0.036
NBW				
Weight loss, %	2.6	4.3	5.1	6.4
Range in wt loss	2.2 - 3.0	3.2 - 4.9	4.4 - 5.9	6.1 - 6.8
Wt loss factor %	0.15	0.081	0.045	0.036

Table 11. Weight loss from 1981 Denali potatoes during four intervals of storage. The potatoes were suberized for three weeks at 60 and 55°F then lowered at the rate of 5° per week to the storage environment of 50°F.

Production Treatment	Weight Loss Storage Period, Days			
	During Suberization	53 days	114 days	177 days
A				
Weight loss, %	3.0	4.5	5.1	8.2
Range in wt loss	2.5 - 3.5	3.4 - 5.5	5.0 - 5.3	
Wt loss factor %	0.18	0.086	0.045	0.046
C				
Weight loss, %	3.4	5.1	6.0	8.9
Range in wt loss	3.0 - 3.6	4.9 - 5.9	5.5 - 6.5	
Wt loss factor %	0.20	0.096	0.053	0.050
BT				
Weight loss, %	4.7	5.8	7.7	10.5
Range in wt loss	4.0 - 5.1	2.4 - 7.6	5.3 - 9.9	10.5 - 10.5
Wt loss factor %	0.28	0.110	0.068	0.059
BW				
Weight loss, %	4.2	6.5	7.8	10.2
Range in wt loss	1.7 - 5.4	5.5 - 7.7	6.8 - 9.1	10.2 - 10.3
Wt loss factor %	0.25	0.123	0.069	0.058
NBT				
Weight loss, %	4.1	5.7	7.1	8.6
Range in wt loss	3.6 - 4.4	4.9 - 6.8	6.3 - 8.3	8.1 - 9.1
Wt loss factor %	0.24	0.110	0.062	0.049
NBW				
Weight loss, %	3.6	5.0	6.0	8.6
Range in wt loss	2.5 - 4.5	4.6 - 5.8	5.6 - 6.8	8.0 - 9.2
Wt loss factor %	0.21	0.095	0.053	0.049

CONCLUSION

1. Market quality (fresh market bins) was higher for short term storage (55 days) at 45 and 50°F than 40°F.

2. Market quality was higher for 116 day storage at 40°F than 45 and 50°F.

3. Non bruised potatoes have a higher market quality (fresh) than bruise treated potatoes.

4. Mertect treated bruised potatoes have a higher market quality than bruised non treated potatoes.

5. Non treated bruised potatoes have a higher weight loss than non treated non bruised potatoes.

6. In general weight loss is less for Mertect treated bruised potatoes than non treated bruised potatoes.

Alcohol Production from Potato Processing Wastes

J.N. Cash, R.D. Huang and D.R. Heldman

Potato processing wastes (PPW) may constitute up to 50% of the potato crop which is processed for food use. This large volume of PPW generated annually represents a rather serious and costly disposal problem and also the wastage of a carbohydrate-rich renewable resource which is potentially convertable into fuel alcohol. There is the potential for production of 130 million gallons of ethanol form the PPW which is annually produced in the U.S. A survey of several Michigan potato processing operations was conducted, in order to determine amounts of waste generated and the composition of waste streams. The wastes from a medium sized French fry plant, (Fig 1 and Table 1) were hydrolyzed with commercial α amylase and glucoamylase to yield a substrate with maximal amounts of hexose sugars. (Fig 2, 3, and 4). A high alcohol tolerant strain of Saccharomyces cerevisiae was used to ferment the hydrolyzed effluent. Approximately 9% (v/v basis) ehtanol production was attained, with 90% efficiency of hexose utilization using a batch type fermentation. Continuous fermentation gave approximately 1.6 times as much productivity as batch type fermentation. In calculating net energy balance, it was found that 59,544 BTU's/Gal were used in the system prior to distillation (Table 2). Distillation uses another 56,578 BTU's/Gal for a total of 116,122 BTU's/Gal (Table 3). But the energy combustion for one gallon of ethanol is only 84,378 BTU's (Table 3). Consequently, in this study there was a negative energy balance. However, fermentation of PPW did neutralize the waste dispersal costs and that was the primary goal of this work. In addition, there are a number of things which could be done to improve the efficiency of this operation, such as, (1) Develop or improve microbiological systems which will allow hydrolysis and fermentation to proceed without the addition of extraneous enzymes; (2) Determine the feasibility of recovering heat from the various processes in the system and using it in subsequent operations; (3)Improve distillation processes by changing operating parameters and/or adding liquid/liquid extraction, membrane separation and using liquid/vapor phase absorption processes; (4) Investigate the effects on ehtanol production of combining PPW with other waste products, such as, cheese whey and fruit and vegetable pomace.

Table 1. Profile of Waste from Different Potato Processing Operations

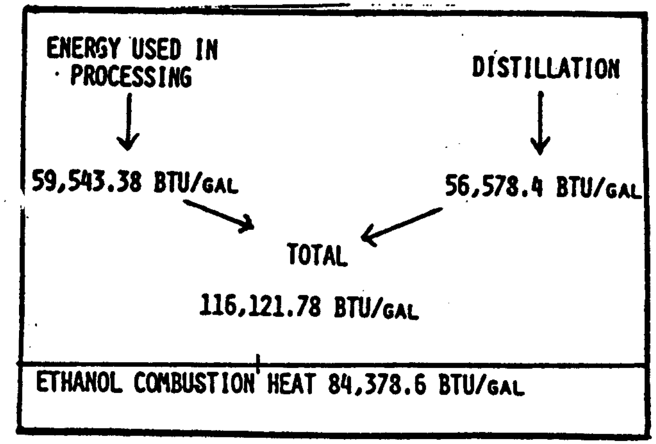
Operation Units		Percent of Total Incoming Raw Potato	Percent of Total Waste	Percent Starch of Total Waste
	Grading, Cull, Silt	1.49	4.0	0.49
	Screened Waste	0.06	0.2	0.01
	Peel Loss	12.55	34.0	1.01
	Dry Handle Waste	0.93	2.5	0.27
*Final Hopper	Scrubber-Loss	2.50	7.0	0.34
*Final Hopper	Trimming Loss	5.82	16.0	2.00
*Final Hopper	Sizer Loss	7.44	20.3	2.19
*Final Hopper	Miscellaneous (Hydrosive & Centrifuge)	5.87	16.0	1.15
	Total	36.66	100.0	7.46

*The final hopper included these fractions which contained 59.3 % of total waste and 76 % of total starch.

Table 2. Calculated Total Energy Input Prior to Distillation

Activity Type	100% Efficiency Energy Expenditure BTU/gal	70% Efficiency Energy Expenditure BTU/gal
Grinding	7360.58	7360.58
Liquefaction	24409.58	30584.68
Saccharification	2507.57	3582.24
Fermentation(Batch)	18015.88	18015.88
Total	49293.61	59543.38

TABLE 3. ENERGY BALANCE



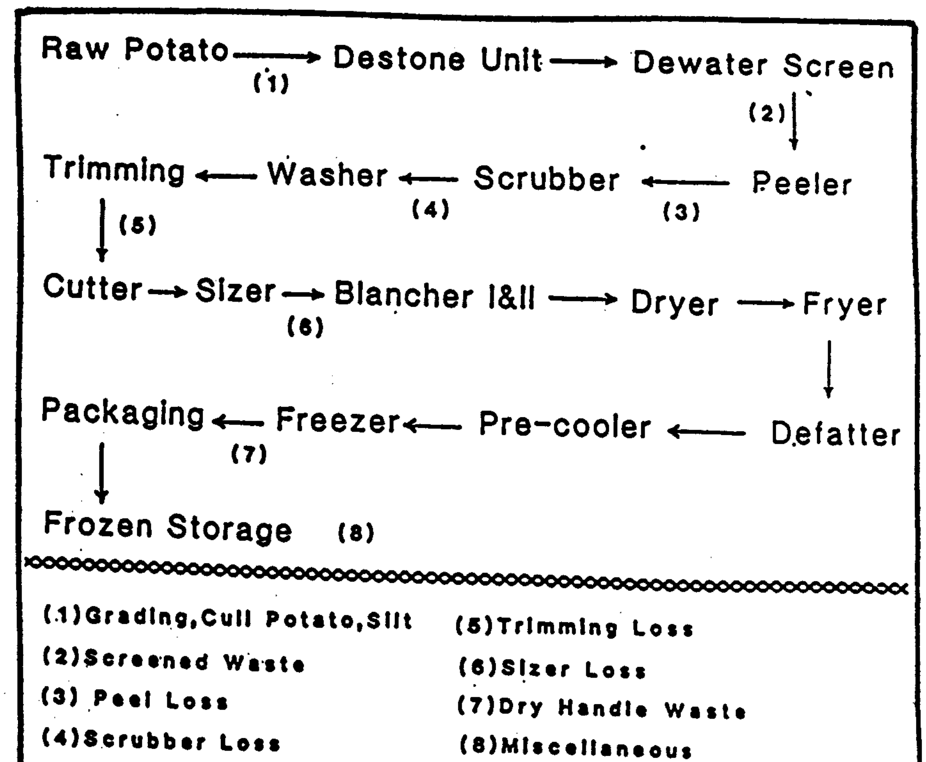


Figure 1. French Fry Plant Flow Chart and Waste Generation Units

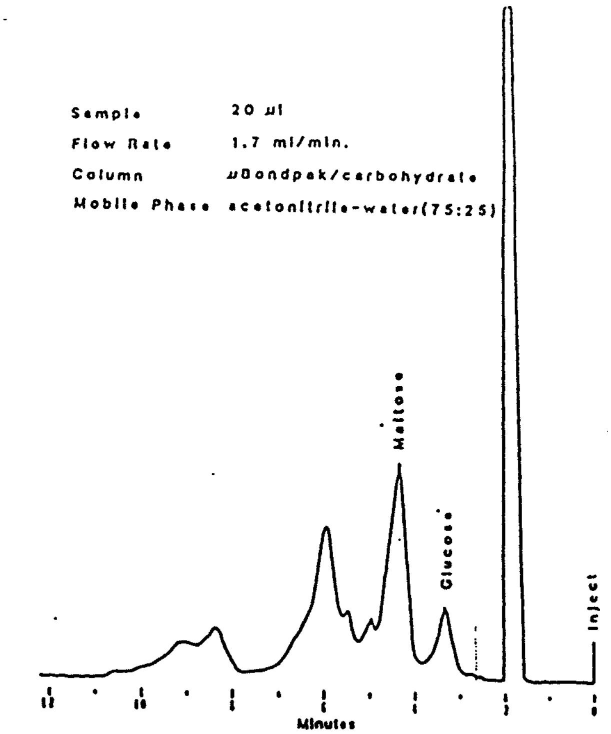


Figure 2. High Performance Liquid Chromatogram of Sugars from Ground Potato Processing Waste

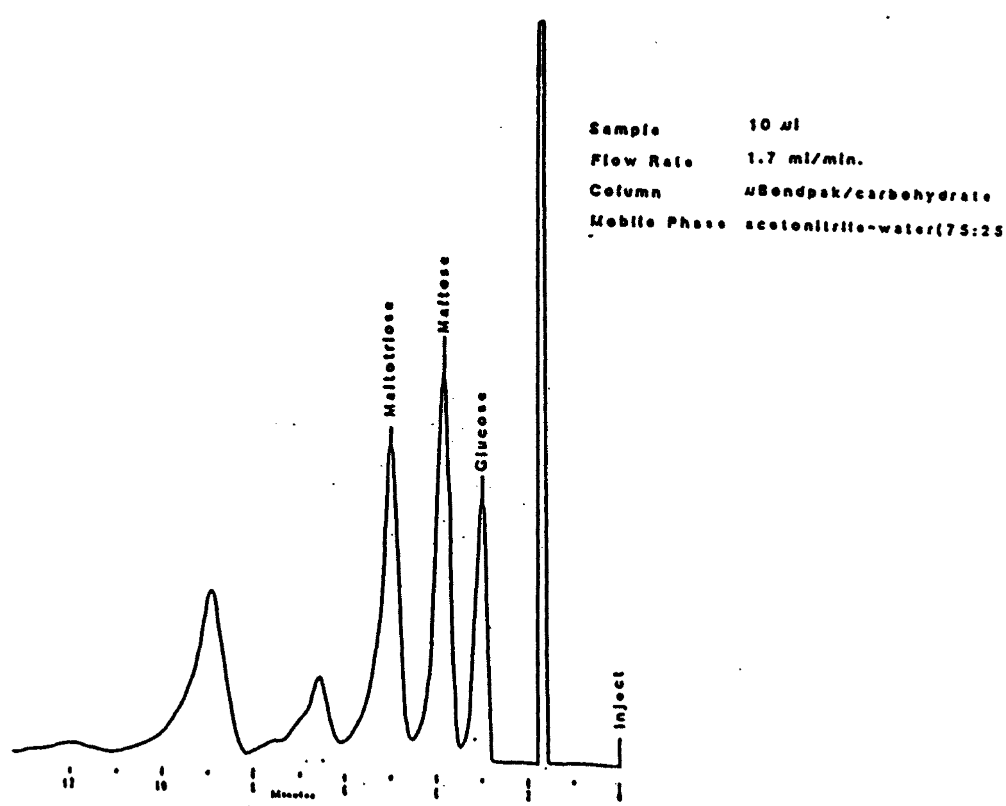


Figure 3. High Performance Liquid Chromatogram of Potato Processing Waste after Completion of Liquefaction with α-amylase

ALCOHOL PRODUCTION FROM POTATO PROCESSING WASTES

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SUMMARY:

Direct fermentation of unhydrolyzed starch, recovered from potato processing wastes, by a synergistic mixed culture of a starch digesting fungus or yeast and a non-starch digesting, ethanol-producing yeast to produce alcohol was investigated. The results showed that a combination of Aspergillus niger and S. cerevisiae was better than a number of others tested in showing higher amylolytic activity and in giving greater yields of ethanol. Both amylolytic activity and ethanol yields were optimal at pH 5.5. The type of aeration employed had a profound effect on ethanol yields. The rate of production of alcohol was greatly influenced by the concentration of Saccharomyces in the inoculum. Increasing Saccharomyces inoculum from 4% to 12% gave a dramatic increase in the rate of ethanol production. Ethanol yields greater than 96% of the theoretical were obtained. The results of this investigation clearly showed that fermentation of potato processing wastes by a mixture of starch-digesting fungus or yeast and alcohol producer such as Saccharomyces is clearly feasible on a laboratory scale. This fermentation needs to be scaled up to a pilot plant level to determine the industrial feasibility of the process.

INTRODUCTION:

It has been well established that during the processing of potatoes to produce french fries and other food products a substantial percentage (35-50%) of the potato tuber ends up as waste (Fig. 1). An estimated 4×10^9 kg of potato processing wastes (PPW) are generated per annum in the U.S. alone. The disposal of the PPW is very costly and also represents a wastage of enormous quantities of starch which is potentially utilizable. Fermentation of starch in PPW to ethanol would eliminate a costly disposal problem and potentially yield 130 million gallons of fuel grade alcohol.

In most processes currently being employed for the production of ethanol from starchy feedstocks, the starch is first hydrolyzed to glucose by commercially available thermophilic amylases and the glucose produced is then fermented to ethanol (Fig. 2). With the eventual objective of improving the economy of PPW fermentation to alcohol, we investigated in this study the possibility of eliminating the initial step of starch hydrolysis by commercial amylases and instead use a synergistic mixture of amylase- producing fungus or yeast which digests starch to glucose and second organism, Saccharomyces cerevisiae which ferments sugar to ethanol.

METHODS:

Potato starch used in this investigation was recovered from waste stream generated by Allied Foods potato chip manufacturing plant located in Livonia, Michigan. This substrate is here after referred to as PPW and contained 98.6% (w/w) carbohydrate. Unless otherwise mentioned, fermentations were conducted in one liter flasks in a sterile medium containing PPW, peptone (0.1%) and minerals. All fermentations were conducted at 30 C at pH 5.5. Flasks were inoculated with different yeasts, fungi or a synergistic combination of both as described in results. Inoculum level was 5% (v/v) unless mentioned otherwise.

Fermentation samples were collected at specified intervals and were analyzed for reducing sugar, total carbohydrate, ethyl alcohol, amylolytic activity and cell yield (dry weight).

RESULTS:

The results of fermentation of PPW by *Aspergillus niger* (a starch digesting fungus) alone, and by a mixture of *A. niger* and *S. cerevisiae* show that starch utilization by both the cultures was comparable but ethanol production was substantially higher by the mixed culture. Furthermore, ethanol production was proportional to the PPW concentration. *A. niger* in pure culture produced very small amounts of ethanol.

The above results clearly indicated that the idea of using a synergistic combination of a starch-digesting microorganism and an alcohol-producing organism is a viable one; however, alcohol yields were relatively low. Therefore, experiments were initiated to optimize the fermentation conditions. The results in Fig. 4 show that the optimum pH for ethanol yield and amylolytic activity is between 5-6. Other experiemnts (not shown here) suggested that *S. cerevisiae* concentration is the rate-limiting step in the fermentation. Hence the effect of increasing concentration of *S. cerevisiae* on fermentation was tested. The results (Fig. 5) showed that ethanol yields ∿96% of the theoretical yeilds could be obtained within 2 days with 10-12% concentration of *S. cerevisiae*. Similar experiments with 8 different combinationns of *S. cerevisiae* and starch digesting organisms (other than *A. niger*) showed that *A. niger* plus *S. cerevisiae* is the most efficient combination.

The results of this investigation clearly showed that fermentation of PPW by a mixture of a starch digesting fungus and an alcohol producer such as *Saccharomyces* is clearly feasible. Such a synergistic combination of organisms may greatly improve the economy of fermentation of PPW to produce fuel-grade alcohol.

Fig. 1

POTATO PROCESSING WASTE

Large percentage of the potato tuber ends up as waste

An estimated four billion Kg wastes per annum

Costly disposal problem ; Wastage of a potential resource

Wased starch equivalent to about 130 million gallons of alcohol

Fermentation of potato prooessing waste to alcohol has economic potential

Fig. 2

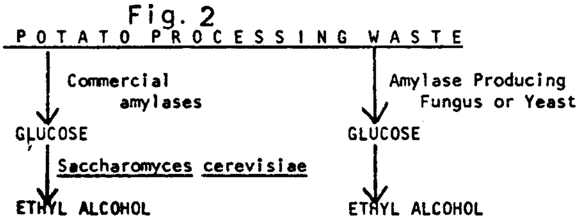


Fig. 3

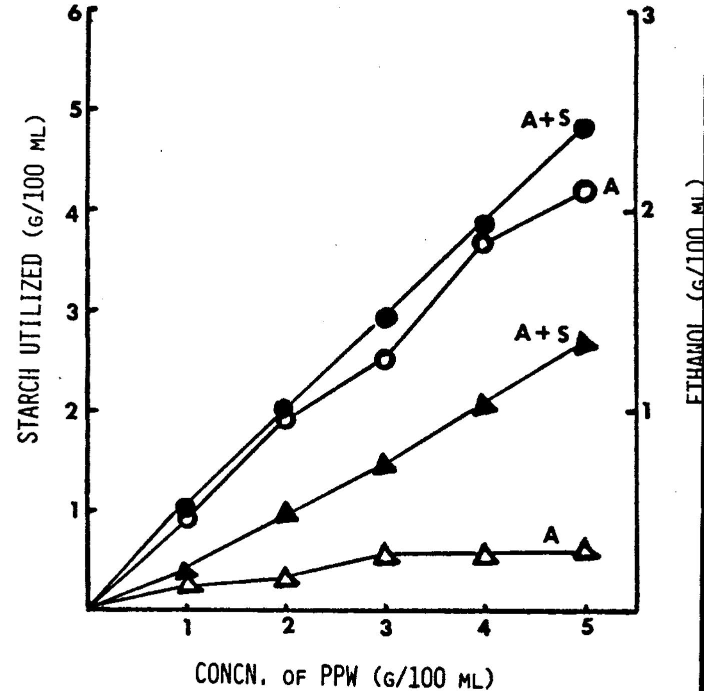


Fig. 4

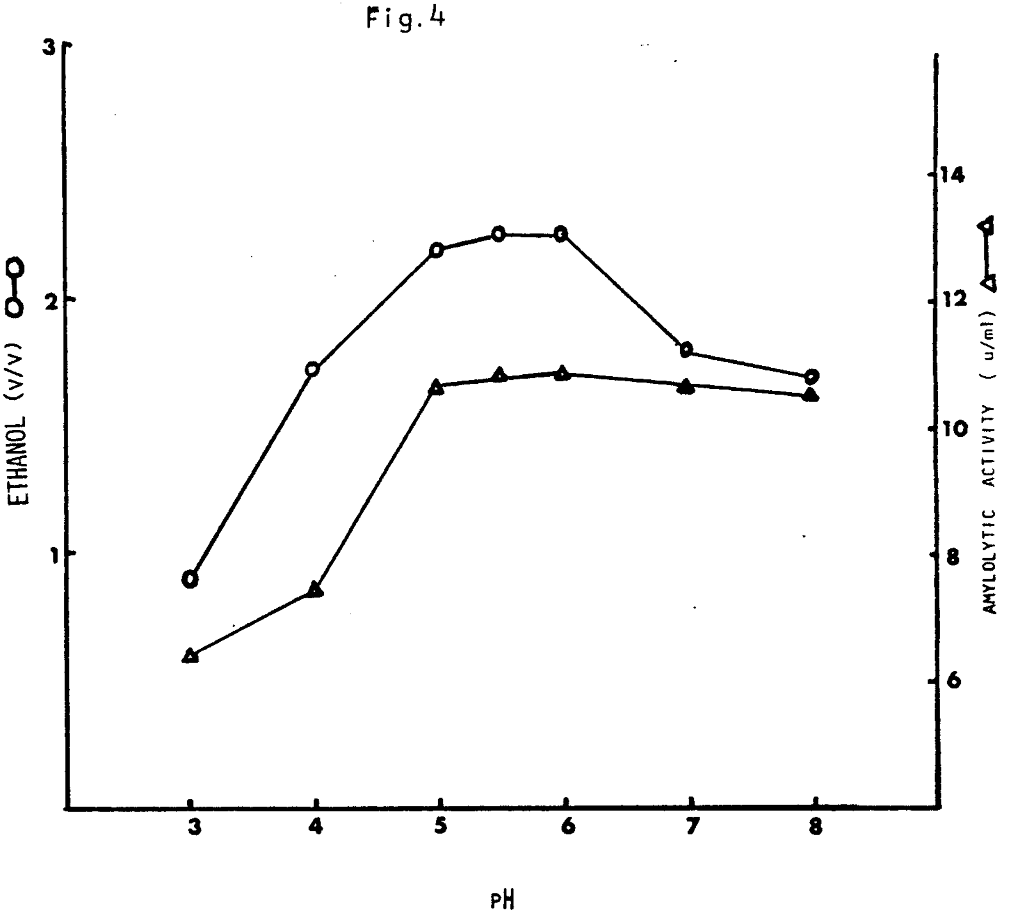
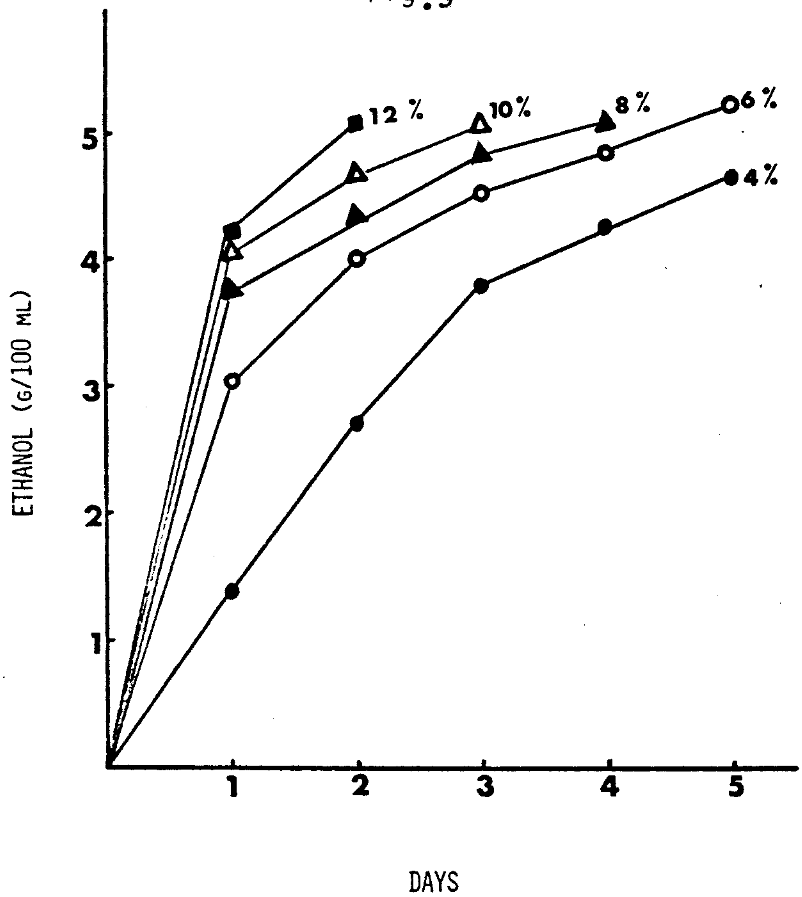


Fig.5



Corn Hybrids, Plant Populations and Irrigation

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Performance data for 82 commercial corn hybrids evaluated in 1982 with and without irrigation are presented in Table 1 along with two and three year averages for those tested in 1981 and 1980, also. Irrigation was applied when soil moisture reached 50% or less of water holding capacity at 6" level. Four inches of supplemental water was applied during July and August.

Irrigated yields averaged 33.0 bushels more than nonirrigated — 146.0 vs. 113.0, an increase of 29%. Hybrids ranged from 108.6 to 183.3 with irrigation and 83.1 to 139.3 without irrigation. Hybrids significantly better than average yield (arranged in order of increasing grain moisture content at harvested) are listed below. Seventeen of the 20 hybrids were in the highest yielding group for both irrigated and nonirrigated plots.

IRRIGATED	NOT IRRIGATED
Garno S90 (2X)	Garno S90 (2X)
Great Lakes GL-422 (2X)	Great Lakes GL-422 (2X)
Stanton SX1095 (2X)	Stanton SX1095 (2X)
Super Crost 2350 (2X)	Super Crost 2350 (2X)
Pioneer 3901 (2X)	Pioneer 3901 (2X)
Hyland HL-2454 (2X)	Payco SX620 (2X)
Payco SX620 (2X)	Pioneer 3744 (2X)
DeKalb EX-1123 (2X)	Northrup King PX37 (2X)
Pioneer 3744 (2X)	DeKalb EX-2120 (2X)
Northrup King PX37 (2X)	Migro M-2018X (2X)
Migro M-2018X (2X)	Stauffer Seeds 606WX (2X)
Stauffer Seeds 606WX (2X)	Great Lakes GL-522 (2X)
Great Lakes GL-522 (2X)	DeKalb T1000 (2X)
DeKalb T1000 (2X)	Northrup King PX39 (2X)
Northrup King PX39 (2X)	DeKalb XL-32A (2X)
DeKalb XL-32A (2X)	Payco SX844 (2X)
Payco SX844 (2X)	Stauffer Seeds S5650 (2X)
Stauffer Seeds S5260 (2X)	Stauffer Seeds S5260 (2X)
Leader SX495 (2X)	Leader SX495 (2X)
Kaltenberg KX68 (2X)	Kaltenberg KX68 (2X)

The correlation of irrigated with nonirrigated yields was highly significant, .817, indicating that the hybrids tended to respond alike in both situations. During the 15-year period, 1968-1982, the correlations have ranged between .7 and .9 except for 1976 when it was .490. All correlations have been highly significant.

Average, highest and lowest yields for corn hybrids irrigated and not irrigated for the 15-year period, 1968-1982, are given in Table 2. The average yielding hybrids have yielded 44 more bushels when irrigated. The highest yielding hybrids have responded with 57 bushels added yield while the lowest yielding hybrids have given only 30 bushels added yield when irrigated. These results demonstrate the importance of choosing high yielding hybrids to maximize returns from irrigation with little, if any, additional cost.

There was three times more stalk lodging without irrigation, 3.8 vs. 11.4% (Table 1). In most (but not all) of the previous years, there was less lodging on the irrigated plots. Generally, stressed weaker plants on nonirrigated plots have been more susceptible to lodging. In 1982, the highest lodging was 9.2% stalk breakage when irrigated compared to 33.6% when not irrigated.

PLANT POPULATION X HYBRIDS

Five adapted hybrids at four plant populations irrigated and not irrigated have been grown in each of the 15 years, 1968-1982, Table 3. Over the 15-year period a harvest plant population of 23,300 has given the highest average yield (165 bushels per acre) when irrigated while 19,300 has given the highest yield (110 bushels) without irrigation. The 23,300 population irrigated has given the highest yield in 12 out of 15 years (1973, 1979 and 1981 being the exceptions). The irrigated yields in 1982 were 150, 168, 177 and 176 for harvest populations of 15,250, 19,300, 23,300 and 27,450, respectively. The 15-year average increase due to irrigation is 63 bushels per acre at the 23,300 population. Nonirrigated yields were 122, 131, 124 and 117 for the same four populations in 1982.

Stalk lodging has increased with plant population. In 1982, there was 5-7 times more lodging at 28,100 than there was at 16,000. Moisture content of grain at harvest has averaged 1-2% higher for the higher populations.

TABLE 1.

NORTH CENTRAL MICHIGAN — Zone 3

Montcalm County Trial - Irrigated vs. Not Irrigated
One, Two, Three Year Averages - 1982, 1981, 1980

Hybrid (Brand-Variety)	% Moisture			Bushels Per Acre						% Stalk Lodging					
	1982	2 Yrs.	3 Yrs.	1982 Irrig	1982 Not Irrig	2 Years Irrig	2 Years Not Irrig	3 Years Irrig	3 Years Not Irrig	1982 Irrig	1982 Not Irrig	2 Years Irrig	2 Years Not Irrig	3 Years Irrig	3 Years Not Irrig
Stanton SX1090 (2X)	20.2	--	--	136.3	108.9	---	---	---	---	0.0	7.2	--	--	--	--
Eastland 238 (MSX)	20.3	--	--	108.6	94.4	---	---	---	---	5.2	6.4	--	--	--	--
McKenzie 870 (2X)	20.3	23	--	120.7	108.6	125	101	---	---	0.8	5.0	3	9	--	--
DeKalb EX-1112 (2X)	20.5	--	--	130.9	106.3	---	---	---	---	0.7	11.5	--	--	--	--
Hyland HL-2428 (2X)	20.5	--	--	127.8	89.8	---	---	---	---	6.9	22.5	--	--	--	--
Dairyland DX1094 (2X)	20.8	--	--	144.3	104.9	---	---	---	---	1.5	6.7	--	--	--	--
Payco SX599 (2X)	21.0	--	--	115.1	90.1	---	---	---	---	1.5	9.9	--	--	--	--
Golden Harvest H-2380 (2X)	21.0	--	--	159.0	124.2	---	---	---	---	5.6	10.5	--	--	--	--
Asgrow RX355 (2X)	21.1	21	--	130.5	95.7	117	82	---	---	4.8	15.0	11	15	--	--
Stauffer Seeds S2202 (2X)	21.1	21	--	117.4	93.6	105	79	---	---	8.3	6.3	7	9	--	--
DeKalb EX-1615 (2X)	21.2	--	--	154.6	110.8	---	---	---	---	3.6	18.3	--	--	--	--
*†Garno S-90 (2X)	21.2	22	23	163.6	126.3	142	110	136	113	4.4	12.4	4	8	8	10
Garno S-85 (2X)	21.3	22	--	133.1	100.7	114	85	---	---	3.1	3.0	4	4	--	--
Dairyland DX1003 (2X)	21.4	23	24	152.9	114.4	138	107	134	111	1.4	9.9	4	7	5	8
Payco SX431 (2X)	21.6	--	--	112.7	92.0	---	---	---	---	6.3	10.6	--	--	--	--

(continued)

TABLE 1. (continued)

Hybrid (Brand-Variety)	% Moisture 1982	% Moisture 2 Yrs.	% Moisture 3 Yrs.	Bushels Per Acre 1982 Irrig	Bushels Per Acre 1982 Not Irrig	Bushels Per Acre 2 Years Irrig	Bushels Per Acre 2 Years Not Irrig	Bushels Per Acre 3 Years Irrig	Bushels Per Acre 3 Years Not Irrig	% Stalk Lodging 1982 Irrig	% Stalk Lodging 1982 Not Irrig	% Stalk Lodging 2 Years Irrig	% Stalk Lodging 2 Years Not Irrig	% Stalk Lodging 3 Years Irrig	% Stalk Lodging 3 Years Not Irrig
Stauffer Seeds S3242 (2X)	21.6	--	--	112.7	97.1	---	---	---	---	2.3	6.2	--	--	--	--
Dairyland DX1096 (2X)	21.6	22	23	156.4	117.1	139	109	139	117	7.9	9.7	10	12	10	12
Jacques JX97 (2X)	21.7	--	--	150.6	111.0	---	---	---	---	3.7	13.4	--	--	--	--
DeKalb XL-8 (2X)	21.7	--	--	132.6	104.8	---	---	---	---	3.9	4.6	--	--	--	--
Pride 3332 (2X)	21.7	22	--	125.7	104.7	108	91	---	---	8.3	15.5	12	15	--	--
DeKalb XL-14AA (2X)	21.7	22	23	151.9	112.9	135	102	134	112	2.4	11.4	4	9	7	8
*†Great Lakes GL-422 (2X)	21.7	22	22	161.2	123.9	143	109	139	112	5.3	10.5	5	7	7	10
Funk G-4256 (3X)	21.8	23	23	135.1	105.3	125	96	118	96	3.0	12.8	2	11	9	14
Leader SX475 (2X)	21.9	--	--	113.3	92.4	---	---	---	---	3.2	18.9	--	--	--	--
Pioneer 3958 (2X)	21.9	22	23	147.7	115.8	125	92	117	94	2.3	6.1	5	13	5	14
Northrup King PX449 (3X)	22.0	--	--	120.0	103.7	---	---	---	---	3.7	4.1	--	--	--	--
Migro HP-266 (2X)	22.1	--	--	144.3	117.7	---	---	---	---	6.3	2.9	--	--	--	--
Hyland HL-2440 (2X)	22.2	--	--	118.8	92.4	---	---	---	---	2.5	15.9	--	--	--	--
*†Stanton SX1095 (2X)	22.2	--	--	166.6	125.8	---	---	---	---	3.1	14.7	--	--	--	--
*†Super Crost 2350 (2X)	22.3	24	24	162.1	124.9	151	113	148	121	3.6	15.6	4	13	5	10
*†Pioneer 3901 (2X)	22.3	22	23	162.4	124.7	146	111	148	120	3.0	6.7	2	4	4	6
Pioneer 3906 (2X)	22.3	23	--	149.0	120.5	140	109	---	---	0.7	2.2	2	4	--	--
Northrup King PX9288 (2X)	22.4	--	--	122.1	98.2	---	---	---	---	4.5	9.2	--	--	--	--
Kaltenberg KX55 (2X)	22.5	24	--	139.1	101.0	128	92	---	---	4.9	13.1	7	10	--	--
Great Lakes GL-455 (2X)	22.5	23	23	155.5	121.9	142	110	145	118	4.5	15.4	7	14	11	17
*Hyland HL-2454 (2X)	22.5	24	--	164.6	122.7	142	105	---	---	4.2	5.5	6	8	--	--
McKenzie 927 (MSX)	22.5	23	--	122.1	101.1	105	85	---	---	9.0	13.8	8	10	--	--
*†Payco SX620 (2X)	22.6	--	--	164.1	124.8	---	---	---	---	2.3	9.6	--	--	--	--
*DeKalb EX-1213 (2X)	22.6	23	--	163.2	121.1	134	103	---	---	3.0	14.4	6	12	--	--
Warwick W901 (2X)	22.6	22	23	141.2	83.1	125	82	119	85	3.6	33.6	7	25	10	24
Pioneer 3780 (2X)	22.6	23	24	151.7	114.6	136	103	137	112	2.2	11.9	4	12	5	10
Stauffer Seeds S3306 (2X)	22.7	22	--	120.2	91.0	119	93	---	---	6.3	9.1	5	7	--	--
P.A.G. SX181 (2X)	22.7	23	24	150.3	104.9	137	99	135	106	1.6	9.5	3	14	10	17
McKenzie 980 (2X)	22.9	--	--	140.3	119.1	---	---	---	---	2.3	2.0	--	--	--	--
*†Pioneer 3744 (2X)	23.1	24	--	160.1	125.5	145	117	---	---	1.4	8.6	2	7	--	--
Funk G-4224 (MSX)	23.2	24	24	123.7	100.2	117	95	115	97	3.8	15.7	4	11	10	15
Northrup King PX485 (2X)	23.2	--	--	123.9	101.9	---	---	---	---	4.4	15.3	--	--	--	--
Great Lakes GL-466 (2X)	23.4	24	--	158.2	118.5	138	101	---	---	2.9	6.2	3	8	--	--
Migro HP-277 (2X)	23.6	23	--	143.5	114.5	129	98	---	---	2.9	5.9	3	4	--	--
*†Northrup King PX37 (2X)	23.6	--	--	171.5	134.0	---	---	---	---	1.5	4.2	--	--	--	--
†DeKalb EX-2120 (2X)	23.7	--	--	145.7	123.8	---	---	---	---	0.7	9.7	--	--	--	--
Jacques JX151 (2X)	23.8	--	--	149.5	112.5	---	---	---	---	5.8	12.6	--	--	--	--
P.A.G. SX189 (2X)	23.8	--	--	158.9	113.1	---	---	---	---	3.1	13.6	--	--	--	--
Great Lakes GL-477 (2X)	23.8	24	25	156.2	115.5	144	107	148	120	5.9	10.1	7	10	7	10
Pride 4461 (2X)	24.1	--	--	143.0	111.7	---	---	---	---	5.9	11.2	--	--	--	--
Super Crost 2396 (2X)	24.2	25	26	158.8	118.9	145	110	141	112	5.8	12.3	5	11	7	12
Paymaster 2990 (2X)	24.2	--	--	153.8	115.5	---	---	---	---	6.4	12.2	--	--	--	--
Dairyland DX1006 (2X)	24.4	--	--	155.3	109.8	---	---	---	---	6.5	16.0	--	--	--	--
*†Migro M-2018X (2X)	24.4	26	27	169.0	128.4	152	118	153	126	3.0	7.5	3	5	4	6
Northrup King PX9415 (2X)	24.4	--	--	152.7	114.5	---	---	---	---	3.1	13.3	--	--	--	--

(continued)

TABLE 1. (continued)

Hybrid (Brand-Variety)	% Moisture 1982	% Moisture 2 Yrs.	% Moisture 3 Yrs.	Bushels Per Acre 1982 Irrig	Bushels Per Acre 1982 Not Irrig	Bushels Per Acre 2 Years Irrig	Bushels Per Acre 2 Years Not Irrig	Bushels Per Acre 3 Years Irrig	Bushels Per Acre 3 Years Not Irrig	% Stalk Lodging 1982 Irrig	% Stalk Lodging 1982 Not Irrig	% Stalk Lodging 2 Years Irrig	% Stalk Lodging 2 Years Not Irrig	% Stalk Lodging 3 Years Irrig	% Stalk Lodging 3 Years Not Irrig
DeKalb T950 (2X)	24.6	24	--	130.4	102.6	113	86	---	---	5.1	12.1	5	8	--	--
Stauffer Seeds S4402 (2X)	24.6	24	--	155.5	116.9	139	101	---	---	8.0	12.9	7	12	--	--
Funk G-4315 (MSX)	24.7	--	--	134.6	104.0	---	---	---	---	3.7	14.1	--	--	--	--
Payco SX788 (2X)	24.8	26	--	148.5	119.4	140	110	---	---	5.2	9.0	7	11	--	--
Super Crost 2410 (2X)	25.1	26	--	144.5	119.8	138	109	---	---	5.3	9.4	6	7	--	--
*†Stauffer Seeds 606WX (2X)	25.2	--	--	163.5	128.2	---	---	---	---	1.5	16.9	--	--	--	--
Stanton SX10100 (2X)	25.4	--	--	144.9	120.0	---	---	---	---	9.2	12.4	--	--	--	--
*†Great Lakes GL-522 (2X)	25.5	26	--	177.2	133.1	153	118	---	---	0.0	8.9	0	6	--	--
Dairyland DX1105 (2X)	25.5	--	--	151.7	109.0	---	---	---	---	5.8	11.6	--	--	--	--
*†DeKalb T1000 (2X)	25.5	26	--	167.5	125.3	145	107	---	---	3.7	8.3	4	9	--	--
Leader SX490 (2X)	25.5	--	--	152.9	112.6	---	---	---	---	6.3	9.0	--	--	--	--
Kaltenberg KX61 (2X)	25.6	--	--	142.6	110.3	---	---	---	---	5.1	9.4	--	--	--	--
*†Northrup King PX39 (2X)	25.7	--	--	167.6	125.5	---	---	---	---	2.4	5.1	--	--	--	--
*†DeKalb XL-32A (2X)	25.7	27	--	183.3	132.8	154	115	---	---	2.9	8.6	3	7	--	--
Stauffer Seeds S5602 (2X)	25.7	26	--	134.3	104.6	128	97	---	---	3.7	7.7	4	10	--	--
Leader SX510 (2X)	25.9	--	--	135.0	110.9	---	---	---	---	2.3	15.0	--	--	--	--
*†Payco SX844 (2X)	25.9	26	--	169.6	128.7	147	106	---	---	2.2	9.8	2	8	--	--
†Stauffer Seeds S5650 (2X)	26.0	--	--	155.0	128.4	---	---	---	---	0.0	6.4	--	--	--	--
*†Stauffer Seeds S5260 (2X)	26.1	27	--	183.0	139.3	145	112	---	---	1.5	4.0	2	5	--	--
Golden Harvest XS-436 (2X)	26.4	27	--	158.2	124.1	136	107	---	---	0.8	1.7	5	4	--	--
*†Leader SX495 (2X)	26.5	--	--	166.1	129.9	---	---	---	---	6.0	8.2	--	--	--	--
*†Kaltenberg KX68 (2X)	26.6	27	--	161.8	126.3	144	111	---	---	2.7	6.8	4	4	--	--
Average	23.1	24	24	146.0	113.0	134	102	136	110	3.8	11.4	5	9	7	12
Range	20.2 to 26.6	21 to 27	22 to 27	108.6 to 183.3	83.1 to 139.3	105 to 154	79 to 118	115 to 153	85 to 126	0.0 to 9.2	1.7 to 33.6	0 to 12	4 to 25	4 to 11	6 to 24
Least Significant Difference	1.5	0.9	0.7	13.7	10.8	9	6	7	5	--	--	--	--	--	--

*Significantly better than average yield, irrigated, in 1982.
†Significantly better than average yield, not irrigated, in 1982.

	1982	*1981*	*1980*
Planted	*May 6*	*May 2*	*May 12*
Harvested	*November 3*	*November 6*	*November 11*
Soil Type	*Montcalm-McBride sandy loam*	*Montcalm-McBride sandy loam*	*Montcalm-McBride sandy loam*
Previous Crop	*Alfalfa*	*Alfalfa*	*Alfalfa*
Population	*21,000*	*20,850*	*20,700*
Rows	*30"*	*30"*	*30"*
Fertilizer	*342-139-139*	*323-143-143*	*315-155-155*
Irrigation	*4 inches*	*4 inches*	*3 inches*
Soil Type: pH	*5.6*	*5.9*	*6.9*
P	*562 (very high)*	*512 (very high)*	*528 (very high)*
K	*251 (high)*	*284 (high)*	*290 (high)*

Farm Cooperator: Theron Comden, Montcalm Research Farm, Lakeview

County Extension Director: James Crosby, Stanton

TABLE 2. Average, highest and lowest yields for corn hybrids irrigated and not irrigated for 15 years, 1968-1982.

Year	No. of Hybrids Tested	AVERAGE		HIGHEST		LOWEST	
		Irrigated	Not Irrigated	Irrigated	Not Irrigated	Irrigated	Not Irrigated
1982	82	146	113	183	139	109	83
1981	90	115	87	141	111	85	62
1980	71	126	114	167	156	74	65
1979	83	109	67	142	92	67	42
1978	73	144	88	186	112	92	61
1977	74	125	73	158	88	89	56
1976	80	156	72	183	93	120	49
1975	75	154	125	207	157	106	80
1974	76	112	103	134	122	65	58
1973	72	114	101	138	120	78	73
1972	72	157	137	206	179	99	91
1971	56	163	28	211	42	91	11
1970	64	144	103	194	128	95	70
1969	63	146	86	185	109	97	56
1968	56	136	96	182	123	92	65
AVERAGE		137	93	175	118	91	61

TABLE 3. Average yield at four plant populations irrigated and not irrigated for 15 years, 1968-1982.

Year	15,250		19,300		23,300		27,450	
	Irrigated	Not Irrigated	Irrigated	Not Irrigated	Irrigated	Not Irrigated	Irrigated	Not Irrigated
1982	150	120	168	131	177	124	176	117
1981	122	93	132	102	130	94	119	86
1980	133	123	146	135	150	131	141	124
1979	123	77	140	87	138	83	131	78
1978	146	92	164	110	175	100	165	94
1977	141	74	152	81	160	70	150	69
1976	153	72	174	84	181	81	161	68
1975	158	136	183	164	196	151	172	146
1974	118	100	130	111	135	98	120	94
1973	108	97	134	116	128	106	108	102
1972	152	132	187	159	191	149	161	144
1971	173	37	189	35	191	20	181	11
1970	122	91	144	112	158	93	151	85
1969	126	91	158	109	173	96	148	86
1968	144	114	169	130	193	107	178	89
AVERAGE	139	98	158	110	165	102	150	94

BIOLOGICAL NITROGEN FIXATION (BNF) EXPERIMENT

M.W. Adams, J.D. Kelly, A. Ghaderi, C. Samper

This experiment was essentially a simple screening test of 92 entries on normal and low N-status sites at the Comden (Montcalm) Farm to see whether some genotypes under low soil N might, through BNF, approach or equal yields obtained when mineral N (as nitrate) was supplied. The low N site had been prepared by the growing and removal of a vegetative crop of sudan grass on the site in 1980 and 1981 without benefit of applied N. Replications 1 and 2 were planted on the low N site (3 pounds N per 1,000,000 pounds soil), and replications 3 and 4 on an adjacent site receiving 40 pounds/acre of N at planting time.

Plots consisted of single rows, 20 inches apart, 16 feet long; 2 meters (6.5 ft) were hand-pulled at maturity for a yield estimate. The yield figures given in Table 1 are in grams (454 grams equal 1 pound).

Of the 92 entries, 23 (4 parents and 19 hybrid-derived selections) were introduced from Dr. F.A. Bliss of the University of Wisconsin. The Bliss lines had been specially selected for good yields under low N conditions and for the ability to fix nitrogen through symbiosis with bacteria. The remaining entries consisted of several navy and black bean varieties and strains from the MSU breeding program that had been selected and tested only under high or medium-high levels of soil nitrogen.

Seed for planting did not receive supplemental inoculation since earlier experiments with commercial inoculants on a limited number of varieties had failed to demonstrate an effect. Natural inoculation in the field was depended upon. This proved only moderately successful. Natural nodulation occurred but it was not abundant. Our planter is now being modified to permit the addition of granular commercial inoculant to the seeded row at planting time, in 1983 experiments.

All plots were visually scored on a 0 to 3 scale for nitrogen deficiency symptoms. Table 2 presents some summary calculations.

Table 2. Summary of yield and nitrogen deficiency scores of particular sub-sets of the 92 entries grown at two levels of soil Nitrogen.

Entries	Low-N Score*	Low-N Yield	High-N Yield
Univ. Wisc. Parents (4)	1.3	199.6	207.9
Univ. Wisc. Selections (19)	0.9	225.6	210.2
MSU Lines (69)	1.7	176.4	280.0
MSU Selected Lines for Low Score (5)	0.5	229.4	278.0
MSU Selected Lines for High Score (7)	3.0	144.2	277.9

*A score of 0 = no visible symptom of N-deficiency; 3 = moderate degree of leaf chlorosis. No severe chlorosis was observed in any plot.

Discussion of Table 2

Let us consider first the University of Wisconsin materials in relation to the unselected 69 MSU entries. The 4 parental lines under low N showed some chlorosis, the 19 selections showed significantly less chlorosis, and the MSU lines, as a group, showed the most. The recorded average yields of these groups under low N vary in direct proportion, the best yields being the 225.6 gms/plot produced by the 19 Univ. of Wisconsin selections, and the poorest 176.4 by the 69 MSU entries. The 4 Univ. of Wisc. parental lines were almost exactly intermediate at 199.6 gms.

With supplemental mineral N, the 4 parental lines rose slightly (about 4%) in yield; the average of the 69 MSU lines rose to 280 grams, a highly significant amount. Surprisingly, the yield of the 19 Univ. of Wisc. selections actually dropped a moderate amount with added N. They dropped to about the level of their original parental stocks, i.e., 210 grams and 208 grams, respectively.

This, if confirmed by the 1983 tests, represents a very interesting finding. Two possible interpretations suggest themselves:

1. The 19 selections had been selected only for performance at low N levels, where clearly progress had been made. They had not been selected for performance at higher levels of N, and at that level, the 19 selections simply expressed a yield potential comparable to that of the 4 parental stocks from which they had come.

2. In failing to respond, as a group, to added N, but instead dropping below their yield under low N, the 19 selections might, in fact, have been the victims of unintended negative yield selection pressure. That is, it could be expected that with added N from fertilizer the yield should have risen significantly, as it did for all other entries.

In fact, yield decreased, leading to the speculation (until rejected or confirmed in subsequent tests) that in the process of improving biological (symbiotic) nitrogen fixing capability, a majority of these 19 selections have incurred impaired ability to respond to supplemental mineral (fertilizer) nitrogen.

Secondly, let us examine the behavior of the MSU lines. The 69 entries from the MSU gene pool had a higher (more sensitive) N-deficiency score than the Wisconsin material and a lower mean-yield (176.4 gms/plot). But their yield with added N was significantly greater, at 280 gms/plot. Clearly, the MSU lines on the average were inferior at low N but superior at high N. This is reflective of the selection history of the MSU materials. They had never been exposed to nor selected under low N conditions, always under high N conditions. Have we inadvertently, in selecting for responsiveness at high N, selected genotypes with less than average ability to nodulate and perform well at low N? Only further and more critical testing will tell.

What we would like, of course, are lines that do well as both low and high N levels. One selection did, in fact, perform in this way. Entry #17, N81002, an upright navy seeded type, yielded 317.5 gms/plot under low N and 332.5 gms/plot under high N. This performance, too, has to be confirmed by repeated testing.

A suggestive, but not critical, comparison was made of yields of MSU selections which scored either low (non-sensitive) or high (sensitive to N-deficiency). The last two rows of data in Table 2 give the results. Lines scoring 0.5 yielded 229.4 under low N, almost the same as the 19 Wisconsin selections, on average, and 278 under high N, which is the same as the average of all 69 MSU lines.

The 7 lines which scored 3 for N-deficiency symptoms yielded an average of only 144.2 gms/plot under low N, the lowest of any group, and 277.9 gms under high N, the same as the average of all 69 MSU entries. The numbers of lines involved in these comparisons are too small for the results to be considered completely reliable and the data come from only one year of testing, but there is the implication that genetic differences exist in bean gene pools for displaying chlorosis in response to low soil N (about 3 parts per million, by soil testing), that these differences are associated with yield differences at low N, and that yielding ability at high N is unaffected by differential genetic effects manifest at low N.

In terms of the original objective, except for entrys #3, 17, 30, 32 and 36, in the MSU series, and the Univ. of Wisconsin selections, the answer must be in the negative. Of these, MSU entry #17 (Acc. # N81002) was clearly outstanding at both N levels. It remains to be seen whether this superiority will be sustained in 1983. The results leave unresolved the question as to whether lines can be deliberately bred to perform in a superior fashion both at low and at high soil N levels, utilizing BNF at the low or at both levels.

Table 1. Performance of selected varieties and lines at two levels of soil Nitrogen.

						N_0			N_1		
Entry #	Name/Acc.#	N_0	N_1	(N_1-N_0)	% Increase (Decrease)	Common Blight	Air Pollution	Nitrogen Stress	CBB	Air Pollution	N-Stress
1	C-20	184.5	357.5	+173.0	93.8	2.5	2.5	2.0	2	1	0
2	4044	178.0	247.5	+ 69.5	39.0	2.5	1.0	1.0	2	0	0
3	61690	237.0	224.0	- 13.0	-(5.5)	2.5	2.0	0.5	2	1	0
4	N76007	161.5	350.5	+189.0	117.0	2.0	2.0	1.0	2	0	0
5	N79021	211.0	248.0	+ 37.0	17.5	2.0	2.5	0.5	1	1	0
6	N79023	177.0	221.5	+ 44.5	25.1	3.0	1.5	1.0	3	3	0
7	N79028	163.5	313.0	+149.5	91.4	2.5	1.0	1.0	1	1	0
8	N79034	169.5	228.5	+ 59.0	34.8	2.5	2.5	1.5	3	1	0
9	N80014	210.5	324.5	+114.0	54.2	3.0	1.0	0.5	2	0	0
10	N80038	171.0	267.5	+ 96.5	56.4	2.5	2.5	2.5	2	0	2
11	N80043	231.0	267.0	+ 36.0	15.6	2.0	0.0	0.5	2	1	0
12	N80054	222.5	286.0	+ 63.5	28.5	2.0	1.0	0.5	2	0	0
13	N80058	200.0	253.0	+ 53.0	26.5	2.5	1.5	2.0	2	1	0
14	N80059	224.0	376.0	+152.0	67.9	2.0	1.0	1.0	1	0	0
15	N80061	177.5	298.5	+121.0	68.2	3.0	3.5	1.0	2	1	0
16	N80068	108.5	336.5	+228.0	210.1	2.5	3.0	3.0	2	0	0
17	N81002	317.5	332.5	+ 15.0	4.7	2.5	1.5	0.5	2	0	0
18	N81004	145.5	253.5	+108.0	74.2	3.0	1.5	2.0	2	0	0
19	N81016	151.5	316.5	+165.0	108.9	3.0	2.0	1.5	2	0	0
20	N81017	147.0	216.5	+ 69.5	47.3	2.0	2.5	3.0	1	0	2
21	N81023	176.0	264.5	+ 88.5	50.3	3.0	2.0	0.5	2	1	0
22	N81026	225.0	308.0	+ 83.0	36.9	2.0	2.5	0.75	2	0	0
23	N81037	210.0	298.0	+ 88.0	41.9	2.0	1.0	1.0	2	0	0
24	N81038	195.0	251.0	+ 56.0	28.7	3.0	3.5	3.0	3	4	2
25	N81052	194.5	357.5	+163.0	83.8	2.5	1.5	1.0	1	1	0
26	N81058	150.0	290.5	+140.5	93.7	3.0	2.5	1.5	3	1	0
27	N81062	162.0	266.0	+104.0	64.2	3.5	3.5	2.5	2	4	0
28	N81064	123.0	381.5	+258.5	210.2	3.5	1.5	3.0	2	3	2
29	N81086	147.5	204.0	+ 56.5	38.3	3.0	3.0	3.0	3	3	3
30	N81095	200.5	215.0	+ 14.5	7.2	3.5	1.5	2.5	3	0	2
31	Swan Valley	206.0	343.0	+137.0	66.5	2.0	1.5	1.5	2	1	0

Table 1. Continued.

Entry #	Name/Acc.#	N_0	N_1	(N_1-N_0)	% Increase (Decrease)	N_C Common Blight	N_C Air Pollution	N_C Nitrogen Stress	N_1 CBB	N_1 Air Pollution	N_1 N-Stress
32	NEP-2	201.0	204.0	+ 3.0	1.5	2.0	2.5	2.0	2	0	0
33	Fleetwood	156.5	166.0	+ 9.5	6.1	3.5	3.5	2.5	3	3	0
34	C-15	153.5	245.0	+ 91.5	59.6	4.0	2.0	1.5	3	0	2
35	Seafarer	144.0	286.5	+142.5	99.0	3.5	4.5	2.5	4	2	3
36	B79004	164.0	172.0	+ 8.0	4.9	3.5	2.0	1.5	3	1	0
37	B76001	170.0	331.0	+161.0	94.7	4.0	2.5	1.0	1	0	0
38	B80026	218.0	290.0	+ 72.0	33.0	3.5	1.5	0.5	1	0	0
39	B81008	157.5	265.5	+108.0	68.6	2.0	0.5	1.5	1	0	0
40	B81005	159.0	221.0	+ 62.0	39.0	3.0	2.5	1.5	3	1	0
41	B80029	209.5	247.5	+ 38.0	18.1	3.5	2.0	1.0	3	0	0
42	B80030	176.0	342.5	+166.5	94.6	3.5	1.5	.75	2	1	0
43	Domino	197.5	282.0	+ 84.5	42.8	3.5	2.0	1.0	2	1	0
44	Black Magic	151.0	304.5	+153.5	101.7	2.5	2.0	2.0	1	1	0
45	T-39	160.0	198.5	+ 38.5	24.1	3.5	3.0	1.5	3	3	2
46	Midnight	172.0	282.0	+110.0	64.0	3.0	2.0	1.0	2	2	0
47	B79001	176.0	260.5	+ 84.5	48.0	3.5	2.5	1.5	2	1	0
48	79B01001	213.5	241.0	+ 27.5	12.9	3.0	0.5	1.2	2	1	0
49	79B01538	175.0	294.0	+119.0	68.0	2.0	2.0	1.7	2	2	0
50	79B03107	158.0	328.0	+170.0	107.6	3.5	3.0	2.0			
51	80B00153	195.5	339.0	+143.5	73.4	3.5	3.0	1.7	1	1	0
52	80B00508	160.5	333.0	+172.5	107.5	3.0	2.5	2.0			
53	80B00533	147.0	282.0	+135.0	91.8	2.5	0.5	2.5	2	2	0
54	80B00541	168.0	266.0	+ 98.0	58.3	2.5	1.0	2.0			
55	80B00552	150.5	297.0	+146.5	97.3	2.5	1.0	2.0	2	2	0
56	80B00572	144.0	247.5	+103.5	71.9	2.5	2.0	2.5	2	3	0
57	80B00596	127.5	272.0	+144.5	113.3	3.5	2.5	2.5	3	3	0
58	80B00962	135.5	293.0	+157.5	116.2	2.5	1.5	2.0	2	1	0
59	80B01313	185.5	270.5	+ 85.0	45.8	3.5	3.0	2.5			
60	80B01519	171.5	284.5	+113.0	65.9	3.0	1.0	2.5			
61	80B01532	166.0	235.5	+ 69.5	41.9	2.0	2.0	2.2	2	1	0
62	80B01561	189.0	267.5	+ 78.5	41.5	2.0	2.0	2.0	1	0	0

Table 1. Continued, respectively.

Entry #	Name/Acc.#	N_0	N_1	(N_1-N_0)	% Increase (Decrease)	N_0 Common Blight	N_0 Air Pollution	N_0 Nitrogen Stress	N_1 CBB	N_1 Air Pollution	N_1 N-Stress
63	79N00457	112.5	265.5	+153.0	136.0	2.5	3.0	2.5	3	3	0
64	79N00458	136.0	265.5	+129.5	95.2	2.5	2.5	2.2			
65	79N00947	150.5	292.5	+142.0	94.4	2.0	1.5	2.0			
66	79N00948	177.5	274.5	+ 97.0	54.6	2.5	3.0	2.0			
67	79N02337	164.5	205.0	+ 40.5	24.6	2.5	3.5	2.0	3	3	0
68	Puebla 152	170.5	206.5	+ 36.0	21.1	2.0	1.0	1.5			
69	Jamapa	205.0	204.0	- 1.0	(.5)	1.5	3.0	1.2			
70	I82055	201.0	203.5	+ 2.5	1.2	1.5	2.0	0.75	3	0	0
71	I82057	175.5	182.0	+ 6.5	3.7	2.5	3.2	0.75			
72	I82056	199.0	239.0	+ 40.0	20.1	2.0	2.2	0.5	3	1	0
73	Nep-2	195.0	260.5	+ 65.5	33.6	1.0	0.5	0.5			
74	I82058	235.0	261.0	+ 26.0	11.1	1.0	2.7	0.25	3	0	0
75	Porillo	231.0	248.5	+ 17.5	7.6	2.0	0.0	0.5			
76	I82065	191.0	182.0	- 9.0	(4.7)	1.5	0.0	0.5			
77	I82063	246.0	251.5	+ 5.5	2.2	2.0	0.5	0.5			
78	I82061	239.5	192.0	- 47.5	(19.8)	2.0	0.0	0.5	3	0	0
79	I82060	227.0	191.5	- 35.5	(15.6)	2.0	0.0	0.75			
80	I82059	220.0	219.0	- 1.0	(0.45)	2.0	0.0	0.75			
81	I82062	243.0	283.0	+ 40.0	16.5	2.5	0.5	1.5			
82	I82064	240.5	184.5	- 56.0	(23.3)	2.0	0.5	0.5	3	0	0
83	I82070	208.5	176.5	- 32.0	(15.3)	3.0	3.0	0.75			
84	I82069	248.0	233.0	- 15.0	(6.0)	2.5	1.0	1.5			
85	I82070	189.0	187.5	- 1.5	(.8)	3.0	2.5	1.0	3	3	0
86	I82072	249.5	270.0	+ 20.5	8.2	3.0	0.5	1.2			
87	I82071	179.5	144.0	- 35.5	(19.8)	3.0	3.0	2.5	3	0	2
88	I82066	245.5	201.5	- 44.0	(17.9)	2.5	2.5	1.2			
89	I82067	287.5	193.0	- 94.5	(32.9)	2.5	1.5	1.0			
90	I82068	262.0	200.0	- 62.0	(23.7)	2.0	1.0	1.0			
91	Sanilac	192.0	172.5	- 19.5	(10.2)	3.5	3.0	2.0	3	1	2
92	N81077	218.5	221.0	+ 2.5	1.1	3.0	1.5	2.5	2	3	3

EARLY GENERATION CRANBERRY & KIDNEY BEAN POPULATION

J.D. Kelly, M.W. Adams, A. Ghaderi, A.W. Saettler, J. Taylor

CRANBERRY: The present objective of the program is to increase the seed size of the bush cranberry (CRAN-028) in order to better meet market acceptance and improve the yield potential and disease resistance of the present varieties.

Twenty-six F_4 generation lines derived from crops CRAN-028/C81005, 800664 were grown in 2-row plots at Montcalm in 1982. Eight lines were selected for performance, adaptation, maturity and seed color. The seed size, determined by the 100-seed weight, ranged from 52 - 60g for the 8 selected lines as compared to 52g for Michicran and 45g for Cran-028. The 8 lines are currently being evaluated for reaction to halo blight and mosaic virus (BCMV) and the resistant lines will enter yield trials in 1983.

KIDNEY: The present objective of the kidney program is to improve the test weight of current dark red variety Montcalm, while retaining its yield potential and disease resistance.

Thirty-seven F_5 generation lines derived from the cross Charlevoix/Montcalm were grown in 2-row plots at Montcalm in 1982. Twenty-five lines were selected for performance, adaptation, maturity and seed color. The seed size was determined using the 100 - seed weight and the test weight was determined by weighing the beans contained in a fixed volume test weight cup. The data is shown below.

Entry	100-Seed Weight (g)	No. of Samples	Test Weight (g) Low	High	Mean
Charlevoix	48.1	19	204	213	206
Montcalm	48.7	19	193	200	196
25 lines	46.2 -53.5	3	199	210	205

The data indicates that the majority of the lines have satisfactory seed size and with the exception of 2 lines the remaining 23 lines had test weight values higher than the Montcalm check. Currently the lines are being evaluated for reaction to halo blight and BCMV and the resistant lines will enter yield trials in 1983.

EXPERIMENT 2218. CRANBERRY AND KIDNEY BEAN VARIETY TRIAL

M.W. Adams, J.D. Kelly, A. Ghaderi, A.W. Saettler, J. Taylor

This test consists of several experimentals from various sources, along with some extensively tested standards. The nursery was beset by common bacterial blight which was more prevalent on some entries (Charlevoix) than others, probably due to seed source.

The Montcalm DRK, reasonably free of blight, was the top yielder at 22.8 bags/acre. Considering the rainfall pattern in 1982, this yield should have been at least 25 bags. The LRK 70688, which has been selected as an early maturing light red with halo blight tolerance, ranked second in yield. This line is under increase for release to seed growers.

There were several other experimental light reds in the tests, some for the first time. Further tests are required before judging these. The new LRK, Ruddy, matured early like Redkloud, but did not yield well at this location. The seed size was the smallest of any line in the test.

The chief objection to Cran 028 as a variety is its seed size. As shown in this test, Cran 028 is about 10% smaller than Michicran. We have been testing some other bush crans with larger seed sizes, numbers 422, 423, 424, 425. These lines are the equal or slightly better than Michicran in seed size, but about the same in yield (not significantly less). They are also earlier in maturity by some 6-9 days. These should be advanced to state-wide tests in 1983.

EXPERIMENT 2218, MONTCALM FARM, 1982 - CRANBERRY & KIDNEY BEAN VARIETY TRIAL

ACC. NO.	SOURCE	SEED* CLASS	ENT. NO.	YIELD LB/A	YIELD % CHK*	100 SEED Wt.g	DAYS TO MAT.	DAYS TO FL.	HT. Cm.	SCORE DES.
MONTCALM	MSU	DRK	16	2278	155	51.2	95	48	42	2.5
70688	MSU	LRK	10	2249	126	51.6	89	42	36	2.5
2204	UCD	LRK	19	2169	122	57.8	98	50	45	2.5
MECOSTA	MSU	LRK	8	2163	121	58.0	95	48	45	3.0
MICRAN*	MSU	C	6	2099	100	52.2	96	52	25	1.0
9482	MSU	LRK	7	2098	118	53.0	97	51	45	2.5
SACRAM	SVM	LRK	14	2098	118	52.8	85	42	32	2.0
S.BROWN	MSU	-	18	2083	99	41.2	93	42	25	1.0
422	MSU	C	1	2059	98	54.2	90	48	38	2.0
2602	UCD	LRK	20	1996	112	59.0	98	50	45	2.0
70700	MSU	LRK	11	1984	111	50.8	87	42	33	2.0
70684	MSU	LRK	12	1950	109	51.0	88	42	35	2.0
MANITOU	MSU	LRK	9	1935	109	60.8	97	49	44	2.5
425	MSU	C	4	1927	92	53.5	88	48	35	2.5
CRAN028	MSU	C	5	1897	90	47.1	94	49	41	2.5
424	MSU	C	3	1889	90	52.7	89	48	41	3.0
REDKLOUD*	CU	LRK	13	1782	100	49.8	88	42	35	2.0
NW341	USDA	LRK	22	1745	98	55.9	98	51	45	2.0
423	MSU	C	2	1736	83	53.6	87	49	35	2.5
RUDDY	CU	LRK	17	1683	94	41.6	87	42	31	1.5
NW126	USDA	LRK	21	1638	92	56.8	98	51	47	2.0
CHARLEVOIX*	MSU	DRK	15	1473	100	52.6	94	48	41	2.5
MEAN (22)				1951	109	52.6	92	47	38	2.2
LSD (.05)				512	-	2.7	4	-	4	-
C.V.				18.5	-	3.6	2.0	-	4.6	-

* % CHK - Yield as percent of check is shown as percent of the check variety in each commercial class (DRK - Dark Red Kidney; LRK - Light Red Kidney; C - Cranberry).

PROCEDURE : Planted June 6, 1982, in 4-row plots -- 16 foot long, 20 inch row width, 4 seeds/foot of row, in a randomized complete block with 4 replications. A 13 foot section of the 2 center rows was pulled at maturity.

CRANBERRY BEAN OBSERVATION TRIAL

J.D. Kelly, M.W. Adams, A. Ghaderi, J. Taylor - Dept. Crop and Soil Sciences
A.W. Saettler - Dept. Botany and Plant Pathology

MSU NO.	U I NO.	GROWTH HABIT	YIELD (LB/A)	MATURITY (day)	SEED WT. (g/100 SEED)	DES. SCORE*
V1	07006	II	1780	93	35	1
V2	07007	I	1755	85	42	2
V3	07008	I	1895	85	44	2
V4	07009	I	1992	95	50	3
V5	8920	I	2070	85	43	4
V6	8921	I	2100	85	46	4
V7	8922	I	2146	85	45	3

* Des. Score: Indicates a desirability score where 1 is unsatisfactory and 5 is excellent.

Procedure: Planted June 6, 1982 in 4-row plots -- 16 foot long, 20 inch row width, 4 seeds/foot of row. At maturity, the 4 rows were pulled as 2 replications to obtain a better estimate of each line's yield potential.

The 7 cranberry lines were received from the University of Idaho for preliminary evaluation for adaptation to Michigan growing conditions. Lines coded V1 and V4 were later maturing while V1 had low desirability score (DS) of 1. Line V4 through V7 had reasonable yield potential and with exception of V4, all were early maturing. Lines V5 and V6 looked particularly promising with a DS value of 4. However, the smaller seed size of 43-46 g/100 seed is not desirable. It is planned to further evaluate lines V4-V7 in replicated yield plots at three locations in 1983.

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