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1981 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 1981 Potato Research Report is the result of the research that was carried on by Michigan State University at the Montcalm Research Farm, Entrican, Michigan.

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 their support can the Potato Industry in Michigan continue with similar research in the future.

Thank you.

Sincerely,

R. H. Kaschyk
Executive Director

RHK:kk
enclosure

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

ACKNOWLEDGMENTS

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Special recognition is given to Mr. Theron Comden for his devoted cooperation and assistance in many of the day-to-day operations.

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MONTCALM BRANCH EXPERIMENT STATION RESEARCH REPORT

R.W. Chase, Coordinator
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INTRODUCTION

The Montcalm Branch Experiment Station was established in 1966 with the first experiments initiated in 1967. This report marks the completion of fifteen years of studies. The 40-acre facility is leased from Mr. Theron Comden and is located in west-central Michigan, one mile west of Entrican. The farm is used primarily for research on potatoes and is located in the heart of a major potato producing area.

This report is designed to coordinate all of the potato research obtained during 1981. 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 fourteen year temperature and rainfall data recorded at the Research Farm. Temperatures during 1981 averaged generally cooler than any of the previous years. April, however was somewhat warmer with several days reaching the 60's and 70's. The balance of the growing season was cooler than normal, particularly in July. It may be that this generally cooler temperature was a contributing factor to the favorable yields and quality and to the apparent accelerated growth of the 1981 crop. The first recorded freezing fall temperature was noted September 23.

Total rainfall was normal compared with the 14 year average. April and May were higher than normal whereas June, July and August were below the average. The heavy rains occurred in October with 5.8 inches recorded on October 1.

Irrigation applications of approximately one inch each were made on June 25, July 3, 6, 9, 17, 22, 27, August 3, 6 and 12.

SOIL TESTS

Soil test results for the general plot area were:

pH	P	K	Ca	Mg
6.0	511	248	853	150

Table 1. The 14 year summary of average maximum and minimum temperatures during the growing season at the Montcalm Branch Experiment Station.

	April		May		June		July		August		September		6-month average	
Year	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
14-year average	54	34	67	43	75	53	81	57	79	56	71	49		

Table 2 The 14-year summary of precipitation (inches per month) recorded during the growing season at the Montcalm Station.

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
1077	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	3.32	19.68
14-year average	2.73	2.79	3.76	2.20	4.38	3.37	19.21

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:

Plow down	- 0-0-60	200 lbs/A
Banded at planting	- 20-10-10	500 lbs/A
Sidedressed at hilling	- 46-0-0	150 lbs/A

A one year cover crop of alfalfa was plowed down prior to plot establishment.

HERBICIDES

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

DISEASE & INSECT CONTROL

Temik at 3 lbs/A was applied at planting.

Foliar fungicide and insecticide sprays were as follows:

June 24	Thiodan
July 3	Monitor
July 13	Monitor
July 22	Bravo + Thiodan
July 29	Bravo + Thiodan
Aug. 7	Bravo + Thiodan
Aug. 24	Bravo + Thiodan
Sept. 2	Bravo + Thiodan

Several plots were topkilled prior to harvest with Paraquat at one qt/A plus X77 at 8 oz./100 gals of water.

INTRODUCTION OF NEW VARIETIES

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

A. LEVERING SEED FARM

Sixty seven different cultivars or seed sources were planted as two cut units. A few units were rogued out because of rhizoctonia or weak growth. The more common virus diseases PVY, leaf roll and spindle tuber were not detected by visual symptoms. The crop was topkilled in mid-August and harvest was completed on September 3. This procedure is followed to minimize late season virus infections.

Mini bulk samples were collected for the winter testing program in Florida. Greenhouse tests will be conducted on the Russet Burbank, Katahdin, Jemseg, Onaway, Atlantic, Denali, Snowchip and G670-11 seed obtained from British Columbia to determine their freedom from PVX, PVY and spindle tuber. As testing techniques are established, it is planned to routinely test new selections that are introduced into the Levering seed plot program so that a nucleus of disease-free seed is available for the Michigan seed industry.

B. MSU ADVANCED SELECTIONS

Sixteen selections retained from the 8,000 new cultivars introduced in 1978 were planted in a replicated yield trial at the Montcalm Research Farm. Table 1. Several exhibited very desirable variety potential and will continue for further testing. Table 2 summarizes the culinary quality of these selections after 3 months storage at 52^{o}F. Most of the selections remained in suitable chipping condition. Maturity has not been consistent with previous years.

C. U.S.D.A. - BELTSVILLE SELECTIONS

A major and continuing source of cultivars is from the USDA-Beltsville program. Eight seedlings were planted in replicated plots at the Montcalm Research Farm for two dates of harvest on August 26 and September 23. Table 3 summarizes the results of these two harvests. There was essentially no yield increase between the first and second harvest dates except for B7805-1 which is an attractive, smooth white skin potato.

Specific gravity readings for these selections are generally medium to low. There was some increase in specific gravity between the first and second harvests, particularly for B8528-3, B8943-4, B8822-9 and Russet Burbank.

TABLE 1. THE CHARACTERISTICS AND PERFORMANCE OF
SEVERAL NEW MICHIGAN SELECTIONS

Cultivar	Flesh Color	Maturity	Total cwt/A	No. 1 cwt/A	% No. 1	% Over 3¼	Specific Gravity	Chip Rating	Comments
700-70	White	Late	536	467	87.1	8.8	1.089	1.5	Eyes slightly deep
700-79	White	Late	371	332	89.5	1.8	1.087	1.0	Smooth, uniform
700-83	White	Medium	552	485	87.9	13.4	1.081	1.5	Smooth, uniform
700-88	White	Medium	368	283	76.9	17.3	1.069	3.0	Pointed, rough
701-22	White	Late	336	322	95.8	20.8	1.086	1.5	Smooth, uniform
702-80	White	Medium	406	359	88.4	6.1	1.075	1.0	Deep eyes, blocky
702-91	White	Medium	542	479	88.4	7.3	1.084	1.5	Tendency to pointed shape
704-3	Golden	Early	349	306	87.7	13.4	1.073	2.0	Smooth, some sungreen
704-10	Golden	Medium	385	324	84.1	5.5	1.085	2.0	Small run
704-17	White	Medium	431	400	92.8	23.5	1.082	2.5	Some scab
709-21	White	Medium	306	281	91.8	21.7	1.074	2.5	Over-size, rough
714-10	White	Medium	367	300	81.7	2.7	1.077	3.0	Smooth, small run
716-15	White	Medium	367	326	88.8	5.5	1.092	1.5	Smooth, uniform
718-6	White	Late	358	339	94.7	36.9	1.083	1.5	Smooth, uniform
718-11	Golden	Early	336	287	85.4	4.2	1.079	1.0	Smooth, uniform
719-38	White	Early	388	353	91.0	11.0	1.078	2.0	Smooth, uniform
Onaway	White	Early	495	458	92.5	26.2	1.066	4.5	Slight greening
Superior	White	Early	403	373	92.6	2.1	1.075	2.0	Rough skin
Atlantic	White	Late	408	367	90.0	12.8	1.090	1.5	Smooth
Monona	White	Late	335	296	88.4	11.1	1.071	1.0	Rough

TABLE 2. THE AFTER- COOKING-DARKENING[1] (ACD) AND CHIP RATING[2] OF SEVERAL NEW MICHIGAN SELECTIONS STORED 3 MONTHS AT 52°F

Selection	Hours After Cooking* 0	1	24	Chip* Score
700-70	1.0	1.5	1.5	1.0
700-79	1.5	2.0	2.0	1.0
700-83	1.0	1.5	2.0	1.5
700-88	1.0	1.0	1.0	2.0
701-22	1.0	1.5	2.0	1.5
702-80	1.0	1.5	1.5	1.0
702-91	1.5	1.5	1.5	1.0
704-3	1.0	1.0	1.0	3.0
704-10	1.0	1.0	1.0	2.0
704-17	1.0	2.0	2.0	2.0
709-21	1.5	2.5	3.0	1.5
714-10	1.5	1.5	1.5	4.0
716-15	1.0	1.5	1.5	1.0
718-6	1.5	2.5	3.0	1.0
718-11	1.5	2.5	2.5	1.0
719-38	1.0	1.0	1.0	2.0
Onaway	1.5	3.5	3.5	4.0
Superior	1.0	2.0	2.0	1.5
Atlantic	1.5	1.5	2.0	1.0
Monona	1.0	2.0	2.0	1.0

[1] ACD scored on a 1-5 scale. 1 = clear with no darkening; 5 = undesirable grayish-black discoloration throughout the cooked flesh.

[2] Chip rating based on a 1-5 scale. 1 = light and very acceptable color; 5 = dark and not acceptable

* Determinations made December 17 and December 23, respectively.

TABLE 3. THE YIELD, SIZE DISTRIBUTION & SPECIFIC GRAVITY OF SEVERAL USDA-BELTSVILLE SELECTIONS HARVESTED ON TWO DATES. MEF 1981

	August 26, 1981							September 23, 1981						
	yield (cwt/A)		Percent size distribution					yield (cwt/A)		Percent size distribution				
	Total	No. 1	2-3¼	Over 3 ¼	B's	Pick outs	Specific Gravity	Total	No. 1	2-3¼	Over 3 ¼	B's	Pick outs	Specific Gravity
B7154-10	471	386	82	0	16	2	1.060	457	399	87	1	11	1	1.063
B7516-7	312	275	86	2	12	0	1.077	303	259	83	3	14	0	1.077
B7805-1	417	385	86	7	5	2	1.070	473	462	80	18	2	0	1.074
B8528-3	320	262	82	0	16	2	1.069	337	261	76	1	23	0	1.075
B8934-4	309	239	75	2	18	5	1.067	309	229	74	1	24	1	1.067
B8943-4	295	207	70	0	30	0	1.066	315	220	70	0	29	1	1.074
B8972-1	273	137	51	0	47	2	1.073	263	125	47	0	53	0	1.075
B8822-9	359	242	68	0	30	2	1.060	339	212	63	0	37	0	1.066
R. Burbank	376	287	76	1	22	1	1.071	406	292	61	11	21	7	1.079
Superior	321	278	87	0	12	1	1.070	324	289	88	1	11	0	1.071
Average	345	270					1.068	352	275					1.072

Planted: May 6, 1981

Fertilizer: 200 lbs/A 0-0-60 plowdown

500 lbs/A 20-10-10 planter + temik 3 lbs/A

200 lbs/A 45-0-0

1981 POTATO VARIETY EVALUATIONS

R.W. Chase, N.R. Thompson, R.B. Kitchen
Department of Crop and Soil Sciences

A. *Dates of Harvest of Several Potato Varieties*

The intensive dates-of-harvest study is conducted each year at the Montcalm Research Farm. Three blocks, each containing 112 ten foot plots were planted May 6, 1981. Each block contained 28 varieties and advanced selections planted in a randomized complete block design with four replications. One block was harvested August 11, a second on August 31 and the third on September 22. At each date, yields, specific gravity and chip scores were determined.

The plot area received 200 lbs/A plow down of 0-0-60, 500 lbs/A 20-10-10 and 150 lbs/A 45-0-0 sidedressed. The plowdown crop was a one year old stand of alfalfa. Temik at 20 lbs/A was applied at planting. Alachlor (Lasso) 2 lbs/A was applied soon after planting as early preemergence and metribrizen (Sencor) 0.5 lbs/A was applied delayed preemergence. The plots were irrigated.

Results

The yield performance at each date of harvest is summarized in Table 1. There was no yield increase between the second and third harvest which was due in part to an increased rate of growth during the season so that many varieties appeared to mature earlier than normal. There also was a definite curtailment in growth in September after the application of copper.

Yields in general were very desirable. Varieties which produced very acceptable yields before September were Atlantic, Crystal, Belchip, Onaway, Pioneer, Rideau, MS402-1, MS108-5, and Wis 718. Chipbelle, Denali, Lemhi, Michimac, Monona, Russet Burbank and CA027 would be judged as later maturing varieties.

Table 2 summarizes the specific gravity and chip quality of each variety. Overall there was no appreciable change in specific gravity between harvests. Varieties which show exceptionally high specific gravity are Chipbelle, Denali and Atlantic. All varieties except Onaway produced acceptable chips at most harvests. Several of the later maturing varieties produced darker chips at the early harvest, particularly if held for one week. Table 3 summarizes the internal and external defects which were observed. Hollow heart, growth cracks and second growth were all minimal. Vascular discolorations were observed in most varieties, however for the most part these were only slight. Dakchip exhibited the most severe vascular discoloration.

Variety Observations

Allagash Russet - yields were below average at all harvests, primarily reflecting a lack of adequate tuber sizing. Specific gravity is also low. Similar results were noted in 1980.

<u>Atlantic</u> - continues to produce very satisfactory yields and consistently high specific gravity. It produces very acceptable potato chips and it appears to be a variety with a fairly wide range in marketable harvest. With its wide adaptability including the southern states, this variety could become a year-around chipping variety.

<u>Belchip</u> - yielded well above the average with medium-high specific gravity. Tuber type and appearance were very good in 1981 and defects were minimal. Maturity is somewhat later than Atlantic.

<u>Chipbelle</u> - appears to be a late maturing variety with exceptionally high specific gravity at each harvest and above average yields. Tuber shape is oval to oblong. The plant is very susceptible to metribuzin (Lexone/Sencor). Chip color has been very good and comparable to Monona and Atlantic.

<u>Crystal</u> - appears to set and size tubers early. Tubers have a bright skin, however if scab is present it is often the deep and pitted scab. Bruising and susceptibility to storage problems have been reported.

<u>Dakchip</u> - yields were above average, however specific gravity is medium to low and it did decline with delayed harvest. Vascular discoloration was severe and this has been noted in previous years. It has a very short dormancy.

<u>Denali</u> - a late maturing variety which yielded well above average. Specific gravity is very high. It has a low tolerance to scab and fields with a history of scab should be avoided.

<u>Highlat Russet</u> - exceptionally low yields with inadequate tuber sizing. Released from Alaska in 1980 for specific markets in Alaska. It does not appear to be well adapted to Michigan.

<u>Jemseg</u> - an early maturing round white with some skin netting. Yields were below average.

<u>Lemhi</u> - yields were well above average and tuber type and shape were very attractive with a higher percentage of U.S. No. 1's than Russet Burbank. It appears to size tubers earlier than Russet Burbank, however hollow heart and blackspot are two serious problems at this point.

<u>Michimac</u> - a late maturing round white with high yields. Appears most suitable for fresh pack from a later harvest or out of storage. Appears to have a low tolerance to scab.

<u>Monona</u> - included as a check variety. Yields were average at the late harvest. Specific gravity was low and chip quality was excellent.

<u>Oceania</u> - yields were slightly below average. Tubers are attractive with shallow eyes and it has low specific gravity. Would appear most suitable for fresh pack.

<u>Onaway</u> - included as a check variety. Yields well above average and type was very good.

Pioneer - a long red variety being evaluated as a potential for early harvest frozen processing. Sets and sizes tubers early with very good yields.

Rideau - a medium-late round red variety with very good color. Yields above average at the later harvests.

Russette - yields were slightly below average. During both 1980 and 1981 hollow heart has been prevalent in this variety although it was not observed in these plots.

Russet Burbank - included as a late maturing check variety. Sizing did not continue after the second harvest which is not normal. Tuber type and quality were very good in 1981.

Superior - yields were very good in 1981.

Yukon - a golden flesh variety which has good yields and very acceptable tuber shape and appearance. Specific gravity readings were consistently above 1.080.

B8972-1 - a russet selection from the USDA-Beltsville program. Tuber sizing was very poor with a high percentage of tubers under 2 inch at all harvests. Yields were very low.

CA-027 - is a late maturing selection from Maine. It yields well above average and appears most suitable as a fresh pack potato.

C-13 - is an advanced selection from the Campbell Co. Yields were below average however tuber shape and appearance were very good.

MS108-5 - is an advanced selection which yielded well above average. Individual tuber sizing is not adequate and at locations where there is a stress, the percentage of tubers under 2 inch increases rapidly. The selection is being deleted.

MS401-2 - matures early and produces tubers which are smooth and sized well. It has a low specific gravity.

MS402-1 - medium maturity with average yields. Tubers sized well and were smooth and well shaped. It has been observed to have some tolerance to scab at some locations.

MS402-5 - has yielded below average and will be deleted.

Wis 718 - yielded exceptionally well with a high percentage of tubers over 3 1/4 inch. On larger tubers hollow heart has been observed. Specific gravity is low and it appears most suited to the fresh pack market.

TABLE 1 THE YIELD & SIZE DISTRIBUTION OF SEVERAL POTATO VARIETIES HARVESTED ON 3 SEPARATE DATES MEF 1981

HARVEST DATE	August 11					August 31					September 22				
			Percent					Percent					Percent		
Variety	Total (cwt/A)	No.1 (cwt/A)	2"-10oz	Over 10oz	B's	Total (cwt/A)	No.1 (cwt/A)	2"-10oz	Over 10oz	B's	Total (cwt/A)	No.1 (cwt/A)	2"-10oz	Over 10oz	B's
Allagash R.	280	229	81	0	19	274	223	81	0	18	278	217	78	0	22
Atlantic	423	376	82	7	9	471	440	82	11	7	451	412	86	5	9
Belchip	321	296	89	3	8	440	403	79	13	7	421	385	76	15	9
Chipbelle	363	334	88	4	8	415	377	89	2	9	451	413	89	3	7
Crystal	409	350	84	4	15	484	421	86	1	13	485	432	86	3	10
Dakchip	359	313	85	2	12	401	358	87	3	10	393	329	78	6	16
Denali	332	305	87	4	9	455	426	88	6	7	476	431	86	4	8
Highlat	203	136	67	0	33	261	184	70	0	29	223	148	66	0	34
Jemseg	253	230	88	2	9	311	288	87	5	6	277	248	85	5	10
Lemhi	350	298	77	8	14	459	394	65	20	13	499	427	72	13	13
Michimac	323	298	90	2	8	467	432	82	10	8	477	434	87	4	9
Nonona	288	261	87	3	10	338	313	86	6	7	395	363	85	8	6
Oceania	351	319	87	3	9	367	319	80	7	13	385	356	86	6	8
Onaway	388	373	84	12	4	442	422	85	10	5	426	402	73	21	5
Pioneer	430	390	72	19	9	471	434	83	9	7	479	435	78	13	9
Rideau	307	290	93	2	6	455	439	84	12	3	413	385	76	17	5
Russette	292	263	85	5	8	346	323	85	8	6	359	326	89	2	9
R. Burbank	280	215	77	0	19	375	286	71	5	18	370	287	75	3	20
Superior	277	252	94	0	6	330	305	90	2	7	335	298	89	0	10
Yukon	309	286	89	4	7	357	332	85	8	6	351	328	82	12	6
B8972-1	280	188	67	0	33	261	157	60	0	40	256	126	50	0	50
CA 027	282	240	81	5	14	417	396	88	7	5	488	452	81	11	6
C13	334	311	79	14	6	330	305	84	8	7	287	257	65	24	9
MS 108-5	378	306	81	0	19	470	400	84	0	14	501	421	84	0	16
MS 401-2	232	203	88	0	12	244	205	84	0	15	250	201	81	0	19
MS 402-1	352	327	90	3	6	392	357	86	5	9	343	309	86	4	9
MS 402-5	303	246	79	2	19	334	292	86	1	13	349	295	84	0	16
WIS 718	367	340	89	3	8	524	507	59	36	5	512	487	75	20	5
Average	324	285				389	348				390	343			

TABLE 2. THE SPECIFIC GRAVITY & CHIP QUALITY OF SEVERAL POTATO VARIETIES HARVESTED ON 3 SEPARATE DATES MEF-1981

Harvest Date	August 11			August 31			September 22	
		chip score*			chip score*			chip score*
	Specific	1	7	Specific	1	7	Specific	
Variety	Gravity	day	days	Gravity	day	days	Gravity	November 19
Allagash R.	1.071	1.0	1.5	1.066	1.0	1.0	1.068	1.5
Atlantic	1.094	1.0	2.5	1.091	1.0	1.0	1.091	1,0
Belchip	1.085	1.0	1.5	1.080	1.0	1.0	1.083	1.0
Chipbelle	1.100	1.5	2.0	1.100	1.0	1.0	1.100	1.0
Crystal	1.074	1.5	2.5	1.074	1.0	1.5	1.079	1.5
Dakchip	1.077	1.0	1.5	1.073	1.0	1.0	1.069	2.0
Denali	1.093	1.0	2.0	1.093	1.0	1.5	1.094	1.5
Highlat	1.069	1.0	2.0	1.067	1.5	1.5	1.066	2.5
Jemseg	1.073	1.5	2.0	1.074	1.0	1.5	1.072	3.5
Lemhi	1.081	2.5	3.0	1.084	1.0	1.0	1.084	1.5
Michimac	1.072	2.0	3.0	1.073	1.0	2.0	1.069	2.0
Monona	1.070	1.0	1.0	1.068	1.0	1.0	1.071	1.0
Oceania	1.068	2.0	2.0	1.066	1.0	1.0	1.065	2.0
Onaway	1.070	3.0	4.0	1.068	3.0	3.0	1.065	4.0
Pioneer	1.075	1.5	2.5	1.076	1.5	1.5	1.075	1.5
Rideau	1.076	2.5	2.0	1.078	1.5	1.5	1.077	2.5
Russette	1.079	2.0	2.0	1.081	1.5	1.5	1.081	3.5
R. Burbank	1.079	2.5	2.5	1.080	1.5	2.5	1.078	3.0
Superior	1.077	1.5	1.5	1.075	1.5	1.5	1.076	1.5
Yukon	1.085	1.5	1.5	1.082	1.0	1.5	1.084	2.0
B8972-1	1.079	1.0	2.0	1.079	1.0	1.5	1.076	1.5
CA 027	1.078	1.5	3.0	1.082	1.0	1.0	1.079	1.5
C13	1.083	1.0	1.0	1.074	1.0	1.0	1.077	1.5
MS108-5	1.082	1.0	2.0	1.084	1.5	1.5	1.082	2.5
MS401-2	1.071	1.0	1.0	1.071	1.0	1.0	1.071	3.0
MS402-1	1.071	1.0	1.5	1.071	1.0	1.5	1.069	1.5
MS402-5	1.082	1.0	1.0	1.075	1.0	1.0	1.077	1.5
WIS718	1.073	1.5	1.5	1.066	1.0	1.5	-----	
Average	1.078			1.077			1.077	

*chip score based on 1-5 scale 1= light & very acceptable; 5 = dark and not acceptable

TABLE 3. THE INCIDENCE OF EXTERNAL* & INTERNAL DEFECTS* ON SEVERAL POTATO VARIETIES MEF 1981

	External			Internal		
Variety	Second Growth	Growth Crack	Scab	Vascular Discoloration	Internal Necrosis	Hollow Heart
Allagash R.	---	---	---	---	---	---
Atlantic	---	---	---	2 sl	---	---
Belchip	1	---	---	2 sl, 2 sev	---	---
Chipbelle	---	---	---	4 sl	---	---
Crystal	---	---	---	2 sl	---	---
Dakchip	---	---	1	2 sl, 12 sev	---	---
Denali	---	---	---	1 sl, 1 sev	---	---
Highlat	---	---	---	2 sl	---	---
Jemseg	---	---	---	1 sl	---	---
Lemhi	---	---	---	4 sl	---	1
Michimac	---	---	1	4 sl, 5 sev	---	---
Monona	---	---	---	2 sl	---	---
Oceania	---	---	---	1 sl	---	---
Onaway	---	---	---	2 sl	1 br center	---
Pioneer	---	---	---	---	---	---
Rideau	---	---	---	2 sl	---	---
Russette	---	1	1	---	---	---
R. Burbank	1	---	---	3 sl	---	---
Superior	---	---	---	2 sl	1 br center	---
Yukon	---	---	1	3 sl	---	---
B8972-1	1	---	---	2 sl	---	---
CA 027	---	---	---	9 sl	---	---
C 13	---	---	---	2 sl	---	---
MS 108-5	---	---	---	---	---	---
MS401-2	---	1	---	---	---	---
MS402-1	---	---	1	---	---	---
MS402-5	---	---	---	3 sl, 1 sev	---	---
WIS 718	---	---	---	---	---	---

* Based on observations of 25 tubers selected at random from the Sept. 22 harvest.
sl = slight; sev = severe; br = brown

Storage evaluations

Table 4 summarizes the culinary quality of these several varieties after 3 months storage at 52F. Generally speaking after-cooking-darkening (ACD) ratings were poorer than other years. In some varieties such as Atlantic, Crystal, Denali, Oceania, Onaway, Pioneer, Rideau, Russet Burbank, Superior, Yukon, B8972-1 and C13 the cooking quality in terms of color was very desirable. Varieties with high specific gravity such as Atlantic, Chipbelle and Denali tend to slough more than do varieties with lower dry matter. Several varieties had the ACD confined to the area outside of the vascular ring and generally was most pronounced on the stem end, which is very typical of this reaction. Similiar samples stored at 40^{o} will be evaluated in February.

Several of the selections remained in very acceptable chipping condition during this storage period. Atlantic, Belchip, Monona, Chipbelle and Allagash Russet remained in the most desirable chipping condition and were closely followed by Crystal, Denali, Superior, B8972-1, C-13, CA 027, MS402-5, Dakchip and Lemhi. Dakchip was badly sprouted at the end of the storage period and of all these varieties displayed the shortest rest period. Similiar samples have also been stored at 40F and these will be removed in February for reconditioning and the determination of their ability to produce an acceptable chip color.

Table 4. The after-cooking-darkening[1] and chip rating[2] of several varieties held in storage at 52^{o}F

Variety	Hours after cooking 0	1	24	Chip score
Allagash Russet	1.0	2.0	3.5	1.0
Atlantic	1.5	1.5	1.5	1.0
Belchip	1.5	2.0	2.5	1.0
Chipbelle	2.0	3.0	3.0	1.0
Crystal	1.0	1.0	1.0	1.5
Dakchip	1.5	2.0	2.0	1.5
Denali	1.5	1.5	1.5	1.5
Highlat	1.0	1.5	2.0	2.0
Jemseg	1.5	2.0	2.0	3.5
Lemhi	1.0	2.0	2.0	1.5
Michimac	2.0	3.5	3.5	3.5
Monona	1.0	2.0	2.0	1.0
Oceania	1.0	1.5	1.5	2.0
Onaway	1.0	1.5	1.5	4.0
Pioneer	1.5	1.5	1.5	2.5
Rideau	1.0	1.5	1.5	3.0
Russette	1.5	2.0	2.0	3.0
R. Burbank	1.0	1.0	1.0	3.5
Superior	1.0	1.5	1.5	1.5
Yukon	1.0	1.0	1.0	3.0
B8972-1	1.0	1.5	1.5	1.5
CA 027	3.0	3.0	3.5	1.5
C 13	1.0	1.5	1.5	1.5
MS 108-5	1.5	2.0	2.0	2.5
MS 401-2	1.0	2.0	2.0	3.0
MS402-1	1.0	2.0	2.0	2.5
MS402-5	1.0	1.5	1.5	1.5

[1]Ratings based on a 1-5 scale. 1 = clear with no after cooking darkening 5 = undesirable greyish black discoloration throughout the flesh

[2]Chip score based on a 1-5 scale. 1 = light color and very acceptable 5 = dark color and not acceptable

B. *10 Hill Observation Plots*

Very few selections were planted in 10 hill observation plots as most seed was sufficient enough to plant in a replicated plot. Following are the four selections observed in a single 10 hill plot.

Selection	Total cwt/A	US No. 1 cwt/A	Percent Under 2"	Percent Over 3 1/4	Percent 2-3 1/4
Shepody	390	335	10	10	76
Snowchip	538	484	9	0	90
G 670-11	577	546	3	27	68
B 8833-6	257	156	36	0	61

C. *Overstate Potato Variety Trials*

Overstate potato variety trials are planted as single row, result-demonstration plots in order to incorporate commercial handling of the seed and harvest. Plots were established at DuRussel Brothers in Manchester, Gordon Corrion in Munger, Leroy Woloszyk in Posen, Hank and Andy Leep at Shelbyville, and Carl and George Horkey at Dundee. Half acre plantings of several varieties were also evaluated at the Wayne Lennard Farm in Samaria.

Except at the Lennard Farm, approximately 35 pounds of seed of each variety was provided to the cooperating grower. The seed was cut in their mechanical cutter and then planted with their planter. The results are summarized in Table 5. Data from the Corrion and Horkey Farms are not included because of water damage to the plots during September and October. There was a significant range in climatic conditions between locations. Extremely dry conditions prevailed during the growing season in the northern Lower Peninsula and this is reflected in the lower yields and high specific gravity at the Woloszyk Farm.

Varieties which seemed to yield consistently well were Atlantic, Chipbelle, Crystal, Denali and Wis 718. Scab was very prevelant with the plot area at Allegan and was most severe on Crystal, Denali and Dakchip. When scab is present it frequently appears as the deep, pitted type on the Crystal variety. Dakchip has not yielded well and vascular discolorations have been frequently observed. Internal defects were less in 1981 than in 1980. Hollow heart was observed on Wis 718, Russette, Allagash Russet, Lemhi and Atlantic. Russette, Oceania and Rideau were observed to be slower in emergence and in early season vigor.

Table 5. The yield and specific gravity of several potato varieties grown at out-state locations in 1981.

	Leep Allegan County			Woloszyk Presque Isle County			DuRussel Washtenaw County			Lennard Monroe County	
Variety	Total (cwt/A)	No. 1 (cwt/A)	Specific Gravity	Total (cwt/A)	No. 1 (cwt/A)	Specific Gravity	Total (cwt/A)	No. 1 (cwt/A)	Specific Gravity	Total (cwt/A)	Specific Gravity
Allagash Russet							220	186	1.058		
Atlantic	420	405	1.082	240	222	1.093				297	1.083
Belchip										352	1.078
Chipbelle	371	328	1.085	260	240	1.089	209	194	1.077	312	1.084
Crystal	401	374	1.070	217	176	1.086	406	381	1.064	346	1.070
Dakchip	333	320	1.065							226	1.065
Denali	453	443	1.083	199	165	1.093	394	363	1.081	288	1.087
Katahdin							276	265	1.066		
Lemhi							354	319	1.076	284	1.073
Michimac				304	263	1.074					
Oceania	292	272	1.066				261	231	1.057	334	1.066
Ontario				254	213	1.074					
Rideau				145	135	1.077	287	273	1.066		
Russette				199	171	1.090	348	293	1.066	289	1.077
B 7805-1							328	271	1.064		
CA 027				222	207	1.084					
MS 108-5	400	364	1.072	219	168	1.086	278	247	1.069		
MS 402-1	302	289	1.062	184	164	1.078	447	392	1.065	319	1.063
Wis 718							368	345	1.057	311	1.063
Average	372	349	1.073	222	193	1.084	321	289	1.067	305	1.074
Planted:	May 15, 1981			May 14, 1981			May 29, 191			April 5, 1981	
Harvested:	September 28, 1981			September 24, 1981			October 12, 1981			September 10, 1981	

1981 NORTH CENTRAL REGIONAL TRIAL

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The North Central Regional Trials are conducted each year at 12 locations throughout the North Central region which includes Alberta and Manitoba. These trials are designed to provide a performance evaluation of advanced selections from the plant breeding programs of Nebraska, Minnesota, North Dakota, Louisiana, Wisconsin and Michigan.

Thirteen entries were evaluated in 1981 and were compared with Norland, Red Pontiac, Norchip and Russet Burbank. Characteristics of the 1981 entries are as follows:

SELECTION NO.	PARENTAGE	MATURITY	COLOR	OTHER INFORMATION
Neb. A129.69-1	Platte x 48.60-1435	Late	White	Chips
Neb. A219.70-3	Sioux x 49.62-5	Medium	White	Chips, Scab Resistant
Neb. 7.67-1	45.51-3 x White Cloud	Medium	White	Chips, Scab Resistant
Minn. 9781	2911.69-1 x 2912.69-3	Medium	Russet	Chips, Scab Resistant, Long
Minn. 8777	32.63-9 x ND6948-14R	Late	Red	Late Blight Resistant
Minn. 10162	Nooksack x 2848.72-4	Medium	White	Late Blight Resistant
La. 7196	11-74 (X)	Late	White	Scab resistant, chips
La. 31-124	Minn. 1317 x 71-110	Medium	White	Chips
Wisc. 726	Wisc. 639 x Kennebec	Med-Late	White	
Wisc. 774R	La. 12-8 x ND6948-14R	Med-Late	Red	
ND146-4R	ND8987-3R x ND9403-20R	Early	Red	Chips, Late Blight resist.
ND119-3	ND8750-20 x Wischip	Medium	White	Chips
ND55-7	B7633-6 x Wischip	Late	White	Chips
Norland	CHECK	Early	Red	
Red Pontiac	CHECK	Late	Red	
Norchip	CHECK	Medium	White	Chips
Russet Burbank	CHECK	Late	Russet	

The performance results are shown in Tables 1 and 2.

Table 1. THE YIELD PERFORMANCE OF SEVERAL ADVANCED SEEDLINGS IN THE 1981 NORTH CENTRAL REGIONAL TRIAL

Variety	Aver. Mat.[1/]	Most[2/] Representative Scab Area-Type	CWT/A Aver. Yield	CWT/A Aver. Yield US #1	Aver. Percent US #1	Aver. Total Solids	Gen.[3/] Merit Rating	Chip[4/] Color	Early[5/] Blight Reading	Comments and General Notes
Early to Medium Early										
ND146-4R	2.0		347	286	82.4	17.1	3	2		smooth but small
Norland	2.0		334	300	89.8	15.4		3		eyes deeper than normal
Medium to Late										
Neb. A129.69-1	4.0		322	292	90.6	18.2	1	3		smooth, uniform
Neb. A219.70-3	3.0		584	579	99.1	17.7	5	3.5		wide variation in size
Neb. 7.67-1	3.0		273	236	86.4	16.2		2		deep eyes
Minn. 9781	2.5		230	123	53.4	18.4		2.5		small, long, round
Minn. 8777	3.5		545	524	96.1	18.4	2	2.5		smooth, shallow eyes
Minn. 10162	3.0	1-3	193	152	78.7	18.4		1		pointed mishape
Wisc. 726	3.5		306	291	95.0	18.2	4	1.5		a few stitched ends
Wisc. 774R	3.5		458	413	90.1	16.9		4		large, rough
La. 7196	3.0		372	327	87.9	18.2		3		pointed
La. 31-124	3.5		364	336	91.3	17.1		2.5		long, round, pointed
ND 119-3	2.5		229	188	82.0	16.2		1		deep eyes, sprouted
ND 55-7	3.5		283	222	78.4	18.0		1.5		irregular shapes
Red Pontiac	4.5		650	599	92.1	17.1		4.5		rough
Russet Burbank	4.5		411	300	72.9	19.2		3		misshaped
Norchip	3.0		382	332	86.9	19.2		1.5		very irregular shape

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

2/ AREA - T-less than 1%; 1 - 1-20%; 2 - 21-40%; 3 - 41-60%; 4 - 61-80%; 5 - 81-100%. TYPE - 1. Small, superficial 2. Larger, superficial; 3. Larger, rough pustules; 4. Larger pustules, shallow holes; 5. Very large pustules,deep holes.

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

4/ Chip Color - PCII Color Chart 1-5 scale 1 = lightest 5 = dark

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

Table 2. THE SUMMARY OF EXTERNAL AND INTERNAL DEFECTS OF SEVERAL ADVANCED SELECTIONS IN THE 1981 NORTH CENTRAL REGIONAL TRIAL

	Percent External Defects (1)				Total (4)	Percent Internal Defects (2)			
Variety	Scab (3)	Growth Cracks	Second Growth	Sun Green	Tubers Free of External Defects	Hollow Heart	Internal Necrosis	Vascular Discoloration	Normal Tubers (5)
Early to Medium Early									
ND146-4R		3			97				100
Norland		4			96		3		97
Medium to Late									
Neb. A129.69-1		5		4	91			7	93
Neb. A219.70-3					100	5			95
Neb. 7.67-1					100			8	92
Minn. 9781				12	88			8	92
Minn. 8777					100		2	2	97
Minn. 10162	20			4	79			18	82
Wisc. 726				11	89		1	4	96
Wisc. 774R				2	98			12	88
La. 7196				10	90			6	94
La. 31-124		4			96			9	91
ND 119-3		8			92			10	90
ND 55-7					100		11	16	78
Red Pontiac		5	4		93	12		4	87
Russet Burbank		6	31		69			19	81
Norchip		8	4	3	86			7	93

(1) Based on four 25 tuber samples (one from each replication). Percentage based on number of tubers.
(2) Based on four 25 tuber samples (one from each replication). Percentage based on number of tubers.
(3) Includes all tubers with scab lesions whether merely surface, pitted or otherwise and regardless of area. Be sure to count tubers with any amount of scab in this category.
(4) This total - tubers free from any external defect of any sort.
(5) Percentage normal tubers are those showing no internal defects. Some individual tubers will have more than one type of internal defects.

USE OF POLYACRYLAMIDE GEL ELECTROPHORESIS IN POTATO SPINDLE TUBER DIAGNOSIS

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Introduction

Potato spindle tuber disease has the potential of being a limiting factor in production due to yield losses and rejection of seed material. Since the disease is tuber borne, it is very important that the seed stock is as free as possible from this disease.

Screening for this disease has relied primarily on visual symptoms and a bioassay on tomato seedlings. However, since the potato spindle tuber viroid exists in many strains that result in mild to severe symptoms or no symptoms, the tomato test is often unable to detect the presence of the viroid. Presence of mild strains can often only be detected by challenging the tomato plant with a known severe strain and checking for cross protection. This adds extra time to the assay. My own experience with the disease has revealed enough variation in the growth of the tomato to cause some confusion in diagnosis.

The spindle tuber viroid consists only of single stranded ribonucleic acid (RNA). Thus, the viroid can be assayed for by physical-chemical means. Since the viroid has a definite size and electrical charge, it can be separated and identified by electrophoresis. Several techniques have been described for such an assay (1,2,3). I have developed a procedure based on these reports which will fit in well with our seed research program.

Procedure

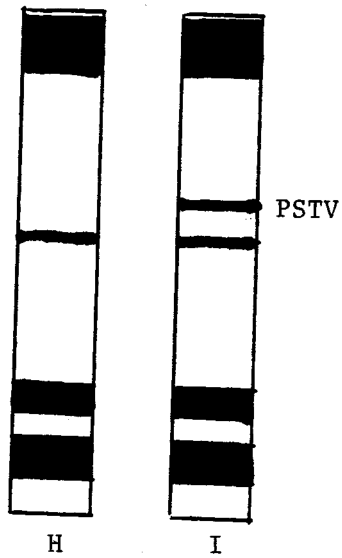
One-half gram of apical stem tissue is excised from infected and non-infected plants. The tissue is immediately placed into liquid nitrogen to freeze the tissue and the tissue is stored at -20C until assayed. The frozen tissue is ground to a fine powder and placed into a pre-chilled 15 ml centrifuge tube. 1.5 ml of extraction buffer and 2 ml of water saturated phenol containing 0.1% 8-hydroxyquinoline are added to the tissue powder and the mixture is allowed to thaw. The thawed mixture is then mixed vigorously and allowed to shake for one hour on ice. The leaf residue is removed by centrifugation and the clear supernatant removed and transferred into another test tube. Three volumes of cold (-20C) 96% ethanol are added to the supernatant and the tube is placed in a freezer for one hour. The plant nucleic acids, and PSTV if present, are precipitated during this time. The precipitate is collected by centrifugation, washed with 96% ethanol and dried under vacuum for 15 minutes. The pellet is redissolved in 200 ul of 0.5M sucrose containing 0.05% bromophenol blu and used immediately for electrophoresis or stored at -20C. Electrophoresis is carried out by the method of Morris and Smith.

Results

Figure 1 shows a diagram of a typical separation of PSTV from infected plants. The technique is sensitive enough to allow assay of several plants at once. This allows the assay of many more plants at once than was possible with the tomato test. When batch testing is performed and a positive test given, then the individual plants can then be tested and removed.

Results with tuber tissue have not been successful in my hands as of this time.

FIGURE 1



H= Healthy plant
I= PSTV infected plant

MINI-TILL POTATOES

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Procedure

Wind erosion on potatoes and sugarbeets are a common occurrence in the Bay County area. In an effort to evaluate the effect of crop residues and tillage on establishing a stand of potatoes, plots were established at the farm of Henry Mulders in Munger. On August 25, 1980 a field previously planted to potatoes was plowed and planted to four cover crops with 3 replications as follows:

Cover Crop	Seeding Rate	Oct. 1980 Growth
Wheeler rye	80 lbs/A	Excellent cover 7-8 inches vigorous growth
Mariner oats	64 lbs/A	no stand - poor seed
Red proso millet	25 lbs/A	Sparse stand* 6 inches
Hay-R-Graze sorghum-sudan hybrid	30 lbs/A	Sparse stand* 6-7 inches

* Both were completely dead by mid-October because of frost

The oats, millet and sorghum-sudan hybrid were selected because they would freeze during the winter and therefore require no tillage or chemicals before planting. It was determined that there was insufficient warm weather in the fall of 1980 to obtain a satisfactory stand of millet or a sorghum-sudan hybrid.

On April 13 the rye was sprayed with paraquat at 1 qt/A plus X77 at 8 ounces/100 gallons water. The area was divided with one half being plowed before planting. The remaining area received no tillage and Katahdins were planted at 8 X 34 inches with a modified two-row Lockwood planter on April 27, 1981. Soil temperature at 8 inches was 44° in the soil seeded to rye and 49° in the tilled area. Fertilizer was applied in the planter at 900 lbs/A 9-18-18 + 2% Mg. 1/2% Mn. Temik was applied at 20 lbs/A.

After planting, one half of the area was dragged off while the remaining area received no tillage until hilling.

Results

At planting difficulty was experienced in obtaining good soil cover over the seed piece in the rye cropped area. The covering soil bunched and did not give good uniform coverage. The planting and coverage in the millet, oats and sorghum-sudan plots was very adequate because of the sparse and non-active vegetative residue.

At harvest there was no problem with the rye residue. Yield checks were taken from the rye and millet plots within the areas which were dragged and not dragged after planting. The yield results are shown in Table 1. Yields from the dragged off rye plots were greater than when not dragged and this is likely due to the improved soil cover over the planted seed piece.

Yield checks from the area which was plowed and prepared conventionally were not taken because of a different planter and planting date. The results of this initial test showed that potatoes can be planted and grown on this soil type without primary tillage with satisfactory yields. The project is being continued and winter cover crops of oats, spring barley and rye were planted on September 14, 1981.

Table 1. The yield, size distribution, and specific gravity of Katahdin potatoes grown with minimum tillage at planting (Mulders 1981)

Cover Crop	Total Yield (cwt/A)	US No.1 Yield (cwt/A)	Percent 2 - 3¼"	Over 3¼"	Under 2"	S.G.
NOT DRAGGED-OFF						
Rye	390	367	55.2	38.8	6.0	1.066
Millet	440	409	64.5	28.4	7.1	1.068
DRAGGED-OFF						
Rye	420	381	69.5	21.2	9.3	1.062
Millet	379	351	65.8	26.7	7.5	1.065

THE EFFECT OF STORAGE TEMPERATURE DELAYED PLANTINGS OF CUT SEED AND SEED TREATMENT ON STAND AND YIELD OF POTATOES

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Environmental studies with cut potato seed were continued at the Montcalm Experimental Farm during 1981. These studies have attempted to evaluate the effect of storage temperature, delayed planting of cut seed and seed treatment on stand and yield. Certified Monona seed was cut and treated at 3 time intervals before planting, 14 days (April 26), 2 days (May 6), and 0 days (May 8). Treatments included (1) sodium hypochlorite (clorox) 500 ppm, (2) streptomycin sulfate + captan 10+10% dust 1 lb/CWT of seed and (3) plain water.

The sodium hypochlorite and water treatments were applied as a 2 minute dip. Streptomycin + captan dust was applied by thoroughly agitating the seed and chemical in a closed plastic bag until cut surface was thoroughly covered. For two weeks prior to planting all whole or cut seed used in the tests was stored at either 40-45°F or at 65-70°F with a relative humidity of 90%.

Planting was done by hand (May 8) in 34 inch rows with seed pieces spaced 9 inches apart. Treatments were randomized and replicated three times in a single block planting. Plots consisted of a single 25 foot row. Temiks was applied at planting for early insect control and supplemented with foliar applications of Thiodan as needed. Fungicide sprays either Dithane M-45 or Bravo 500 were applied at regular intervals. Irrigation was used when necessary to maintain vigorous growth.

A stand count was taken at 4 and 6 weeks after planting. The plots were harvested on October 6.

Results indicate that the longer the time interval between cutting seed and planting the poorer the stand. Seed stored at 40-45°F is likely to produce a poorer stand than seed stored at 65-70°F. The greatest difference in the effect of temperature on stand is found with cut seed stored at the longest time interval. And inversely the least effect of temperature on stand occurs where seed is cut and planted the same day. Chemical seed treatment appears to benefit stand particularly when cut seed is stored for longer periods before planting. This is more apt to be true when stored at 40-45°F than at 65-70°F. In this and in previous tests there wasn't always a good correlation between stand and yields. In some instances a moderate stand would result in a higher yield than a very good stand.

1981 RESULTS POTATO CUT SEED TRIALS

		TIME SEED CUT BEFORE PLANTING-DAYS			%	YIELD CWT/A	
TREATMENT AND RATE	METHOD OF APPLICATION	14	2	0	STAND	US#1	BGRADE
	STORAGE TEMPERATURE 40-45°F						
SODIUM HYPOCHLORITE 500PPM	DIP	X			66.2	354.0	21.5
" " "	"		X		90.0	360.8	12.3
" " "	"			X	92.5	366.3	13.0
STREPTOMYCIN SULFATE+CAPTAN 10+10%D 1 LB/CWT OF SEED	DUST	X			74.0	338.6	9.2
" "	"		X		88.8	364.5	21.5
" "	"			X	94.5	355.9	12.4
WATER ONLY	DIP	X			63.0	293.7	17.9
" "	"		X		62.7	320.2	16.0
" "	"			X	79.0	327.6	18.7
NO TREATMENT		X			60.0	315.8	14.2
" "			X		77.5	338.6	9.2
" "				X	88.8	346.0	16.5
LSD .05					13.0	23.0	4.3
.01					19.6	34.2	6.5
	STORAGE TEMPERATURE 65-70°F						
SODIUM HYPOCHLORITE 500PPM	DIP	X			82.8	366.3	12.3
" " "	"		X		88.2	371.3	13.5
" " "	"			X	97.3	370.4	14.2
STREPTOMYCIN SULFATE+CAPTAN 10+10%DUST 1 LB/CWT OF SEED	DUST	X			87.0	349.8	23.4
" "	"		X		95.3	380.1	18.5
" "	"			X	98.7	399.5	9.2
WATER ONLY	DIP	X			79.2	307.8	18.5
" "	"		X		87.3	322.9	24.6
" "	"			X	82.0	329.4	20.3
NO TREATMENT		X			76.5	324.5	15.4
" "			X		92.8	341.7	16.0
" "				X	94.7	353.0	15.4
LSD .05					7.5	27.5	4.6
.01					11.3	41.7	6.9
COMBINED TABLES							
LSD .05					10.2	25.2	4.4
.01					15.4	37.9	6.7

WEED CONTROL IN POTATOES

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Herbicide treatments for control of barnyard grass and annual broadleaved weeds are shown in Table 1. All soil applied treatments, Eptam (PPI), Lasso, Dual and Prowl (Pre), provided excellent control of barnyard grass. Lexone, Sencor and Lorox applied as a delayed preemergence treatment (after weeds had emerged, but before potatoes emerged) gave complete control of broadleaved weeds. Combinations of the grass herbicides (Lasso, Dual, Prowl) plus Lexone or Sencor applied as a preemergence treatment also provided excellent grass and broadleaved weed control. Plots that were weed-free at the time of early hilling (weeds covered by hilling) and then sprayed preemergence also remained weed-free throughout the growing season. In general if treatments are applied early and no further tillage is practiced, excellent weed control throughout the season is possible.

Another phase of the study was to evaluate new chemicals for postemergence control of annual grass. Several treatments shown in Table 1, were applied to barnyard grass 2-4 inches tall. Broadleaved weeds had been controlled with Lexone or Sencor applied delayed preemergence. Excellent grass control 95-98% was obtained from all chemicals tested with little or no visible injury to potatoes. Oil concentrate at 1 quart per acre was added to all postemergence treatments to increase penetration of weed foliage.

Potato yields shown in Table 1, indicated few significant reductions. Two exceptions, were combinations that included Prowl applied preplant incorporated or after early hilling and Dual at high rates. In these cases the yields were significantly lower than highest yields in test and not lower than the overall treatments average. Yields were somewhat variable.

Data for the potato vine killing study is shown in Table 2. In this study, an evaluation was made to determine if more effective desiccation or burn-down could be obtained if the vines were pushed over to give more direct contact with the potato stems. Two methods were used to push down the vines directly in front of the spray boom. The results of this study did not show any advantage for pushing the vines down. At the time of application, the potato vines were beginning to mature, and good to excellent "kill" was obtained with all treatments. Diquat, which obtained label clearance in 1981 for potato vine desiccation, provided the most effective "kill".

TABLE 1: Preplant Incorporated, Preemergence and Postemergence Weed Control Evaluations in Potatoes Montcalm Co., Michigan 1981.

Date Planted:	May 8, 1981	Date Treated:	PPI: - 5/8/81
Variety:	Russett Burbanks		Pre: - 5/8/81
Row Spacing:	34"		Delayed Pre: - 5/27/81
Plot Size:	102" x 50'		Post: - 6/17/81
No. of Replications:	3	Date Rated:	6/23/81
Incorporation Equipment:	Springtooth Drag x 2	Soil Texture:	Loamy Sand
		Organic Matter:	2%

Weeds Present: Barnyard grass, Pigweed, Lambsquarters

Trt. No.	Treatment	Rate lbs/A	BG	PW	LQ	Injury	Yield cwt/A
	PPI D. Pre						
1.	Eptam + Lexone DF	4 + 1/2	9.0	10.0	10.0	0.0	313
2.	Eptam + Prowl + Lexone DF	2 + 1 + 1/2	9.2	10.0	10.0	1.3	289
	Pre D. Pre						
3.	Prowl + Lexone DF	1 + 1/2	9.5	10.0	10.0	0.0	339
4.	Prowl + Lorox 4L	1 + 1	9.8	10.0	10.0	0.0	325
5.	Dual + Lexone DF	3.6 + 1/2	10.0	10.0	10.0	0.0	315
6.	Dual + Lexone DF	4.8 + 1/2	10.0	10.0	10.0	0.0	278
7.	Dual + Lorox 4L	3.6 + 1	10.0	10.0	10.0	0.0	299
8.	Dual + Lexone DF	2.4 + 1/2	10.0	10.0	10.0	0.0	300
9.	Surflan + Lexone DF	3/4 + 1/2	8.5	10.0	10.0	0.0	330
	Pre						
10.	Prowl + Lexone DF	1 + 1/2	8.8	10.0	10.0	0.0	341
11.	Dual + Lexone	2 + 1/2	9.8	10.0	10.0	0.0	326
12.	Lasso + Lexone	2 + 1/2	8.3	10.0	10.0	0.0	334
	Early Hill & Spray						
13.	Lasso + Sencor Sprayule	2 + 1/2	9.2	10.0	10.0	0.0	347
14.	Dual + Sencor Sprayule	2 + 1/2	9.8	10.0	9.7	0.0	314
15.	Prowl + Sencor Sprayule	1 + 1/2	9.0	9.8	10.0	0.0	274
16.	Sencor + Poast + OC	1/2 + 1/8 + 1 qt	9.8	10.0	10.0	0.0	312
17.	Sencor	1/2	8.8	10.0	10.0	0.0	329
18.	Sencor	1/2	8.3	10.0	10.0	0.0	328
19.	Lexone DF + CGA 82725 + OC	1/2 + 1/4 + 1 qt	9.2	10.0	10.0	0.0	306
20.	Lexone DF + CGA 82725 + OC	1/2 + 1/2 + 1 qt	9.8	10.0	10.0	0.0	314
21.	Lexone DF + ICI PP 009 + OC	1/2 + 1/4 + 1 qt	9.5	10.0	10.0	0.0	306
22.	Lexone DF + Nissan 96683 + OC	1/2 + 1/4 + 1 qt	9.7	10.0	10.0	1.0	312
	LSD						43

Rating based on a 1-10 scale; 0 = no injury, 10 = complete kill

TABLE 2: Potato Vine Killing, Montcalm County, Michigan, 1981

Variety:	Russett Burbank	Date Treated:	9/3/81
Row Spacing:	34"	Date Rated:	9/8/81
Plot Size:	102" x 50'	Spray Pressure:	40 PSI
No. of Replications:	3	Spray Volume:	46 GPA

*Wood Board and Steel Bar were draged behind spray tractor, but directly in front of spray boom to hold potato vines down.

Trt. No.	Treatment	Rate lbs/A	Average 3 Reps % Kill
1.	Diquat	1 pt (1" x 2" Steel Bar)	93
2.	Diquat	1 pt (2" x 4" Wood Board)	90
3.	Diquat	1 pt	93
4.	Diquat	1 1/2 pt (1" x 2" Steel Bar)	85
5.	Diquat	1 1/2 pt (2" x 4" Wood Board)	93
6.	Diquat	1 1/2 pt	95
7.	Diquat + Ammonium Sulfate	1 pt + 5 lb	88
8.	Diquat + Copper Sulfate	1 pt + 8 lb	82
9.	Dow General + Ammonium Sulfate	2 pt + 5 lb	90
10.	Dow General + Copper Sulfate	2 pt + 8 lb	85
11.	Dow General	2 pt (1" x 2" Steel Bar)	80
12.	Dow General	2 pt (2" x 4" Wood Board)	87
13.	Dow General	2 pt	85
14.	Dow General	3 pt (1" x 2" Steel Bar)	87
15.	Dow General	3 pt (2" x 4" Wood Board)	92
16.	Dow General	3 pt	87

THE INFLUENCE OF NEMATICIDES ON PRATYLENCHUS PENETRANS AND TUBER YIELDS OF 'ATLANTIC' POTATOES

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Temik 15G (3.0 lb. a.i./A) and Mocap 10G (1.5, 3.0, 6.0 and 9.0 lbs. a.i./A) were evaluated for the control of Pratylenchus penetrans associated with the production of Atlantic potatoes. A complete randomized block design was used with five replications. Seed pieces were planted May 14, 1981 at the Montcalm Potato Research Farm. Each consisted of four rows 34 inches apart, 50 feet long and seed pieces at a 10 inch spacing. All nematicides were applied the day of planting. Mocap treatments were broadcast and incorporated and the Temik 15G was banded beside the seed furrow. The experiment received the same rate of fertilizer, foliar insecticides and irrigation as the general test plots on the Montcalm farm. Soil samples were analyzed for nematodes using the centrifugation-floatation technique and the roots were processed using the shaker extraction technique.

P. penetrans, the root-lesion nematode, densities at planting averaged 17 per 100cm^3 of soil were not significantly different (P=0.05) between treatments (Table 1). They were sampled on 5/14, 7/9, 8/10, and 9/11. On July 9 the root samples indicated no significant differences in nematode densities, however the soil analysis indicated that generally the check had higher populations than the nematicide treatments. On August 10, based on the results from the root extractions, the check had the highest population densities of P. penetrans. The nematicides had lower densities with some differences in control between the nematicide treatments. On September 11 the use of Temik 15G resulted in significantly greater control of P. penetrans than all other treatments.

Total tuber production was lowest in the check and Mocap 10G at 1.5 lb. a.i./A treatments and significantly higher in all other treatments (Table 2). There were no differences in 'b' size tuber yields. The use of Temik 15G resulted in a significantly higher amount of oversized tubers than the check, but the specific gravity was lower than all other treatments.

Table 1. The Influence of Nematicides on Pratylenchus penetrans Associated with Atlantic Potatoes

Nematicide		Pratylenchus penetrans			Population Density		
		May 14	July 9		August 10		Sept. 11
	a.i./A	100cm3 soil	1.0g root	100cm3 soil	1.0g root	100cm3 soil	100cm3 soil
Check		16.0a[1]	5.6a	7.2b	76.4c	1.6a	69.6b
Temik 15G [2]	3.0	18.4a	1.6a	1.6a	0.4a	0.0a	4.0a
Mocap 10G [3]	1.5	16.8a	4.8a	2.4ab	9.6ab	1.6a	64.8b
Mocap 10G	3.0	14.4a	2.8a	0.2a	0.4a	1.6a	52.8b
Mocap 10G	6.0	20.8a	4.0a	2.0ab	16.8b	3.2a	100.0b
Mocap 10G	9.0	17.6a	0.4a	0.8a	8.0ab	0.8a	80.8b

[1] Column means followed by the same letter are not significantly different according to the Student-Newman-Keuls Multiple Range Test.

[2] Banded beside the seed furrow

[3] Broadcast and incorporated with a disk

Table 2. Tuber Yields of Atlantic Potatoes as Affected by Nematicides

Nematicide		Tuber Yields (cwt/A)			
	a.i./A	Total	Oversized	Small	Specific Gravity
Check		330.4a[1]	45.2a	13.2a	1.093b
Temik 15G[2]	3.0	369.5b	81.2b	13.2a	1.085a
Mocap 10G[3]	1.5	326.2a	60.1ab	11.8a	1.091b
Mocap 10G	3.0	378.1b	60.6ab	14.0a	1.092b
Mocap 10G	6.0	397.2b	67.6ab	13.4a	1.090b
Mocap 10G	9.0	393.2b	68.9ab	14.6a	1.091b

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

[2] Banded beside the seed furrow

[3] Broadcast and incorporated with a disk

EFFECT OF PRE-PLANT SOIL TREATMENTS ON THE CONTROL OF POTATO SCAB

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In 1981 additional tests were conducted at the Michigan State University Soils Farm to further evaluate the nitrate inhibitor Dwell and the fungicide Terraclor for control of potato scab. The test site had a fine sandy loam soil with a pH of 7.2. It had been used to grow potatoes for the past five years and the soil was known to be heavily infested with the scab pathogen.

All fertilizer requirements except nitrogen were plowed down. Nitrogen as urea was banded on the furrow at planting along with Dwell and Terraclor. Up until now this had been done with a hand sprayer followed by rototilling to get a uniform mix with the soil. In 1981 a new type of applicator was used which sprays and incorporates the chemical in one operation. The applicator consists of a rectangular frame within which are mounted two back swepted shanks that can extend into the soil to a depth of 7 inches. Wide angle flat fan nozzles are mounted on the shanks. On one, the nozzle is located so as to spray at a depth of 3 1/2 inches, on the other at a depth of 7 inches. Delta wing shrouds cover the nozzles and allow the spray to be distributed across a 12 inch band. A series of vibrating type tines set at different depths are mounted behind the shanks. These vertically mix the soil and distribute the chemical within the soil profile. A conventional spray pump system delivers the chemicals to the nozzles. The entire unit is mounted on a 3 point hitch tool bar. Application of treatment with this equipment were made prior to planting. However, it would be desirable to use the applicator in conjunction with the planting operation. This probably could be done by extending the tongue of the planter to allow room for the equipment mounted on the tool bar.

When using the applicator this past summer the tractor was operated at 3 to 4 m.p.h. At these speeds we got excellent distribution which was determined by using florescent tracers.

Certified Sebago seed was used in the 1981 tests. This was cut and planted on May 22 in single row plots 50 feet long. The row width was 32 inches with seed pieces spaced 9 inches apart. A single guard row separated each plot. Treatments were arranged in a single block planting, randomized and replicated 5 times. Plots were mechanically weeded and sprayed weekly for disease control. Temik was not used in the furrow because of the possibility that it might interfere with the scab treatments. Foliar insecticides were substituted for Temik as needed.

The results from these tests show a highly significant increase in the percent and yield of marketable tubers with the Dwell Terraclor treatment as compared with the checks. Terraclor alone also significantly increased percent and yield of marketable tubers but Dwell alone did not although the data were trending in that direction. In past tests Dwell alone consistently resulted in significant benefits equal to that of Terraclor alone.

The results of this test further indicates that the experimental applicator used for the first time in 1981 may be a practical substitute for tedious time consuming application methods previously used. Further modifications of this equipment are planned which we hope will improve its operating capabilities.

EFFECT OF PRE-PLANT SOIL TREATMENTS ON THE CONTROL OF SCAB

Treatment[1]	Rate/A	Average Yield CWT/A Harvested US#1	Harvested B Grade	Marketable[2] US#1	Marketable[2] B Grade	Ave. % Marketable Tubers
Dwell 2EC	.5 lb ai (1 (qt)	169.0	18.0	128.6	13.7	76.2
Terraclor 2EC	12.5 gal	165.1	16.6	133.8	13.7	80.9*
Dwell 2EC + Terraclor 2EC	.5 lb ai (1 qt) + 12.5 gal	169.3	20.6	154.0	17.6	91.0**
Check	- - -	159.2	14.7	101.8	9.5	63.6
LDS .05		NS	4.2	30.0	5.2	14.5
.01			NS	42.1	7.5	20.3

1 150 lbs of N in form of urea applied in a band on all plots.

2 Potato tubers with not mroe than 2% scab.

3 * = significantly different from check at 5% level.
** = " " " " " 1% level.

CONTROLLED DROPLET SPRAYING FOR CONTROL OF EARLY AND LATE BLIGHT OF POTATOES

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Controlled droplet and conventional nozzle methods of spraying were compared on potatoes for control of late blight (Phytophthora infestans) and early blight (Alternaria solani) using Bravo 500 at the recommended rate (2 pt/A) and at the half rate (1 pt/A).

Tests were conducted at the Michigan State University Muck Research Farm with the variety Russet Burbank. The experimental design consisted of two parallel block plantings 200 feet long and 50 feet wide. Treatments were randomized and replicated twice in each block. The plots were 50 feet in length and 12 feet in width. They were arranged along both sides of the blocks so that sprays could be applied without mechanically damaging the plants. A 25 foot wide unsprayed strip running down the center of each block served as a check.

The spray equipment used was an experimental tractor-mounted unit supplied by the Spray-Rite Company. It combined two types of spraying devices. On one side was a conventional brush boom with low pressure flat fan wide angle (110^{o}) nozzles (Spraying Systems #11003LP). On the other a boom on which were mounted 5 micromax rotary atomizers (Micron) spaced 2 ft. 7 in. apart. The atomizers were electrically powered with a belt drive and two pully combinations, one for high speed operation (5000 RPM) and one for low speed (2000 RPM). Changing the rotating speed regulates the droplet size. In this test the rotating speed was 2000 RPM which produced droplet sizes ranging between 200 and 250 microns.

Both spraying systems were operated at 20 psi. The output for the conventional nozzles was 25 gal/A and for the controlled droplet atomizer (C.D.) 5 gal/A. Fungicide applications were applied weekly from June 29 to September 22 (13 applications). Plots were inoculated at the end of July and again in mid August with the late blight fungus. The disease, however, did not begin to develop until early September when the weather turned cool and wet. By the middle of the month when final disease readings were taken, both late blight and early blight infections were moderate to severe in the unsprayed control. Shortly after that the vines were severely damaged by frost and later by flooding. Harvesting took place during the first week in October.

Results shown in the table below indicate that method of application had no significant effect on the incidence of early and late blight infection nor on yield of US#1 potatoes. The rate of application, likewise, had no significant effect on disease incidence, but at the half rate, yields were significantly less than at the full rate.

Based on these and other data it is apparent that controlled droplet applicators using reduced amounts of water may be substituted for conventional spray equipment. However, at this time it would be unadvisable to apply less than the recommended rate of a chemical when using controlled droplet atomizers or any other type of spray dispensing equipment.

EFFECT OF CONTROLLED DROPLET AND CONVENTIONAL SPRAYING METHODS
ON DISEASE CONTROL AND YIELD IN POTATOES

		Disease Index[2]		Yield CWT/A	
Atomizer Type	Rate[1]	Late Blight	Early Blight	US#1	B Grade
Nozzle	Full	1.8	1.7	262.9	57.0
Nozzle	Half	2.8	2.6	223.3	63.4
C.D. Atomizer	Full	1.9	1.6	264.5	58.6
C.D. Atomizer	Half	2.4	1.8	224.9	64.9
Control		5.3	3.8	166.3	63.4
LSD .05		1.5	1.2	35.0	NS

[1]Bravo 500 Full rate 2 pts., half rate 1 pt. (Formulation)

[2]Disease Index - 0 = No disease - 10 = 100% defoliation

WIREWORM AND WHITE GRUB CONTROL IN POTATOES

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Wireworms and white grubs (Phyllophaga sp) continue to be the most serious soil insects on first year potatoes after breaking up fallow sod-born fields. When the normal food source of these insects which have built up over successive years is destroyed by plowing and cultivation the larvae will shift their feeding to the roots of the newly planted crops. Complete destruction of the yield or quality of the crop may result if an effective control program is not available.

The loss of chlordane and other chlorinated hydrocarbon insecticides led immediately to the search for substitute compounds such as the organophosphates. Certain of these have shown to be effective and are now labeled for use against wireworms on most crops including potatoes, however no materials have been labeled for white grubs on potatoes. Since the use of systemic insecticides which are effective on certain soil organisms has been accepted so extensively by the growers the possible effectiveness of a combination of broadcast soil insecticide and the in-row application of the systemics is being studied.

Previous research reports have indicated these combinations have been additive in their effectiveness on wireworms and possibly white grubs. Low resident populations of white grubs in the research plots has not provided adequate data to support this registration or use pattern. One of the biggest deterrants to this research objective is the locating of grub infested fields which would be available for this type of work. The field should be in a potato growing area so commercial production practices could be followed.

Another factor is the control process estimating the resident population of the soil insects and determining their damage potential to the potato crop. The use of baits to attract the insect larvae have been studied in other areas but have not been evaluated in Michigan.

1981 Research

A field was located near Rockford in Kent County to evaluate the sampling of soil insect larvae and their control with the use of combination insecticide treatments. The field which consisted of about 14 A. had been fallow for several years and was to be planted to potatoes. Baits were prepared by cutting squares of cheese cloth and placing a small handful of corn meal, rolled oats, shelled corn and 1/2 potato on each and tieing into a sack. On April 3 twenty of these bait stations were placed randomly around the field at a 6 inch depth and marked with a white stake. This placed them in the root zone of the grass and weed cover and would attract any wireworms or white grubs which may come up and feed in the area. Three weeks later, on April 24, the bait stations were examined for insects.

The bait bags were carefully removed from the soil and placed in a 1/4 inch wire sieve and examined for insects. A one square foot sample of sod around the bait was also removed and sifted for insects. Another sample immediately below the root zone was also examined and sifted for insects which might still be moving up into the root zone for feeding. The insect populations from the samples are given in Table 1.

The field was plowed in early May prior to planting potatoes. Arrangements were made with the grower to apply Dyfonate 4 A at 1 gallon per acre on part of the field leaving a strip one spray boom wide untreated as a check. The part of the field on the other side of the creek was treated with Mocap 6 E at 2/3 gallon per acre and the rest to Dyfonate separated from the Mocap with an untreated strip. The materials were applied with a herbicide as a tank mix. The field was disced immediately after to incorporate the pesticides prior to planting. The field was planted in mid May using Sebago seed and applying Temik 15 at 20 lb/A in the fertilizer band. Normal cultural practices were then followed until harvest.

On October 5, 20 row-foot samples were selected at random in each of the treated areas. The hills were dug and the tubers were bagged and identified for future examination. All insects seen in the bottom of the hills or on the exposed soil were saved, identified and the numbers are presented in Table 2. The tubers were taken to the Montcalm Experimental Farm and allowed to dry for damage evaluation.

The tubers were graded by size into B's (to 1-7/8"), A's (1-7/8" - 3-1/4") and oversize (3-1/4" +). Each of these size grades were further rated according to wireworm and white grub damage. A damage rating of 1-indicated no insect feeding damage, 2-minor wireworm feeding, 3-extensive wireworm damage and white grub damage. The tubers in each of these size and damage grades were counted and weighed to determine the yield and effectiveness of the soil insecticide program. The data are presented in Table 3.

Results. The soil sampling was a more effective means of estimating the insect populations than were the baits alone, however it is possible the insects were attracted up into the root zone around the baits. The fermentation of the bait attracted more wireworms than white grubs. Over 75% of the insects were found in the root zone with the rest equally divided between the bait and the sub-root zone area. The overall sampling indicated an average of 3.3 white grubs and 3.5 wireworms per square foot of soil. This population is considered as having an extremely damaging potential to potatoes. The free insects collected at harvest indicate a shift of the small spring white grubs to the later instar forms with no reproduction of young in the treated plots. The wireworm population remained high in the untreated area in the south field.

Both soil materials were very effective in controlling wireworms when compared with the tuber damage in the areas treated only with Temik. The combination treatments also greatly reduced the amount of grub damage in the tubers. There appeared to be very little if any difference in yield or sizes of the tubers in any of the plots.

Table 1. Wireworm and white grub populations near the bait stations

		White Grubs			
		Large	Small	Wireworms	Cutworms
South Field					
1	Bait	0	0	0	0
	Root Zone	4	3	2	0
	Sub-Root Zone	0	0	0	0
2	Bait	Ripped up by a fox or skunk			
	Root Zone	4	5	0	0
	Sub-Root Zone	1	2	0	0
3	Bait	0	0	0	0
	Root Zone	2	6	7	1
	Sub-Root Zone	4	2	0	0
4	Bait	0	0	0	0
	Root Zone	1	0	1	0
	Sub-Root Zone	0	0	0	0
5	Bait	1	0	1	0
	Root Zone	1	0	7 + 1 Ad	0
	Sub-Root Zone	0	0	0	0
6	Bait	0	0	0	0
	Root Zone	4	1	0	1
	Sub-Root Zone	0	0	0	0
7	Bait	0	0	0	0
	Root Zone	1	0	3 + 1 Ad	-
	Sub-Root Zone	1	0	0	0
8	Bait	0	0	0	0
	Root Zone	0	0	1 + 1 Ad	0
	Sub-Root Zone	0	0	0	0
9	Bait	0	0	3	0
	Root Zone	0	0	9	0
	Sub-Root Zone	0	0	0	0
10	Bait	0	0	0	0
	Root Zone	0	0	3	0
	Sub-Root Zone	0	0	6	0
Samples 1-10 Totals					
	Bait	1	0	4	0
	Root Zone	17	15	33 + 3 Ad	2
	Sub-Root Zone	6	4	6	0
	Totals	24	19	43 3	2

Table 1--Continued

		White Grubs Large	White Grubs Small	Wireworms	Cutworms
North Field					
11	Bait	0	0	1	0
	Root Zone	0	2	5	0
	Sub-Root Zone	0	0	0	0
12	Bait	0	0	8	0
	Root Zone	3	2	3	0
	Sub-Root Zone	2	0	0	0
13	Bait	0	0	0	0
	Root Zone	2	0	0	0
	Sub-Root Zone	1	0	0	0
14	Bait	0	0	0	0
	Root Zone	0	0	1	0
	Sub-Root Zone	0	0	0	0
15	Bait	0	0	0	0
	Root Zone	3	0	0	0
	Sub-Root Zone	0	0	0	1
16	Bait	0	0	0	0
	Root Zone	0	0	0	0
	Sub-Root Zone	0	0	0	0
17	Bait	0	0	1 + 1 Ad	0
	Root Zone	0	0	0	0
	Sub-Root Zone	0	0	0	0
18	Bait	0	0	0	0
	Root Zone	0	0	0	0
	Sub-Root Zone	0	0	0	0
19	Bait	1	0	1	0
	Root Zone	0	0	0	0
	Sub-Root Zone	0	0	0	0
20	Bait	0	0	0	0
	Root Zone	1	5	3	0
	Sub-Root Zone	0	1	1	0
Samples 11-20 Totals					
	Bait	1	0	11 + 1 Ad	0
	Root Zone	9	9	12	0
	Sub-Root Zone	3	1	1	1
	Totals	13	10	24 1	1

Table 2. Soil insects found while sampling the potato plots

Location and Treatment	White Grubs Large	Small	Adult	Wireworms	False Wireworms	Wooly Bears
South Field						
Dyfonate 4E	1	0	3	1	0	0
Untreated	3	1	1	33	1	0
North Field						
Dyfonate 4E	1	0	0	1	2	1
Mocap 6E	4	0	3	1	1	1
Untreated	10	0	1	1	1	1

Table 3. Yields, size grades and tuber damage from the soil insect study

	CWT/A	Percent by Size B's	A's	3-1/4 +	Percent by Damage Rating 1	2	3	Grub
South								
Dyfonate 4E	255	7	76	17	91.9	4.5	0.4	3.2
Untreated	262	7	63	30	53.2	19.1	18.5	9.2
North								
Dyfonate 4E	283	5	61	34	93.6	4.4	--	2.0
Mocap 6E	277	4	60	36	93.1	0.7	0.3	5.9
Untreated	280	6	64	30	70.2	14.0	1.2	14.6

FOLIAR INSECT CONTROL ON POTATOES

Arthur L. Wells
Department of Entomology

Sixteen insecticide treatments including foliar and soil systemic materials were evaluated against the foliar insect complex on potatoes in 1981. The plots consisted of paired 50 foot rows randomized in three replications using Russet Burbank variety of seed. The rows were left open during the planting operation on May 13 so the band applications of the systemics could be made prior to covering. Space for one row was left between each plot to allow access to the plots for spraying and sampling. Recommended fertilizer, herbicide and fungicide programs were followed during the study.

A CO_2 sprayer delivering 70 gallons per acre was used to apply the foliar insecticides. Applications were made on June 30, July 7 and 24 and August 10. The foliar insects were sampled with an insect net on July 7, 24, August 3 and 19 prior to the insecticide application on the corresponding days. The insect data are presented in Table 1 and 2. A vine killer was applied in mid September and the plots were harvested on October 8. The potato yields, size distribution, and specific gravity from the plots are presented in Table 3.

Results

The principle insects present in the samples were tarnished plant bugs and Colorado potato beetles. A few potato leafhoppers and other insects occurred early in the plots but they are not included in the tables. The potato beetle was certainly the predominant foliar feeder and caused extensive foliage loss to the untreated plots. All of the foliar insecticides in the study with the exception of Monitor and Lorsban were synthetic pyrethroid compounds and have shown effectiveness against the beetles in other studies. They again, as a group, provided as good control as Monitor even at extremely low rates of application. Lorsban was shown to be very effective also. The BASF material and Temik gave season long control of the beetles, however the Temik provided better yield possibly due to the nematicidal activity. All of the foliars gave higher yields than the untreated plots which indicate the value of an effective control program for this insect. There appeared to be very little differences in the size grade or the specific gravity of the tubers from any of the plots.

Table 1. Control of tarnished plant bugs in foliar evaluation study

		Total Insects/30 Sweeps				
	Lb ai	July		August		Total
Treatment	/A	7	24	3	19	Insects
Foliar Applications						
Pay Off 2.5EC	0.05	1	4	4	11	20
Pay Off 2.5EC	0.10	2	5	0	8	15
Ammo 2.5EC	0.05	3	4	7	15	29
FMC-54800 0.8EC	0.04	1	6	0	7	14
FMC-54617 0.8EC	0.04	2	10	29	6	47
Ambush 2E	0.10	0	8	2	11	21
Pydrin 2.4EC	0.10	2	7	6	6	21
Sum. S-3206 2.4EC	0.10	0	4	0	15	19
L-676863 0.03EC	0.01	2	24	7	14	47
FCR-1272 200EC	0.05	2	8	0	9	19
Monitor 4EC	0.75	0	9	0	8	17
Lorsban 4EC	1.00	1	7	3	17	28
Soil Systemics						
BAS-263-11 10G	3.00	4	11	16	17	48
Temik 15G	3.00	1	0	3	8	12
Untreated	--	1	10	0	9	20
Untreated	--	0	18	0	6	24

Table 2. Control of Colorado potato beetle adults and larvae

	Total Insects/30 Sweeps								Total Insects	
	July				August					
	7		24		3		19			
Treatment	Ad	La	Ad	La	Ad	La	Ad	La	Ad	La
Foliar Application										
Pay Off	1	37	5	11	25	1	25	32	56	81
Pay Off	3	9	9	1	27	-	13	56	52	66
Ammo	1	10	5	5	8	2	16	6	30	23
FMC-54800	0	21	6	6	23	-	7	28	36	55
FMC-54617	0	5	14	1	11	-	16	11	41	17
Ambush	1	46	14	4	51	-	7	146	73	196
Pydrin	0	9	19	4	22	-	13	51	54	64
S-3206	0	19	9	16	42	-	26	28	77	63
L-676863	2	2	8	0	23	-	6	6	39	8
FCR-1272	0	0	5	2	14	-	10	21	29	23
Monitor	0	29	22	2	46	-	8	42	76	73
Lorsban	0	11	3	0	37	-	9	15	49	26
Soil Systemics										
BAS-263-11	0	0	3	0	3	-	5	6	11	6
Temik	0	0	3	0	2	-	0	0	5	0
Untreated	0	162	63	11	140	-	11	78	214	251
Untreated	0	114	89	5	90	-	19	114	198	233
Totals	8	474	277	68	564	3	191	640	1040	1185
Percent	2%	98%	80%	20%	99%	1%	23%	77%		

Table 3. Yields and specific gravity of tubers from foliar evaluation study

Material and Formulation	Rate (ai) per A	Yield per A	Percent by Grade Size B's	A's	10 oz	Off Type	Spec Grav
Foliar Applications							
Pay Off 2.5EC	0.05 lb	418 cwt	12%	61%	17%	10%	1.080
Pay Off 2.5EC	0.10	372	15	64	12	9	1.080
Ammo 2.5EC	0.05	448	9	64	20		1.083
FMC-54800 0.8EC	0.04	421	10	69	14		1.080
FMC-54617 0.8EC	0.04	374	14	64	12	[illegible]	1.080
Ambush 2E	0.10	397	11	65	18	[illegible]	1.083
Pydrin 2.4EC	0.10	407	11	64	18	[illegible]	1.079
Sum. S-3206 2.4EC	0.10	399	10	64	19	7	1.077
L-676863 0.03EC	0.01	405	8	67	15	10	1.080
FCR-1272 200 EC	0.05	435	9	62	21	8	1.080
Monitor 4EC	0.75	356	11	67	14	8	1.079
Lorsban 4EC	1.0	348	12	66	14	8	1.079
Soil Systemics							
BAS-263-11 10G	3.0	424	11	62	17	10	1.079
Temik 15G	3.0	488	8	63	21	8	1.081
Untreated	--	320	14	72	8	6	1.080
Untreated	--	328	13	68	12	7	1.079

BIOLOGY AND CONTROL STRATEGIES FOR INSECT PESTS OF POTATOES

1981 Research Report to the Michigan Potato Industry Commission

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Research emphasis in 1981 was placed on continuing to gather information on control and impact of cutworms in Michigan potatoes. Sex attractant trap catches of adult male variegated cutworms in 1981 were much higher than in 1980, indicating the potential for damaging infestations in Michigan potatoes. Since the last outbreak year was 1977, it was imperative that additional data be collected. Although directly comparable results are not available for potatoes, trap catch records from celery in 1980 and 1981 clearly show the increased adult flight activity in 1981 and also the comparatively long duration of peak flight activity (Fig. 1).

The objectives of the field research were to:

1) continue evaluation of the effect of variegated and other cutworms on tuber yield and tuber damage

and 2) assess the relative effectiveness of grower applied insecticides in terms of cutworm population reduction and prevention of yield loss and/or tuber damage.

Methods

Research plots were established at the Montcalm Co. research farm, and commercial fields in Montcalm and Presque Isle Counties.

At the Montcalm Co. research farm, cutworm larvae or egg masses were obtained from laboratory culture and released in the center row of 5 row plots of Onaway, Monona and Russet Burbank potatoes. An average of 16 eggs per plant were released in the center row of the Onaway and Monona plots and 50 eggs per plant in the Russet Burbank plots. Cutworm counts and yield data were taken from the release row and 1-5 or more rows away from the release row. Cutworm densities were expected to decrease gradually away from the row where they were released, giving rows with different population levels.

In the commercial fields in Montcalm Co. (cv. Russet Burbank; John Crawford, cooperator) and in Presque Isle Co. (non-irrigated; cv. Ontario; Jerry Kroll, cooperator), cutworm densities were monitored in treated and untreated plots. Yield and damage estimates were taken at harvest. Various estimates of % foliage loss were also taken, however, these data are not fully analyzed at this time. In the Montcalm field, foliage loss averaged approximately 10%, a conservative estimate of the economic injury level, at the time of the last insecticide treatment (Pydrin). In the Presque Isle field, foliage loss in the untreated plots was also approximately 10%.

Results

Population estimates from the release rows and adjacent rows at the Montcalm Co. research farm showed very low survival of cutworm larvae (less than 1 per plant in the release rows) and little defoliation. Yield results reflected the low population densities and there were no significant effect of cutworms on yield even in the release rows (Table 1). Although no insecticides had been applied to the plots for 1 or more weeks prior to the cutworm releases, residual material may have been present. It is thought, however, that natural mortality of eggs and larvae is very high and that natural enemies and/or weather conditions were responsible for the low larval survival.

Larval densities in the Montcalm Co. commercial field averaged nearly 7 variegated and spotted cutworms per plant prior to treatment (Table 2). Black cutworms were also present in very low numbers. Parathion and Sevin were applied in treatment 2, as soon as larvae were detected and followed 1 week later with a parathion treatment. Pydrin was applied in treatment 1 when foliage losses had reached approximately 10% and high cutworm densities were still present.

In Presque Isle Co., a field (cv. Ontario) was located with a fairly uniform density of $3.3 \pm .80$ variegated cutworms per plant. That population was considered an economic threat for several reasons. The plants were small (drought), defoliation already averaged slightly more than 5%, the cutworm population was just getting to the final larval stage where most of the feeding is done, and the plants were just starting into the tuber bulking stage. Pydrin and Lannate both appeared to effectively reduce the cutworm population levels (Table 3). However, this did not significantly increase yields or reduce tuber feeding damage (Table 3).

Conclusions

As the result of the Montcalm Co. research farm releases, it is suggested that egg and/or early larval mortality due to natural enemies or climatic factors is much higher than had been previously thought. This may explain why cutworms and particularly variegated cutworms are sporadic problems even in outbreak years such as 1981 and are rarely a problem in years of average adult flights and oviposition.

Results from the commercial fields demonstrated that considerable foliage loss can be tolerated without significant yield reductions. Cutworm densities of 3 larvae or more per plant apparently cause little or no yield losses even in non-irrigated potatoes. Tuber damage occurred only sporadically even in the Presque Isle field where conditions were very dry, foliage was not lush, and larvae in untreated plots were allowed to reach maturity. Black cutworms were generally less abundant in 1981 than in previous years. These factors support the hypothesis that foliar feeding cutworms are not a major cause of tuber damage, whereas black cutworms (although generally less numerous) are the cause of most tuber damage.

Results from research plots and other commercial fields indicate that adequate control can be obtained either by carefully timed treatments of parathion and Sevin or through the use of materials such as Pydrin, Lannate, or Monitor for control when larvae are larger and defoliation becomes noticeable. Since outbreaks cannot be reliably predicted from year-to-year or field-to-field, the latter approach, combined with routine scouting of fields is recommended.

It is concluded that with current programs of field scouting and the availability of several highly effective materials, foliar-feeding species such as variegated and spotted cutworms are not as severe a problem as they were even a few years ago.

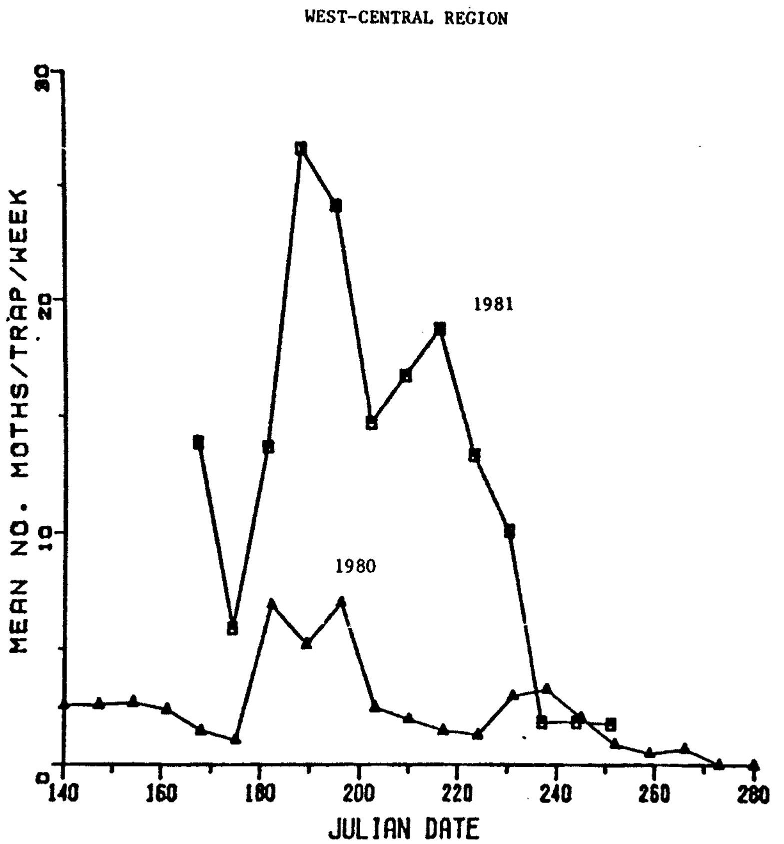

Figure 1. Comparison of sex attractant trap catches of adult male variegated cutworms between 1980 and 1981 from traps in celery fields in West-central Michigan (Allegan, Hudsonville, Byron Center, etc). Julian date 182 corresponds to June 1.

Table 1

Effect of Distance from Variegated Cutworm Release on Yield[1]

Rows away from release	Onaway[2] A	Onaway[2] Over	Onaway[2] A+O	Monona[2] A	Monona[2] Over	Monona[2] A+O	Russet Burbank[3] A	Russet Burbank[3] Jumbo	Russet Burbank[3] A+J
0	90.1	33.3	123.8	87.1	30.5	117.6	82.3	15.5	100.7
1	92.3	33.4	125.9	91.1	30.7	121.8	85.8	15.2	101.1
2	98.6	30.1	119.8	91.9	21.9	123.8	80.0	15.9	95.9
3	89.2	30.8	120.0	92.0	26.1	118.1	-	-	-
4	89.9	29.8	119.7	87.3	30.5	117.8	-	-	-
5+	87.9	35.6	123.5	90.1	25.5	115.6	-	-	-
6+[4]	-	-	-	-	-	-	87.1	18.1	105.2

[1]Yield expressed as lb. per 50 row ft.

[2]Onaway and Monona varieties had two releases (July 11 and July 24) averaging 8 eggs per plant on each date.

[3]Russet Burbank variety had 5 releases (July 18, 24, 31; Aug. 7 and 14) averaging 10 eggs per plant on each date.

[4]Beginning with row 6 in the Burbanks, foliar insecticides were applied to prevent all cutworm damage.

Table 2

Effects of Control Options on Cutworm Populations and Yield at Harvest for Russet Burbank Potatoes in Montcalm Co.

Cutworm Density and Stage[3]	Treatment 1[1]					Treatment 2[2]		
Date	Spotted Cutworms #/plant	Spotted Cutworms stage	Variegated Cutworms #/plant	Variegated Cutworms stage	Total #/plant	Spotted #/plant	Variegated #/plant	Total #/plant
7/8	0	-	0	-	0	0	0	0
7/15	3.4	4.1	2.8	4.2	6.3	same as treatment 1		
7/17	not sprayed					sprayed with 1 pt. parathion + 1.25# Sevin 80S		
7/22[4]	1.4	4.6	2.1	4.9	3.5	0.5	1.1	1.7
7/24	not sprayed					sprayed with 1 pt. parathion		
7/29	4.5	4.5	2.4	5.7	7.0	1.0	2.0	3.0
7/31	sprayed with 7 oz. Pydrin					not sprayed		
8/5	0.1	-	0.6	-	0.7	0	2.2	2.2
8/12	0.03	6.0	0.03	6.0	0.06	0	0.03	0.03

Yield (lb./10 row ft.)	Treatment 1	Treatment 2
A's	16.8	14.3
Jumbos[5]	1.9	3.1
A's + Jumbos	18.7	17.4
Off types	3.2	4.6
B's	3.4	3.8

[1]Treated with 13.3# Temik at planting.
[2]Treated with 20# Temik at planting.
[3]Stage estimated as average instar; instar 1 = newly hatched, instar 6 = mature.
[4]This figure includes rows affected by spray drift from treatment 2.
[5]Yield of jumbos was significantly higher in treatment 2 (t-test, $P < 0.05$).

Table 3

Effect of Insecticide Treatments on Variegated Cutworm Density, Tuber Yields and Tuber Feeding Damage

		Pydrin[1]	Pydrin Ck	Lannate[2]	Lannate Ck
Cutworm Density[3]--8/5		0	2.0	0	1.0
Yield[4]		12.2	10.9	9.9	10.6
% Tuber Feeding	A's	0	.76	.23	1.0
	B's	.1	.83	.98	.08

1.Applied on July 24 at 5 oz./A
2.Applied on July 24 at 5 oz./A
3. Density is expressed as the # of cutworms per plant. Pre-treatment density was 3.3 $\pm$ .8053 and the cutworms averaged 5.6 instar or nearly mature.
4.Lbs. A's/ 10 row ft. cv Ontario.

POTATO IRRIGATION STUDY

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Department of Crop and Soil Sciences

Introduction

At the present time growers have very little information available to them for the improvement of their irrigation management practices. With 80% of Michigan's potato crop under irrigation and in view of the rapidly rising cost of irrigation, filling this void in our knowledge is of obvious importance.

This study examines the response of three different varieties of potatoes to various levels of irrigation. The objectives were to gain information on rates of water use by the crop through the season; to evaluate yield and tuber quality under different water regimes; to determine what information growers can currently use and evaluate options available for disseminating this information.

Procedure

The Michigan State Soils Research Farm was the site of this experiment. Within the experimental area there were three ranges each having a different potato variety, Superior, Atlantic, or Russet-Burbank. Each plot was arranged with a discard row between each pair of harvest rows. Differing rates of water were applied by a single irrigation line running down the center of the plot with risers at ten foot spacings. This arrangement results in a triangular shaped distribution pattern with the rows closest to the line receiving the maximum rate of water (100 %) and the rows further away receiving progressively less. The outside rows got no irrigation water (0%).

Tensiometers and a neutron probe provided soil moisture measurements. In each range one row from each of the moisture regimes had two tensiometers, one at nine inches and one at 18 inches. Two neutron probe access tubes were in harvest rows of the 100%, 66% and 0% moisture regimes within each range. This gave a total of 6 access tubes in each range.

The tensiometers were read three times per week while neutron probe readings were taken once a week at each access tube. It became clear early in the summer that it would only be possible to maintain tension in the tensiometers at the 100% irrigation level. Due to the dry conditions the others ceased to function.

Irrigation began when the tensiometers at the 100% moisture level showed 50 centibars tension. Only a half inch of water could be applied at a time without runoff occurring due to the high rate of application along the irrigation line.

The second part of this project was to evaluate our ability to help growers schedule irrigation water. Three outstate sites were selected for this study. At each of these sites the neutron probe and tensiometers monitored soil moisture. From this data, recommendations were made on the timing and amount of the next irrigation.

Results

Tables 1 and 2 show the yield results for the Superior and Atlantic varieties. While there are strong trends towards maximum yields with maximum water rates, statistically significant yield reductions did not occur until the irrigation was below 83% (5.1") in the Atlantics.

Total yield and U.S. #1's appear to be relatively sensitive to reductions in water. Oversize tubers in Superiors were significantly reduced with less than 66% (4.1") irrigation water. This yield reduction was not seen in the Atlantics. Undersize and specific gravities were generally much less sensitive to the same conditions.

Table 3 shows the yield results for the Russet Burbank variety. The maximum rate of water (7.7") shows a large, though not statistically significant, drop in yield compared with the 83% (6.4") level. This can largely be attributed to heavy early blight in the Treatment 1 harvest rows. This variety shows the highest sensitivity to reduced water with the U.S. #1's and the off-types. Off-types greatly increase with dryer conditions. Total yields and specific gravities were moderately sensitive to lower water while oversize and under size yields were fairly insensitive.

Figure 1 shows the comparison between our cumulative evapotranspiration (ET) estimates and cumulative water (rain + irrigation). Irrigation applications were carried out according to the soil moisture instruments yet the cumulative water did not keep up with the cumulative ET estimates through the season. The difference widened especially on days where there was significant rainfall. This suggests that our ET estimates are too high. Adding a relative humidity and possibly a solar radiation term to our ET equation may help bring the ET estimates in line with the actual soil moisture losses.

Figures 2-4 show tensiometer readings for the three ranges and Figures 5-7 show neutron probe readings for three treatments at five depths for the three ranges. These graphs plot the soil moisture fluctuations seen in the experimental plot. Be sure that the y-axis on each graph is clearly understood when making comparisons between graphs.

Outstate Scheduling Experiment

The data for these studies are shown in Figures 8 and 9. Figure 8 shows cumulative estimated ET and water for the Alan Anderson Farm. Cumulative water was less than cumulative ET during July but rains at the end of July and beginning of August alleviated this difference. Figure 9 shows the tensiometer readings for this field. It is clear that soil moisture was adequate.

For this farm ET estimates appear quite good. When the ET prediction equation includes only a few climatic factors, there can be great variability in the accuracy of the ET estimates depending on the localized climates.

Table 1. Yield results for Superior variety

		Superior				
TRT	Irrigation Water	Over Size	U.S. # 1	Under Size	Total	Specific Gravity
	% (inches)	- - - - - - - - - - - cwt/A - - - - -				
1	100% (6.2)	51.7a[1]	377.6a	15.0a	444.3a	1.075a
2	83 (5.1)	52.3a	361.4a	12.5a	426.2ab	1.075a
3	66 (4.1)	48.9ab	326.1 b	14.6a	389.6 b	1.076a
4	33 (2.0)	33.2 b	278.3 c	12.5a	323.0 c	1.078a
5	0 (0)	16.0 c	216.8 d	14.3a	247.1 d	1.078a
LSD (.05)	-	16.5	32.6	4.5	39.8	.006

[1]Means followed by the same letter are not statistically different as determined by the Least Significant Different Test (P = 0.5).

Table 2. Yield results for Atlantic variety.

		Atlantics				
TRT	Irrigation Water	Over Size	U.S. # 1	Under Size	Total	Specific Gravity
	% (inches)	- - - - - - - - - - - - - cwt/A - - - -				
1	100% (7.7")	96.6a[1]	382.2a	23.9a	502.7a	1.091a
2	83 (6.4)	97.0a	355.9a	21.0ab	473.9a	1.092a
3	66 (5.1")	97.0a	353.3a	20.7ab	471.0a	1.089a
4	33 (2.5")	83.6a	304.1 b	20.8ab	408.5 b	1.086a
5	0 (0)	59.0 b	273.5 b	19.2 b	376.7 b	1.089a
LSD (.05)	-	21.5	32.0	4.2	41.0	.006

[1]Means followed by the same letter are not statistically different as determined by the Least Significant Difference Test (P = 0.5).

Table 3. Yield results for Russet Burbank variety.

	Russet Burbank						
TRT	Irrigation Water	Off Type	Over Size	U.S. # 1	Under Size	Total	Specific Gravity
	% (inches)	cwt/A					
1	100% (7.7")	60.7a[1]	17.7a	302.6a	50.1a	431.0ab	1.080a
2	83 (6.4")	123.9 b	13.8a	288.7ab	36.7 b	467.2a	1.078a
3	66 (5.1")	159.1 b	10.8ab	235.4 b	44.6 ba	449.9ab	1.075ab
4	33 (2.5")	210.0 c	0.8 b	154.5 c	51.3a	416.6 bc	1.073 b
5	0 (0)	214.3 c	0.0 b	107.3 c	56.6a	377.8 c	1.072 b
LSD (.05)	-	48.3	10.9	66.6	12.5	45.0	.004

[1]Means followed by the same letter are not statistically different as determined by the Least Significant Difference Test (P = 0.5).

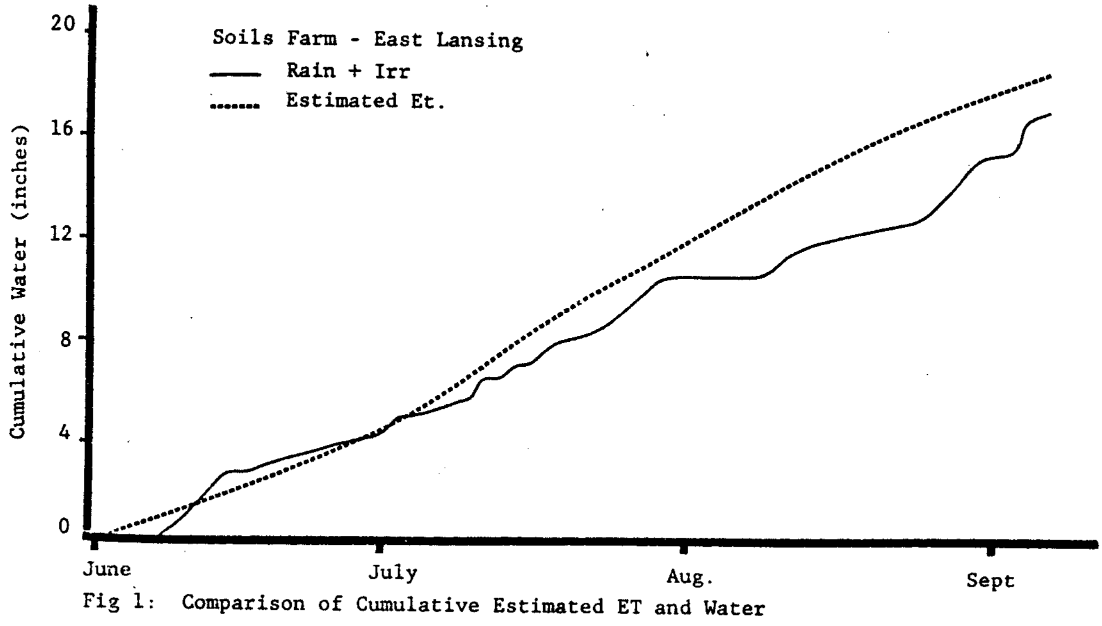

Fig 1: Comparison of Cumulative Estimated ET and Water

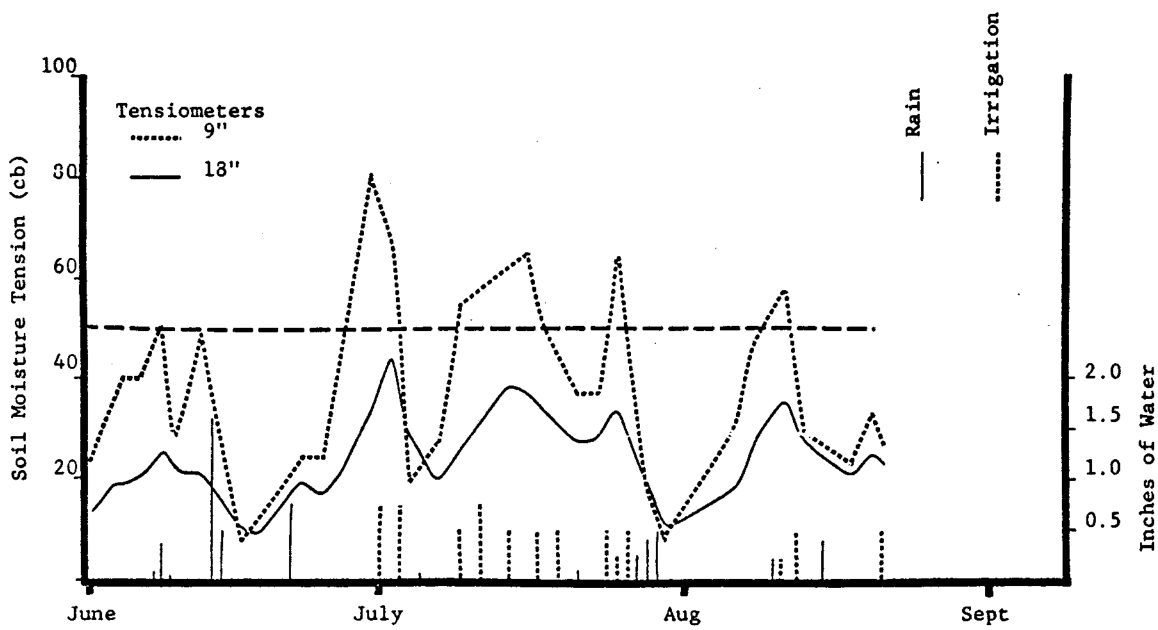

Fig 2: Tensiometer Readings for Range I

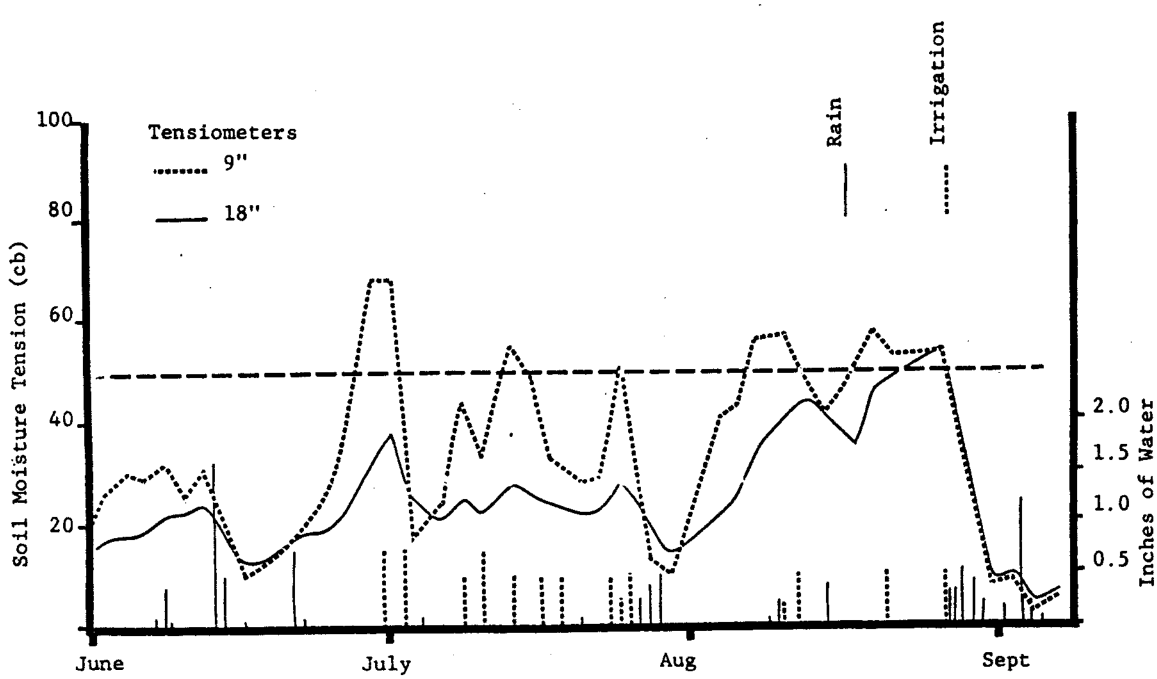

Fig 3: Tensiometer Readings for Range II

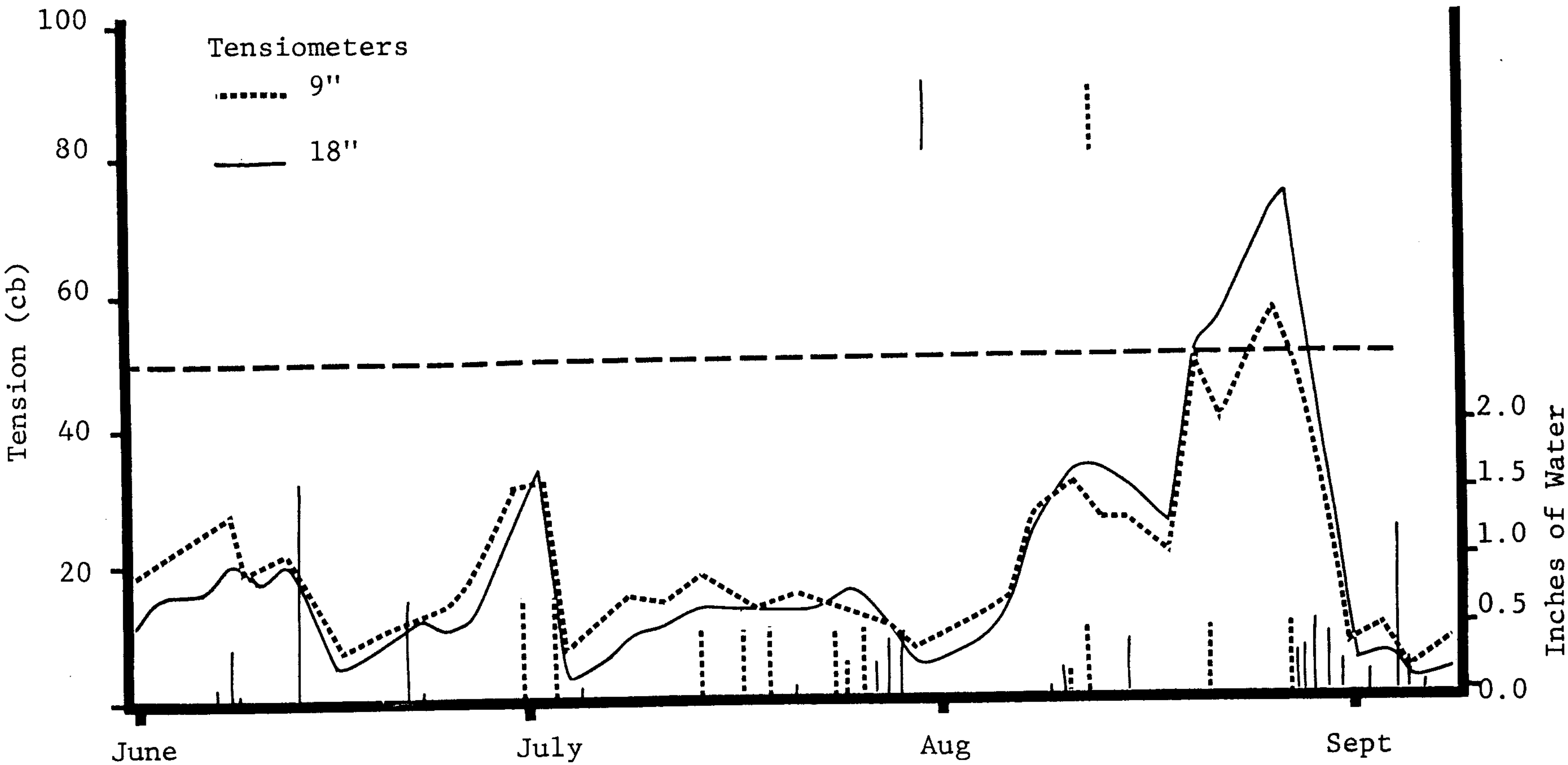

Fig 4: Tensiometer Readings for Range III

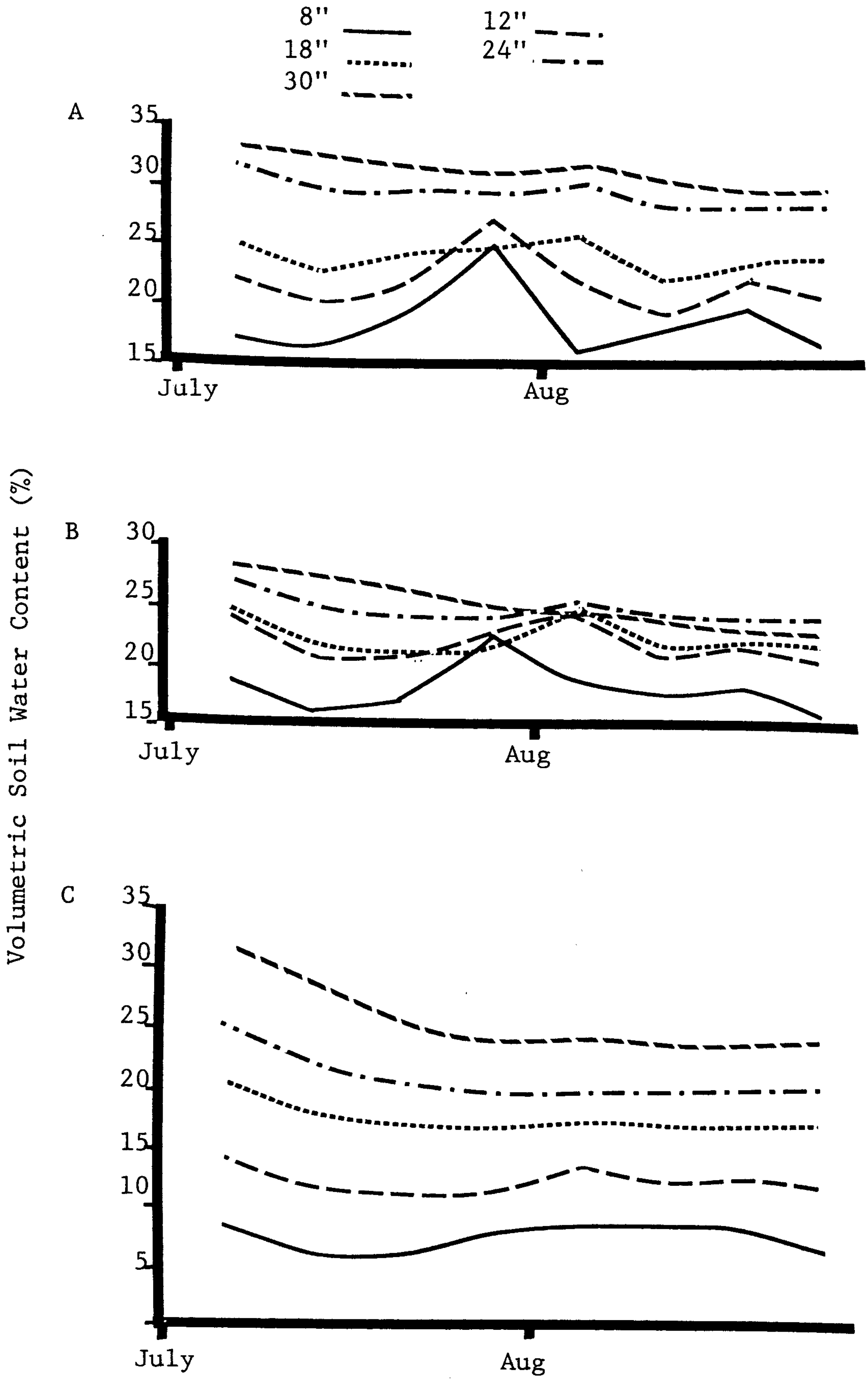

Fig 5: Range I Neutron Probe Readings (% Volumetric Moisture) At Five Depths for Treatments 1(A), 3(B), and 5(C)

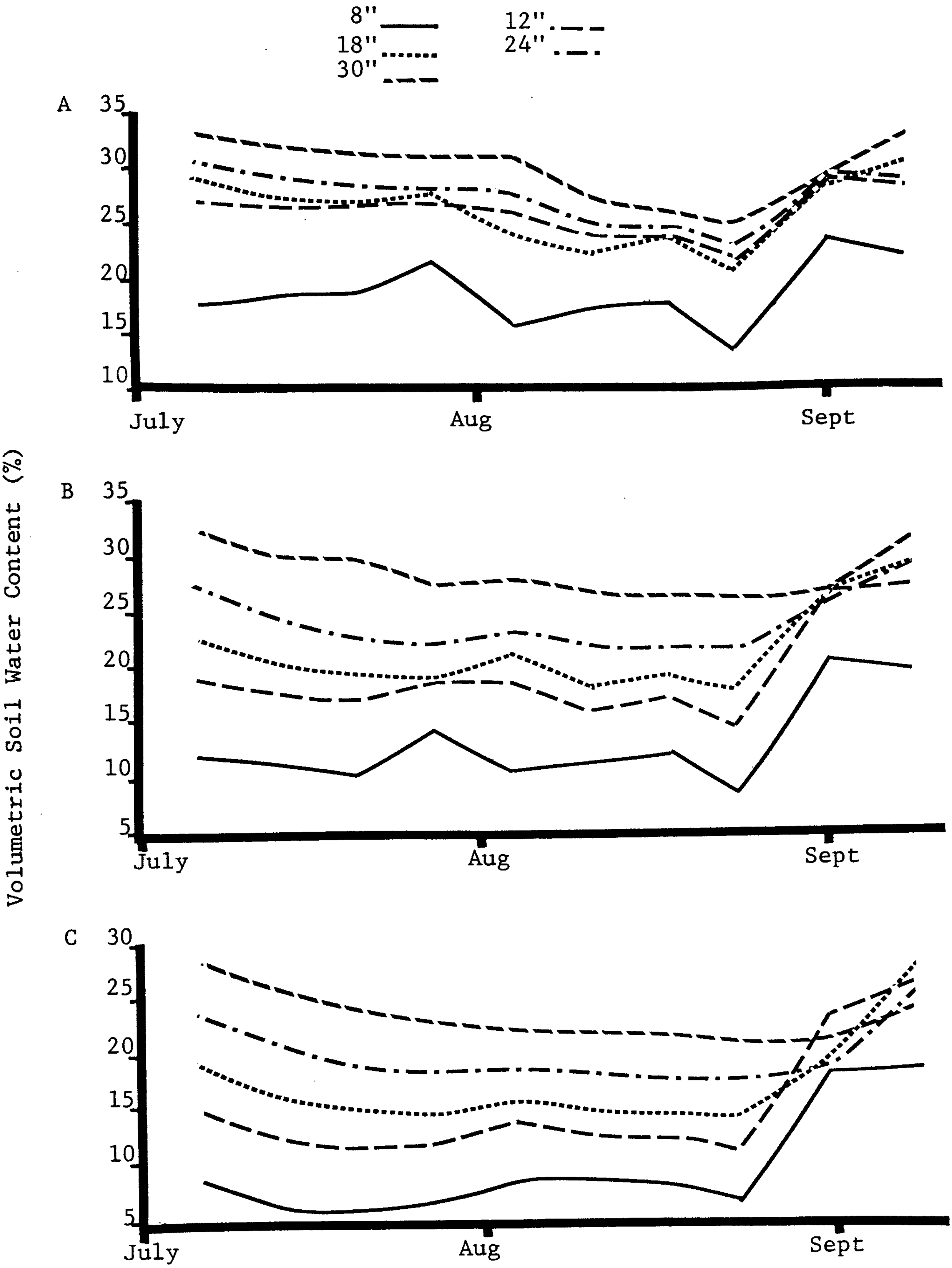

Fig 6: Range II Neutron Probe Readings at Five Depths for Treatments 1(A), 3(B), 5(C)

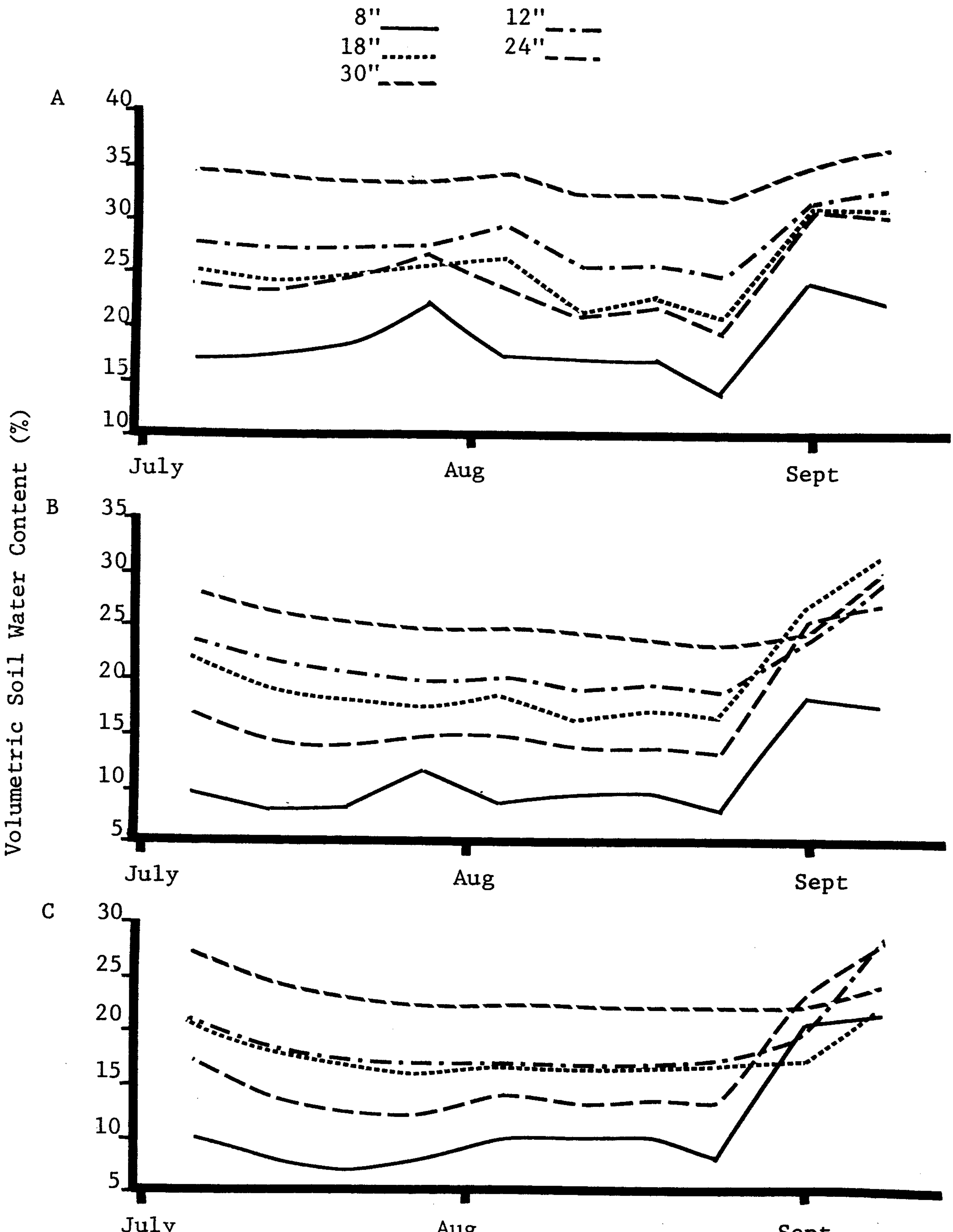

Fig 7: Range III Neutron Probe Readings at Five Depths for Treatments 1(A), 3(B), 5(C)

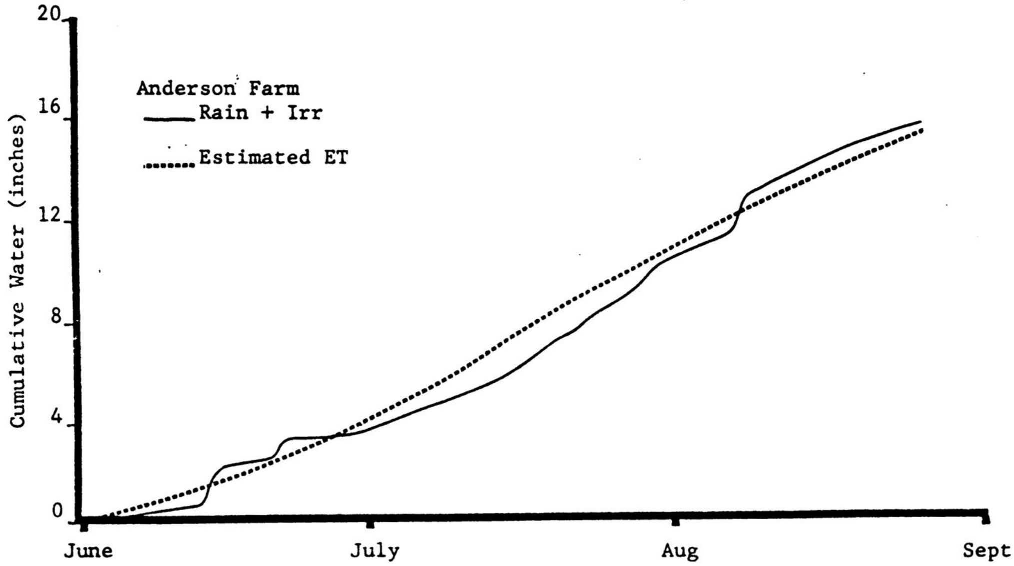

Fig 8: Comparison of Cumulative Estimated ET and Water

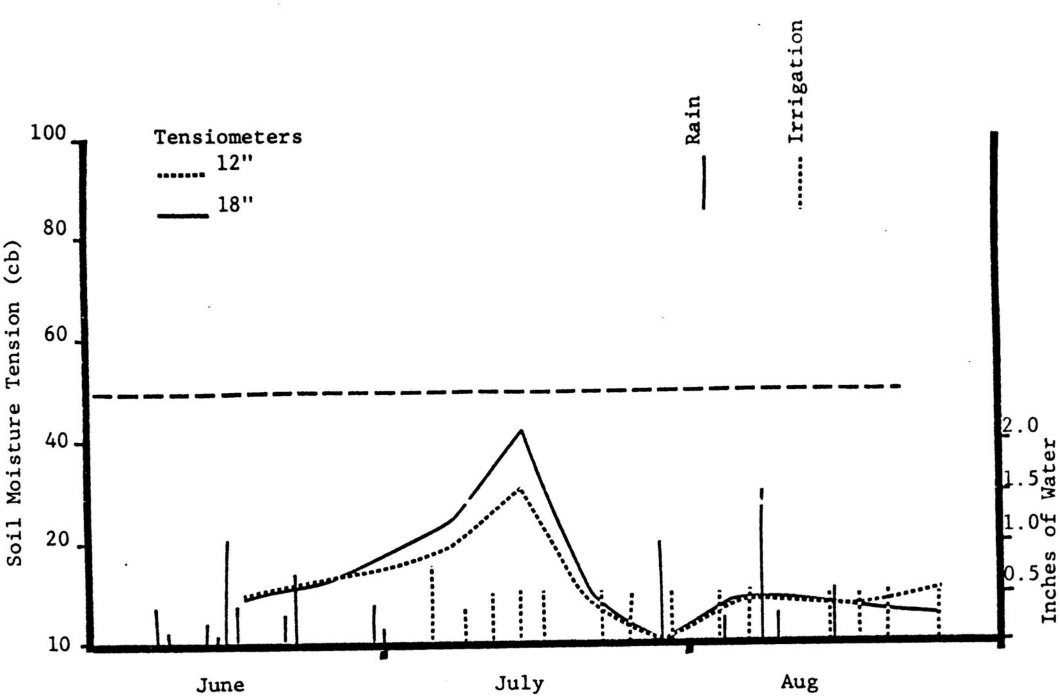

Fig 9: Tensiometer Readings for the Alan Anderson Farm

PRODUCTION AND MANAGEMENT FACTORS TO MAXIMIZE SPECIFIC GRAVITY AND THE USE OF CARBOHYDRATE ANALYSIS TO DETERMINE HARVEST MATURITY AND PROCESSING QUALITY OF MICHIGAN POTATOES

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In 1979 and 1980 the potato varieties Atlantic, Belchip, Denali, Monona and Norchip were grown at the Montcalm Research Farm. In 1980, Russet Burbank was also added and in 1981, Red Pontiac was included in the study. In 1979, each of the varieties was grown at nitrogen levels of 120, 200 and 280 pounds per acre. In 1980 and 1981, the nitrogen levels were 170 and 240 pounds per acre. Varying nitrogen levels did not elevate yield increases in any of the varieties tested and there were no statistical differences in sucrose or specific gravity between varieties due to nitrogen. Therefore, the data reported are averages of the nitrogen levels for each year. The data for 1979 and 1980 have been discussed in previous reports.

Harvesting of tubers in 1981 began on August 3 (87 days after planting) and continued at biweekly intervals until October 14 (159 from planting). At each harvest date, sugar changes were determined by a standard sucrose rating (SR) technique and by high pressure liquid chromatography (HPLC) analysis for glucose and fructose.

Crop growth during 1981 appeared to develop at a more accelerated rate than noted in previous years. Nearly all the varieties in the study reached a maximum marketable yield by late August, which sharply contrasts with 1980 when several of the later maturing cultivars continued to increase yields into late September. Figures 8-13. Specific gravity followed a similar trend, with maximum levels being attained by mid August. There was a general decline with delays in harvest. Previous work, using the SR for predicting storage stability, has shown that an SR of 2.8 or less is desirable for good processing potatoes (although more recent work seems to indicate that this maximum level should be lowered in many instances).

All the varieties except Red Pontiac maintained sucrose contents below the 2.8 level throughout the season. All the chipping varieties (Atlantic, Belchip, Denali, Monona and Norchip) had minimal sucrose levels at the early harvest dates, further corroborating the early maturity of these tubers. Chip quality for the chipping varieties was very acceptable at all harvests, although soil temperatures were below 50°F during most of the first two weeks in October.

ATLANTIC

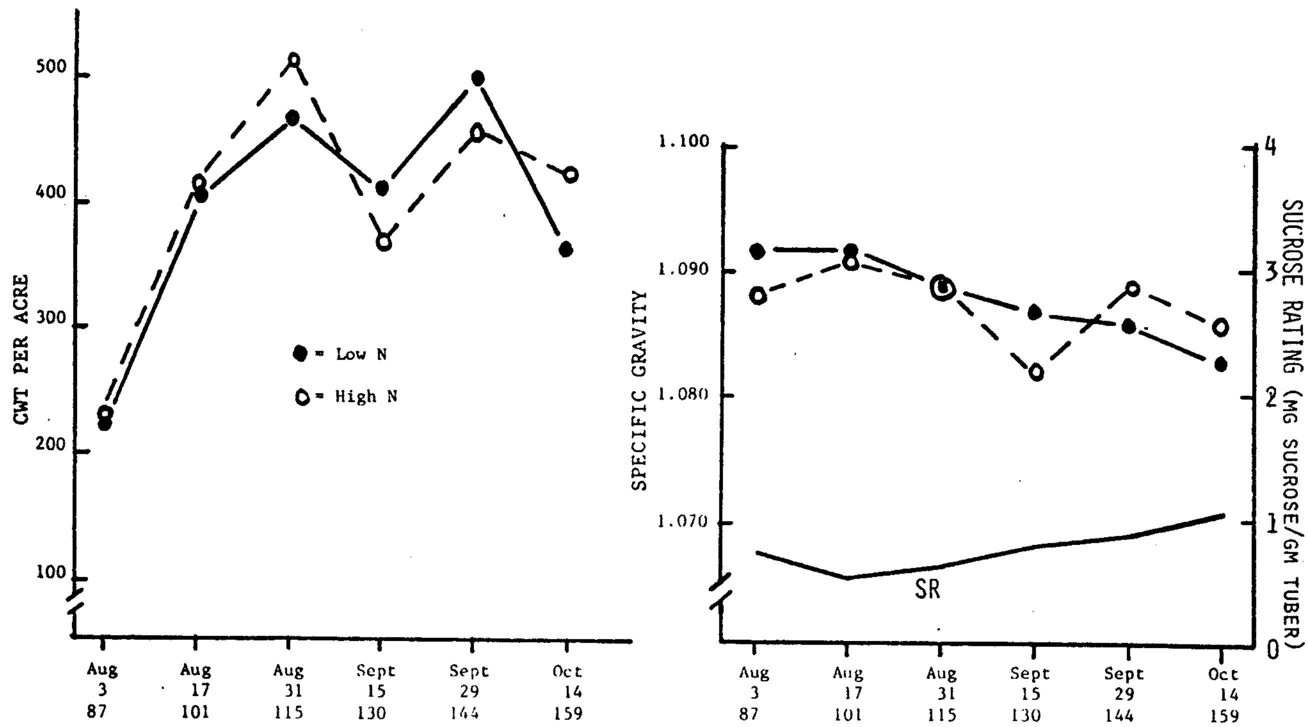

Figure 1. Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Atlantic grown at two nitrogen levels and harvested on different days after planting.

BELCHIP

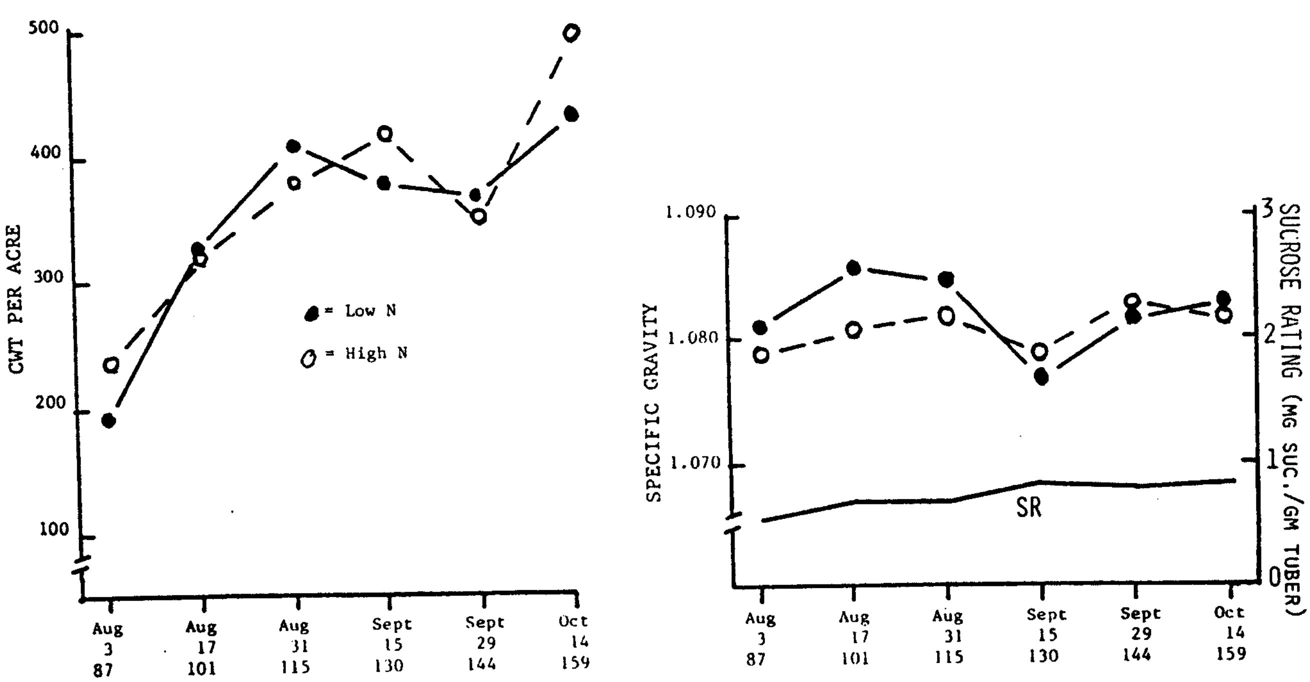

Figure 2 Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Belchip grown at two nitrogen levels and harvested on different days after planting.

DENALI

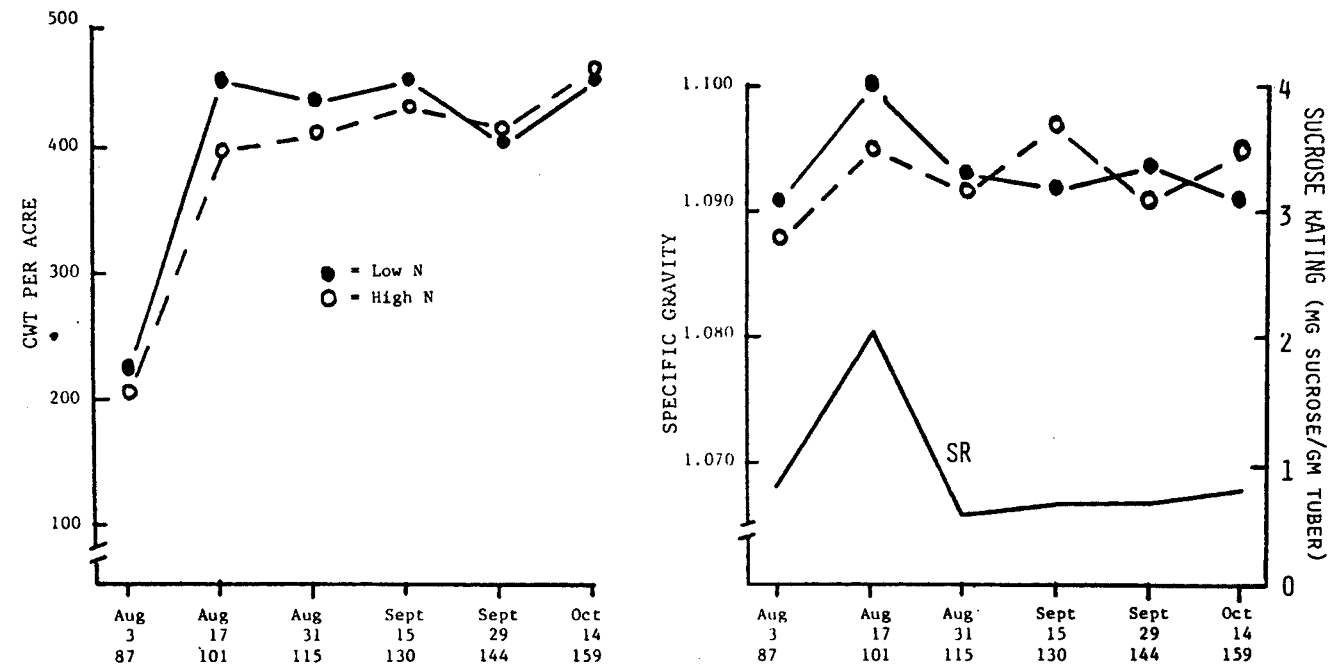

Figure 3. Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Denali grown at two nitrogen levels and harvested on different days after planting.

MONONA

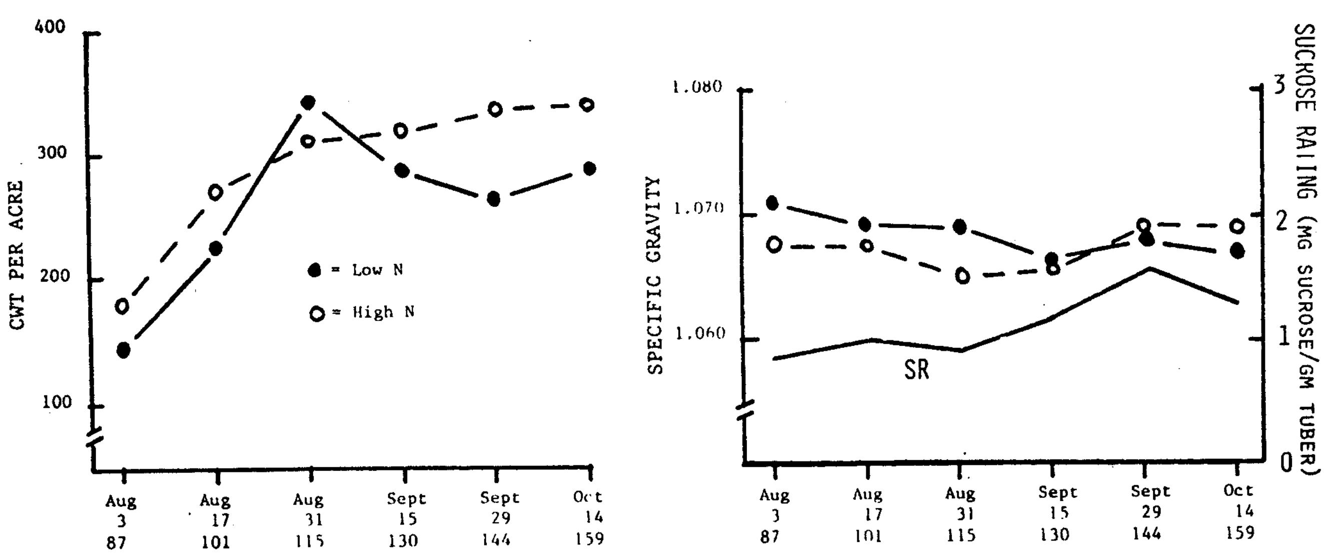

Figure 4 Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Monona grown at two nitrogen levels and harvested on different days after planting.

NORCHIP

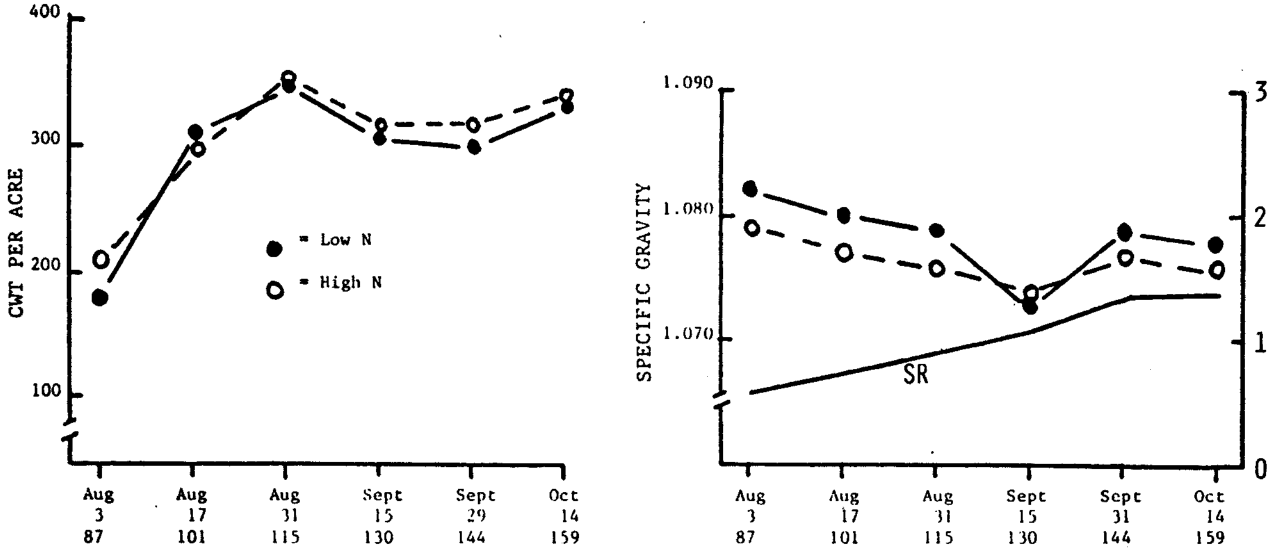

Figure 5 Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Norchip grown at two nitrogen levels and harvested on different days after planting

RUSSET BURBANK

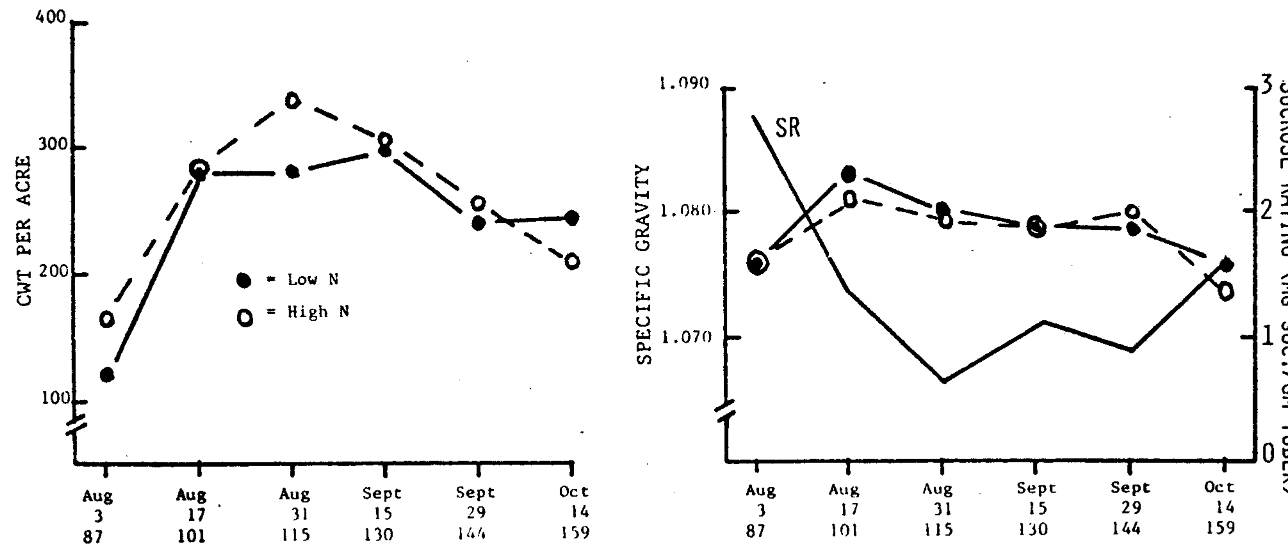

Figure 6 Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Russet Burbank grown at two nitrogen levels and harvested on different days after planting.

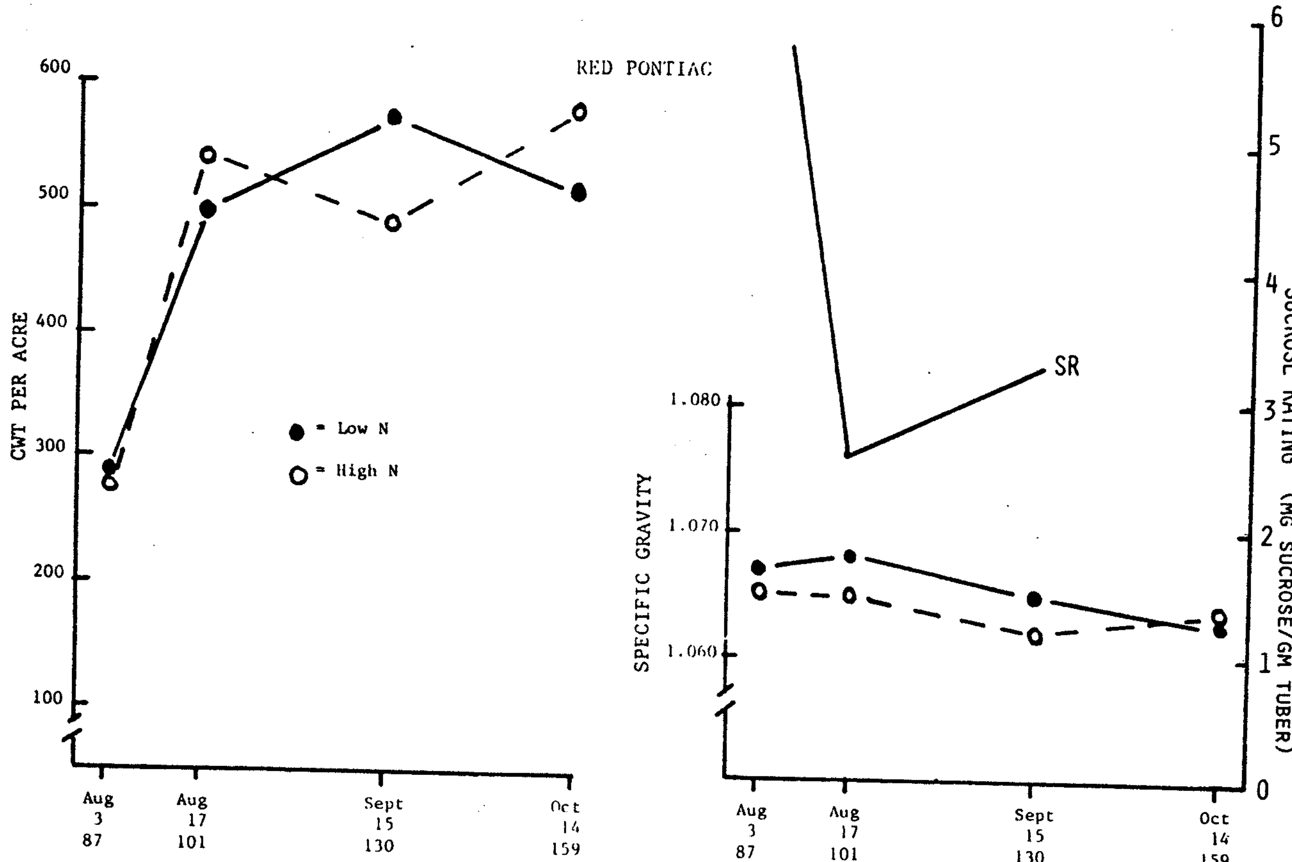

Figure 7 Date and Days after Planting - Montcalm Research Farm 1981

The marketable yield and specific gravity of Red Pontiac grown at two nitrogen levels and harvested on different days after planting.

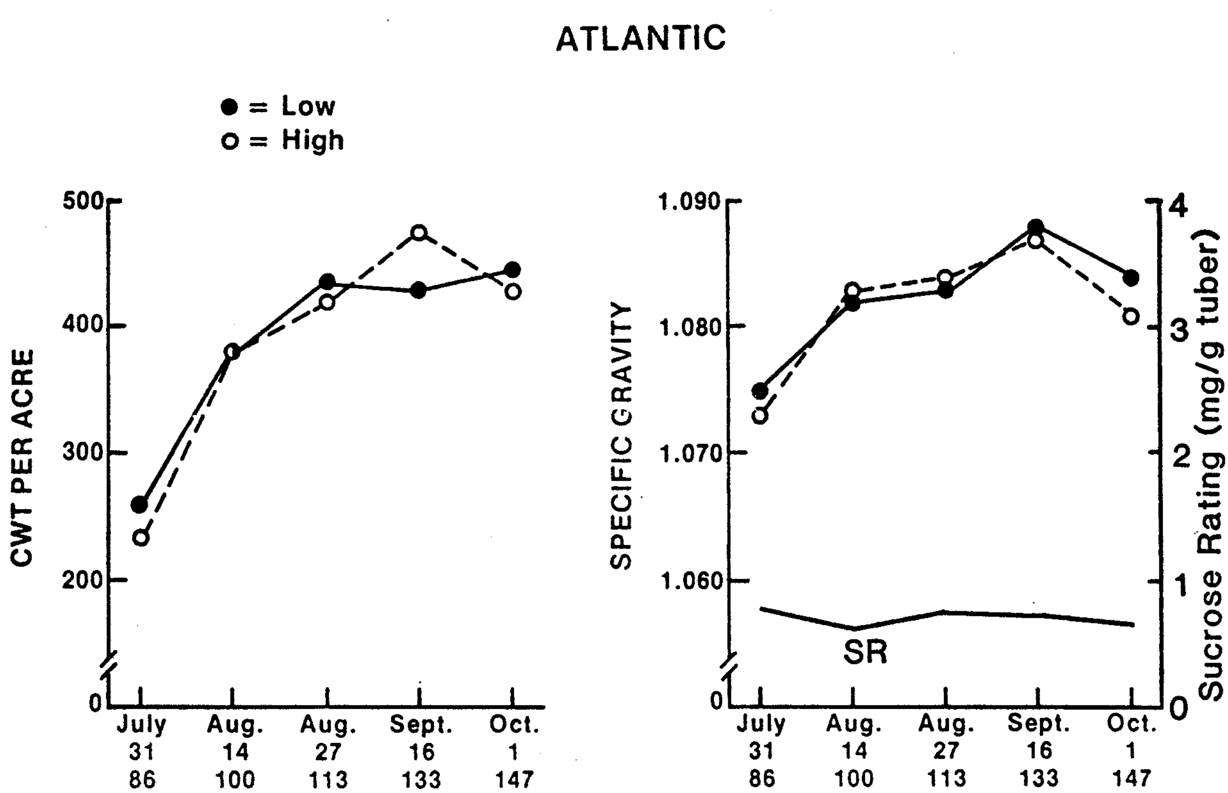

Figure 8 **Date and Days after Planting - Montcalm Research Farm 1980**

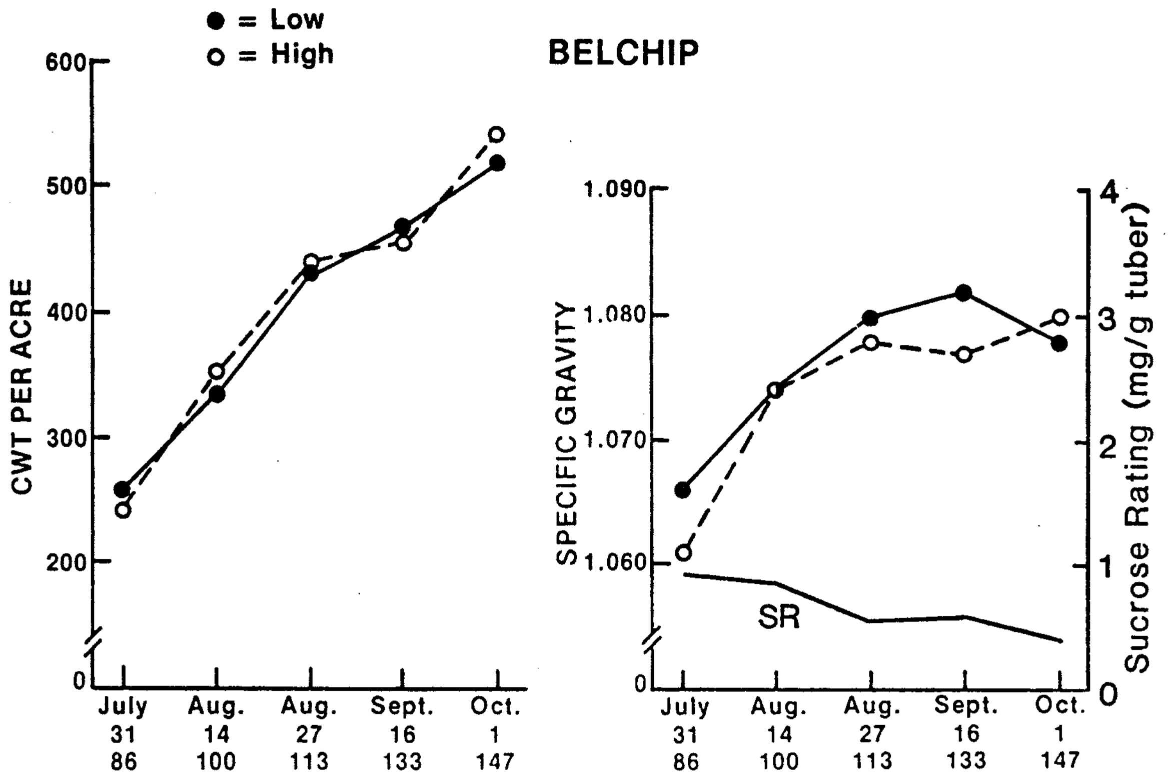

Figure 9 Date and Days after Planting - Montcalm Research Farm 1980

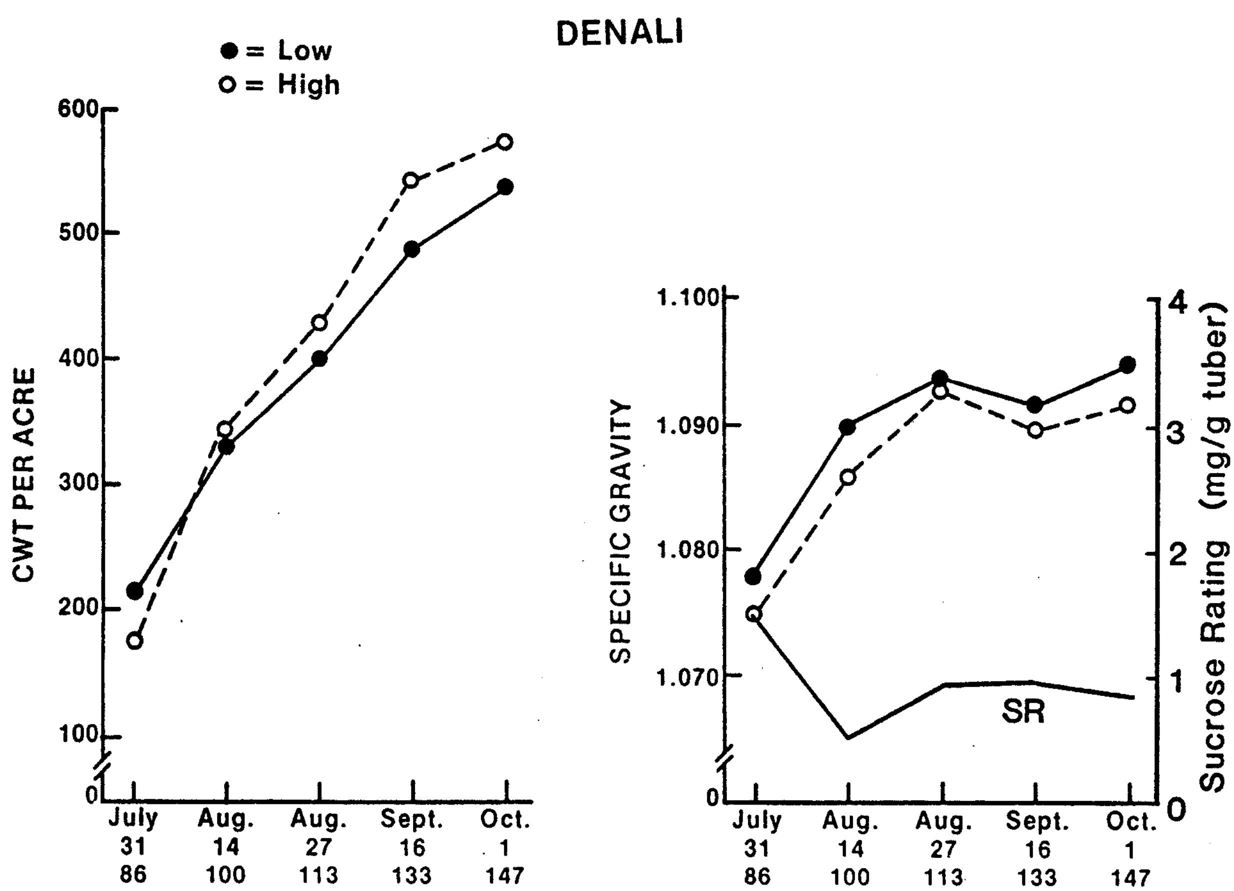

Figure 10 Date and Days after Planting - Montcalm Research Farm 1980

MONONA

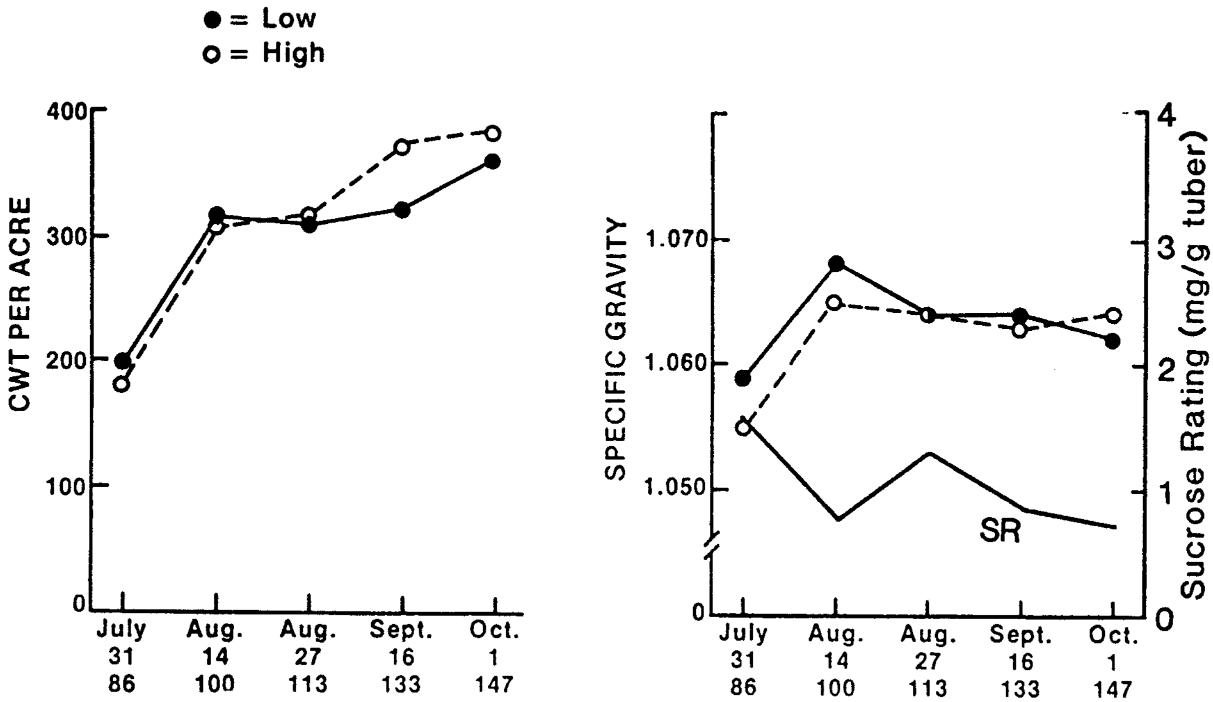

Figure 11 Date and Days after Planting - Montcalm Research Farm 1980

NORCHIP

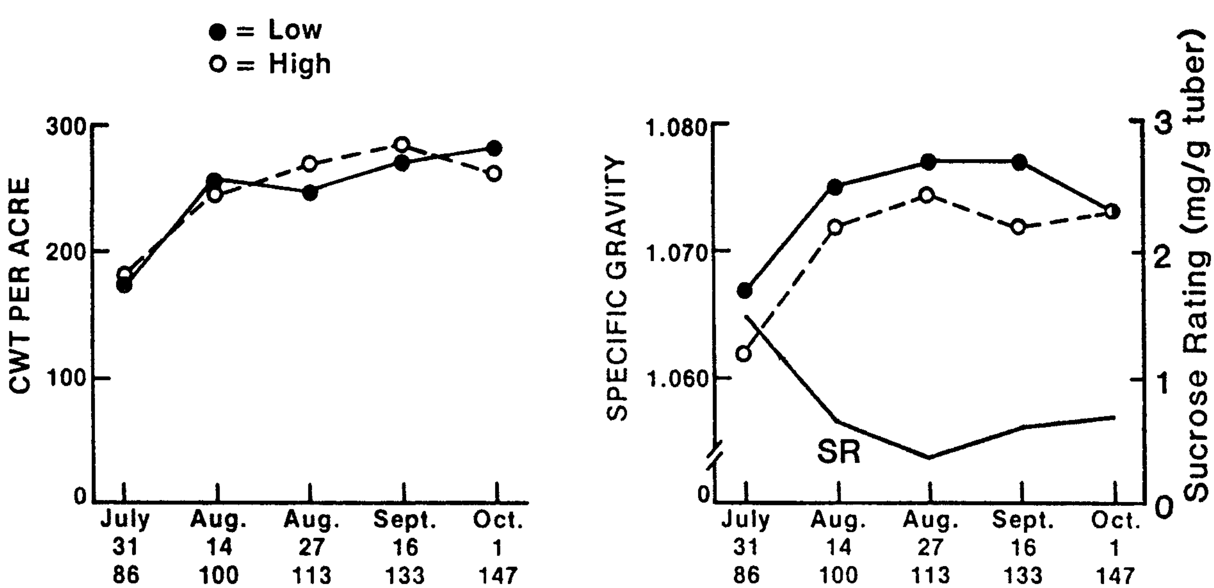

Figure 12 Date and Days after Planting - Montcalm Research Farm 1980

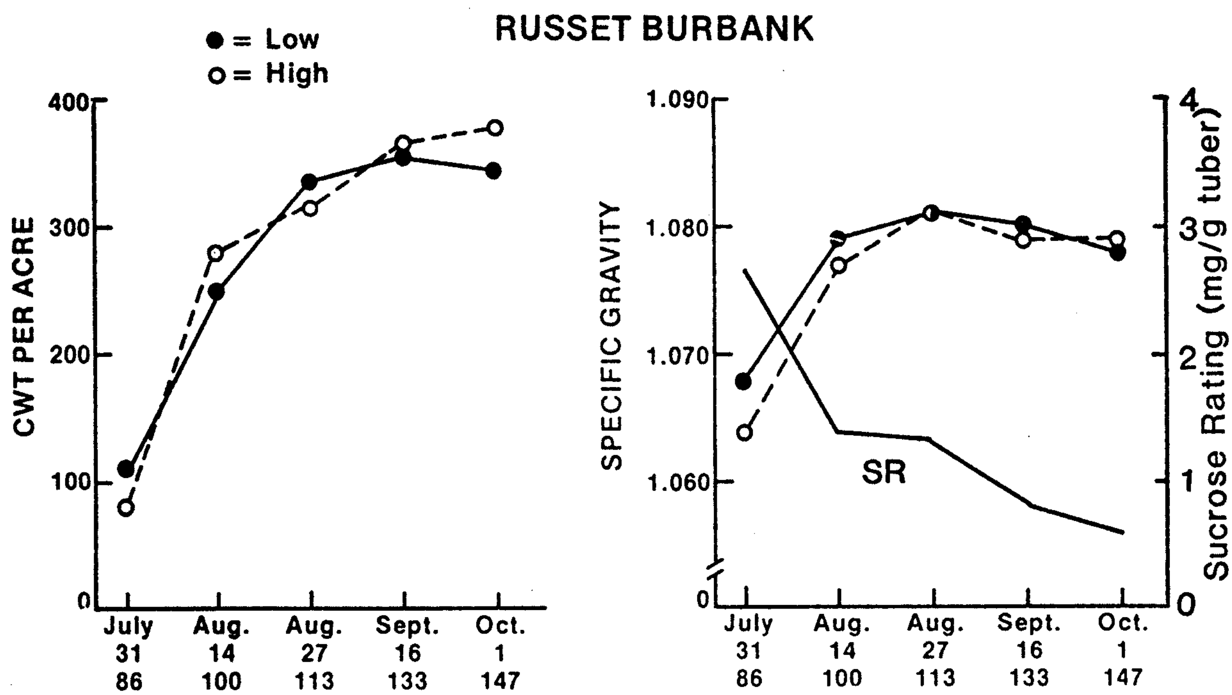

Figure 13 Date and Days after Planting - Montcalm Research Farm 1980

THE INFLUENCE OF SELECTED PRODUCTION MANAGEMENT PRACTICES ON THE YIELD, QUALITY AND STORABILITY OF POTATOES

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

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

METHODS

In the spring of 1980 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 were left in the field. Both ranges were plowed the last week of April, 1981. The plots that required fumigation received 10 gallons of Vorlex per acre chiseled in at an eight inch depth on April 28. All other plots received the same tillage, but no Vorlex was added. Treatment applications and planting were completed for the corn range on May 14, 1981 and for the alfalfa range on May 15. Each plot consisted of four rows 50 feet long having a 34 inch row width and 8 to 12 inches between seed pieces. Superior potatoes were to be evaluated using a 2X4 factorial design with five replications. Russet Burbank and Denali potatoes received only the highest levels of inputs. Temik 15G at 3.0 lbs. active ingredient per acre was added at-planting, in a band beside the seed furrow, to the plots that required aldicarb. Fertilizer was banded two inches to the side and two inches 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 lbs. N per acre. All plots received 75 lbs. N/A at-planting but the high N (225 lbs. N/A) plots received two side-dressings of 75 lbs. N/A each. The nitrogen form used was Urea.

Soil nutrient levels were sampled at planting. Plant nutrient composition was determined by sampling petioles on June 30 and their subsequent anlaysis. Nematodes were sampled at-plant, 5-14, and on 6-15, 7-27, and 8-26. Nematodes were extracted from soil samples using the centrifugation-flotation technique and the roots were processed using the giratory shaker technique. Fungi were sampled on 6-15, 6-30, 7-15, and 7-30. Stem sections were sampled at the soil surface level for lab analysis to determine the presence of Rhizoctonia spp. and Verticillium spp. Insects were monitored weekly to properly time foliar insecticide sprays and minimize insect damage.

The center two rows of each plot were harvested, graded and weighed. The corn rotation range was harvested on August 25 and the alfalfa range was harvested the next day.

RESULTS

The Russet Burbank and Denali varieties were unintentionally killed shortly after the Superiors were harvested. As a result the yields were uncharacteristically low and only the nutrient composition data are provided for these varieties in this report.

Tuber Yields Following Alfalfa

Marketable Tubers:

Marketable tubers are tubers greater than two inches in diameter having no signs of rotting, graded comming off the harvester. At the low level of nitrogen, Temik and Temik plus Vorlex significantly ($P=0.05$) increased yields above the low N check (Table 1). Vorlex did not significantly increase yields at either level of N. Temik at the high level of N significantly increased tuber yields above all the low N treatments as well as the high N check (no nematicides) and Vorlex treatments. Temik plus Vorlex with high N significantly increased yields above all treatments except the high N Temik. Temik plus Vorlex increased yields by 69 cwt/A at the low N level and 105 cwt/A at the high N level, above the respective checks. Temik increased yields by 59 cwt/A at the low N level and 66 cwt/A at the high N level.

Oversized Tubers:

Temik with 225 lbs. N/A significantly increased tuber yields over all the 75 lb. N/A treatments plus the check and Vorlex with high N (Table 2). Temik plus Vorlex significantly increased tuber yields over the low N check. Tuber yields for the high N check, Temik, and Temik plus Vorlex were 42, 72 and 61 cwt per acre, respectively.

'b' Sized Tubers:

There was a small range of differences in tuber yields (Table 3). The lowest was the check at 225 lbs. N/A which yielded 10 cwt/A and the highest was Temik plus Vorlex at the low N level yielding 14 cwt/A, these two treatments were the only ones significantly different.

Specific Gravities:

The specific gravities were not significantly affected by the treatments (Table 4).

Tuber Yields Following Corn

Marketable Tubers:

Nematicides did not affect yields at the 75 lb. N/A level, nitrogen was a limiting factor (Table 1). Raising the nitrogen application level to 225 lbs. N/A did not significantly increase yields in the absence of nematicides. However, high N in the presence of Temik or Vorlex increased the yields above the low N check by 84 and 76 cwt/A, respectively. Temik plus Vorlex significantly increased yields above all the low N treatments and the high N check, the yields were increased 119cwt over the low N check and 89 cwt over the high N check.

Oversized Tubers:

Again nematicides had no significant impact on tuber yields at the low level of nitrogen (Table 2). With the application of 225 lbs. N/A both Vorlex and Temik treatments significantly increased tuber yields above all the low N treatments and the high N check. The tuber yields in the Temik plus Vorlex treatment were significantly greater than all other treatments.

'b' Sized Tubers:

The production of 'b' sized tubers was significantly reduced in all treatments by raising the N level to 225 lbs. per acre (Table 3).

Specific Gravities:

Raising the N level significantly reduced the gravities in all but the Vorlex treatment (Table 4).

Nutrients

Nitrate nitrogen in potato petioles was directly related to the addition of nitrogen fertilizer (Tables 5 and 6). In the corn rotation the 75 lb. rate of N resulted in significantly lower nitrate (NO_3) nitrogen in the potato petioles than 225 lbs. N/A. Slightly lower NO_3 levels were found when Vorlex was used at the lower N rate. Vorlex, a soil fumigant, probably reduced mineralization of soil organic matter and may also have delayed nitrification, conversion of ammonium nitrogen (NH_4) to NO_3. Other research has shown that potatoes prefer the NO_3 form of nitrogen over the NH_4 form. Higher levels of NO_3 were found in the alfalfa rotation, particularly at the lower levels of N fertilizer. 75 lbs. N/A appeared to be adequate at the time of this early sampling.

Calcium and magnesium concentrations were significantly increased in the corn rotation when 225 lbs. N/A was added, particularly when Temik and Vorlex were added. This relationship did not exist in the alfalfa rotation and is not immediately clear. All other nutrients analyzed were not significantly affected by any of the treatment combinations.

Biotic Components

Nitrogen levels had no significant effect on the biotic components monitored (Table 7). *Verticillium* spp. levels were not significantly affected by any single treatment combination (Tables 8 and 10). *Rhizoctonia* spp., though only significant in the alfalfa rotation in June 30, showed a trend toward higher infection levels in the nematicide treatments as compared to the checks (Tables 9 and 11). Symptoms of either pathogen did not appear sever on any treatments during the growing season. *Pratylenchus penetrans*, the root-lesion nematode, was present at low numbers in all the plots at planting, May 14 (Table 12). Treatment with Temik 15G resulted in season long control of the nematodes, the population densities were significantly lower than the check or Vorlex in both of the rotations on July 27 (Table 13). At this sampling date we expect the nematodes to be at their highest seasonal population levels on Superior. In the corn rotation the use of Vorlex resulted in some nematode control but not in the alfalfa rotation. Table 14 compares some of the treatment effects on pathogens and yields.

The two nitrogen levels were averaged together in Table 15 to illustrate the main effects of the nematicides. When the data are compared in this manner nematicides had a significant impact of fungal infection in the alfalfa rotation. Rhizoctonia levels show the same trend as mentioned before. Verticillium levels were significantly higher in the Vorlex treatment than the other treatments in the alfalfa rotation.

ECONOMIC COMPARISONS

In order to make the results of this experiment more useful we have attempted to standardize the treatments by putting them on a cost per unit return. To examine the effects of each treatment independent of all the other inputs that influenced the tuber yields one can compare the results from a treatment to the results of its check. The check receives all the same inputs except the added treatment itself. In examining the dollar returns of each treatment we treat the check as a base level, or zero returns. The treatments will result in yield changes from the check and costs over the check, which effect the net returns. In figure 1 the amount that a treatment increased tuber yields over its respective check is multiplied by a chosen market value then the cost of the treatment itself is subtracted to obtain the net returns per acre above what the check would provide. In other words, the check is the X axis, zero returns. If the market value per cwt is $3.00 all treatments except Vorlex resulted in a net return above their respective check, whether high N or low N.

Figure 2 illustrates the effects of the treatments following corn. At a market value of $3.00, at 75 lbs N/A only Temik provides a net return above the check. Again, the use of Vorlex at 10 gal/A with a market value of $3.00 resulted in a net cost at either N level.

Figures 3 and 4 allows one to estimate the net returns of the high N treatments when the low N check is considered as the base level of returns.

Figures 1 through 4 allow oneto observe the marketable tuber yield responses with a different perspective. However, only those treatments which resulted in significantly different marketable tuber yields (Table 1) should be viewed as having differences in net returns until further analysis is completed.

Figures 5 through 7 illustrate the same type of relationships except total returns per acre, with only the costs of nitrogen and nematicides subtracted, are used on the Y axis. From these figures one can obtain the total returns of the checks that were used as a base level for the previous figures.

SUMMARY

Due to the experimental design the corn and alfalfa rotations cannot be directly compared. However, the relationships of the treatment results within rotations indicate the responses to be expected from the crop rotation. These relationships illustrate the differences in the dynamics of the two systems, of which there are many. Caution should be exercised in predicting responses based on the results of just one year's data.

Table 1. The influence of selected management practices on tuber yields of potatoes (cv Superior).

Marketable Tuber Yields 1981

Treatments		Rotation	
lbs N/A	Nematicide	Alfalfa	Corn
		- cwt/A -	
	Check	319.2 a[1]	275.1 a
75	Vorlex	354.3 abc	304.6 ab
	Temik	378.6 bc	305.9 ab
	Temik & Vorlex	387.8 bc	310.0 ab
	Check	338.8 ab	305.0 ab
225	Vorlex	356.4 abc	351.3 bc
	Temik	405.3 cd	359.7 bc
	Temik & Vorlex	444.0 d	394.0 c

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

Table 2. The influence of selected management practices on tuber yields of potatoes (cv Superior).

Oversized Tuber Yields 1981

Treatment		Rotation	
lbs N/A	Nematicide	Alfalfa	Corn
		-cwt/A-	
	Check	25.0[a] [1]	8.3[a]
75	Vorlex	44.3[ab]	10.0[a]
	Temik	40.6[ab]	7.4[a]
	Temik & Vorlex	49.1[ab]	8.7[a]
	Check	42.5[ab]	17.2[a]
225	Vorlex	43.5[ab]	35.1[b]
	Temik	72.0[c]	42.1[b]
	Temik & Vorlex	61.3[bc]	56.4[c]

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

Figure 3. The influence of selected management practices on tuber yields of potatoes (cv Superior).

Yields of Tubers Less Than Two Inches in Diameter

Treatments		Rotation	
lbs N/A	Nematicides	Alfalfa	Corn
		-cwt/A-	
	Check	11.4ab[1]	22.3b
	Vorlex	11.7ab	21.7b
75	Temik	12.3ab	22.8b
	Temik & Vorlex	14.0b	23.4b
	Check	10.0a	14.4a
	Vorlex	10.9ab	14.4a
225	Temik	12.8ab	16.3a
	Temik & Vorlex	12.9ab	15.5a

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

Table 4.

Marketable tuber yields and specific gravities as affected by selected production management practices.

Treatments		Crop Rotation			
lbs N/A	Nematicide	Alfalfa		Corn	
		yields[z]	sp. gr.	yields	sp. gr.
75	Check	319.2a[1]	1.071a	275.1a	1.072b
	Vorlex	354.3abc	1.070a	304.6ab	1.072b
	Temik	378.6bc	1.069a	305.9ab	1.072b
	Temik & Vorlex	387.8bc	1.069a	310.0ab	1.070b
225	Check	338.8ab	1.071a	305.0ab	1.067a
	Vorlex	356.4abc	1.072a	351.3bc	1.069ab
	Temik	405.3cd	1.069a	359.7bc	1.067a
	Temik & Vorlex	444.0d	1.072a	394.0c	1.068a

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

[z] cwt/A

Table 5. Effect of nitrogen rate and nematicides on nutrient composition of potato petioles from Superior, Russet Burbank and Denali potatoes grown in an alfalfa rotation.

Nitrogen Rate	Nematicide		Variety	Nutrients[1]							
	Temik	Vorlex		NO_3	P	K	Ca	Mg	Zn	Fe	Mn
lbs N/A				ppm	--------- %			------------	------ ppm		------
75	no	no	Superior	28,985a[2]	.38a	9.19a	.89a	.44a	38abc	99a	127a
	no	yes	"	29,731ab	.36a	9.29a	.89a	.47ab	31a	94a	98a
	yes	no	"	31,447abc	.37a	8.80a	.90ab	.47ab	35ab	80a	106a
	yes	yes	"	28,999a	139a	9.00a	.89a	.48a	42abc	88a	136a
225	no	no	Superior	34,314cde	.35a	9.40a	.91ab	.48a	37ab	93a	129a
	no	yes	"	32,165bcd	.32a	9.02a	.90ab	.50ab	37ab	89a	109a
	yes	no	"	34,899cde	.40a	9.67a	1.05b	.61b	47bcd	90a	134a
	yes	yes	"	35,501e	.36a	9.69a	1.01b	.61b	56d	102a	132a
225	yes	yes	R. Burbank	31,008ab	.40a	9.27a	1.03b	.61b	51cd	90a	172a
	yes	yes	Denali	29,124a	.29a	9.01a	.79a	138a	41abc	94a	135a
Sufficiency Levels				16,000- 20,000	.18- .22	6.0- 9.0	.36- .50	.17- .22	30- 100	30+	30- 200

[1] Sampled June 30,1981

[2] Column means followed by the same letter are not significantly different (P=0.05) according to the least significant difference test.

Table 6. Effect of nitrogen rate and nematicides on nutrient composition of potato petioles from Superior, Russet Burbank and Denali potatoes grown in a corn rotation.

Nitrogen Rate lb N/A	Nematicide Temik	Nematicide Vorlex	Variety	Nutrients[1] NO3 ppm	P %	K %	Ca %	Mg %	Zn ppm	Fe ppm	Mn ppm
75	no	no	Superior	16,687a[2]	.51a	10.46a	.76a	.33a	55a	138a	242a
	no	yes	"	14,906a	.48a	10.11a	.71a	.33a	50a	135a	221a
	yes	no	"	16,392a	.43a	10.75a	.76a	.31a	66a	129a	274a
	yes	yes	"	14,515a	.41a	9.39a	.66a	.32a	68a	130a	224a
225	no	no	Superior	27,230bc	.44a	9.47a	.68a	.34a	73a	141a	244a
	no	yes	"	24,882b	.42a	10.35a	.74a	.39a	70a	119a	181a
	yes	no	"	29,140c	.47a	9.66a	.79a	.38a	68a	140a	217a
	yes	yes	"	27,212bc	.42a	9.84c	.76a	.42a	72a	128a	193a
225	yes	yes	R. Burbank	23,980b	.40a	9.14a	.67a	.36a	82a	113a	231a
	yes	yes	Denali	24,766b	.44a	9.46a	.64	.32a	80a	145a	237a
Sufficiency Levels				16,000-20,000	.18-.22	6.0-9.0	.36-.50	.17-.22	30-100	30+	30-200

[1] Sampled June 30, 1981

[2] Column means followed by the same letter are not significantly different (P=0.05) according to the least significant difference test.

Table 7.

Marketable tuber yields and biotic components as affected by nitrogen levels.

Rotation	lbs N/A	cwt/A	P. penetrans	Rhizoctonia	Verticillium
Alfalfa	75	360.0a[1]	24.1a[2]	30a[3]	23a
	225	386.1a	21.2a	17a	23a
Corn	75	284.6a	12.4a	20a	33a
	225	352.5b	10.2a	8a	35a

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

2 P penetrans per gram of root. Sampled 7/27/81.

3 Percent of plants infected. Sampled 6/30/81.

Table 8.

Percent of Superior potatoes infected with Verticillium following alfalfa in a crop rotation.

lbs N/A	Nematicide	Date Sampled			
		6/15	6/30	7/15	7/30
75	Check	0a[1]	20a	20a	67a
	Vorlex	0a	47a	20a	67a
	Temik	7a	27a	27a	60a
	Temik & Vorlex	7a	0a	47a	60a
225	Check	0a	27a	33a	73a
	Vorlex	7a	53a	20a	60a
	Temik	0a	0a	47a	60a
	Temik & Vorlex	13a	13a	20a	60a

[1] Column means followed by the same letter are not significantly different according to the Student-Newman-Keuls Multiple Range Test.

Table 9.

Percent of Superior potatoes infected with Rhizoctonia following alfalfa in a crop rotation.

lbs N/A	Nematicide	Date Sampled			
		6/15	6/30	7/15	7/30
75	Check	13a[1]	0a	13a	40a
	Vorlex	60a	27ab	33a	33a
	Temik	60a	40ab	40a	20a
	Temik & Vorlex	73a	53b	13a	40a
225	Check	73a	0a	0a	20a
	Vorlex	53a	7ab	33a	33a
	Temik	73a	20ab	47a	40a
	Temik & Vorlex	67a	40ab	40a	27a

[1] Column means followed by the same letter are not significantly different according to the Student-Newman-Keuls Multiple Range Test.

Table 10.

Percent of Superior potato plants infected with Verticillium following corn in a crop rotation.

lbs N/A	Nematicide	Date Sampled			
		6/15	6/30	7/15	7/30
75	Check	7[1]	40	60	87
	Vorlex	0	20	73	47
	Temik	7	27	73	73
	Temik & Vorlex	0	20	67	73
225	Check	0	47	47	60
	Vorlex	0	13	53	80
	Temik	7	33	60	60
	Temik & Vorlex	13	47	47	47

[1] Column means are not significantly different according to the Student-Newman-Keuls Multiple Range Test.

Table 11.

Percent of Superior potato plants infected with Rhizoctonia following corn in a crop rotation.

lbs N/A	Nematicide	Date Sampled			
		6/15	6/30	7/15	7/30
75	Check	0[1]	7	7	0
	Vorlex	7	27	20	7
	Temik	13	27	13	13
	Temik & Vorlex	20	20	7	27
225	Check	0	0	0	7
	Vorlex	7	7	0	7
	Temik	20	13	27	7
	Temik & Vorlex	0	13	27	13

[1] Column means are not significantly different according to the Student-Newman-Keuls Multiple Range Test.

Table 12. The Influence of selected management practices on the population densities of *P. penetrans*.

Initial Population Densities of the Root Lesion Nematode.

Following:	
Alfalfa	Corn
2.4[a]	3.1

[a] *P. penetrans* per 100 cm^3 soil.

Table 13. The influence of selected management practices on the population densities of *P. penetrans*.

Pratylenchus penetrans per gram of root. (07/27/81)

Treatments		Rotation	
lbs N/A	Nematicides	Alfalfa	Corn
	Check	84.8[a][1]	80.0[c]
75	Vorlex	103.2[a]	18.8[b]
	Temik	2.8[b]	0.4[a]
	Temik & Vorlex	2.0[b]	0.4[a]
	Check	72.8[a]	55.6[c]
225	Vorlex	95.6[a]	24.0[b]
	Temik	0.4[b]	0[a]
	Temik & Vorlex	1.2[b]	2.0[a]

1 Column means followed by the same letter are not significantly different according to the Student-Newman-Keuls Multiple Range Test.

Table 14.

Marketable tuber yields of Superior and biotic components as influenced by selected production management practices.

Rotation	lbs N/A	Nematicides	cwt/A	P. penetrans[1]	Rhizoctonia[2]	Verticillium[2]
		Check	319.2a[3]	84.8b	0a	0a
		Vorlex	354.3abc	103.2b	27ab	27a
Alfalfa	75	Temik	378.6bc	2.8a	40ab	47a
		Temik & Vorlex	387.8bc	2.0	53b	20a
		Check	338.8ab	72.8b	0a	13a
		Vorlex	356.4abc	95.6b	7ab	0a
Alfalfa	225	Temik	405.3cd	0.4a	20ab	53a
		Temik & Vorlex	444.0d	1.2a	40ab	27a
		Check	275.1a	80.0c	20a	20a
		Vorlex	304.6ab	18.8b	27a	27a
Corn	75	Temik	305.9ab	0.4a	27a	20a
		Temik & Vorlex	310.0ab	0.4a	7a	40a
		Check	305.0ab	55.6c	0a	47a
		Vorlex	351.3bc	24.0b	7a	33a
Corn	225	Temik	359.7bc	0.0a	13a	13a
		Temik & Vorlex	394.0c	2.0a	13a	47a

1 Pratylenchus penetrans, Root-lesion nematode, per gram of root tissue, sampled 7-27-81.

2 Percent of plants infected, sampled 6-30-81

3 Column means within crop rotation followed by the same letter are not significantly different (P=0.05) according to the Student-Newman-Keuls Multiple Range Test.

Table 15.

Marketable tuber yields and biotic components as affected by nematicides.

Rotation	Nematicide	cwt/A	P.penetrans	Rhizoctonia	Verticillium
	Check	329.0ab[1]	39.4b[2]	0a[3]	24a[3]
	Vorlex	355.3bc	49.7b	17ab	50b
Alfalfa	Temik	392.0cd	0.8a	30bc	13a
	Temik & Vorlex	415.6d	0.8a	47c	7a
	Check	289.8a	33.9b	3a	43a
	Vorlex	328.0ab	10.7a	17a	17a
Corn	Temik	332.8ab	0.1a	20a	30a
	Temik & Vorlex	352.0bc	0.6a	17a	33a

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

2 P. penetrans per gram of root tissue, sampled 7/27/81.

3 Percent of plants infected, sampled 6/30/81.

Figure 1.

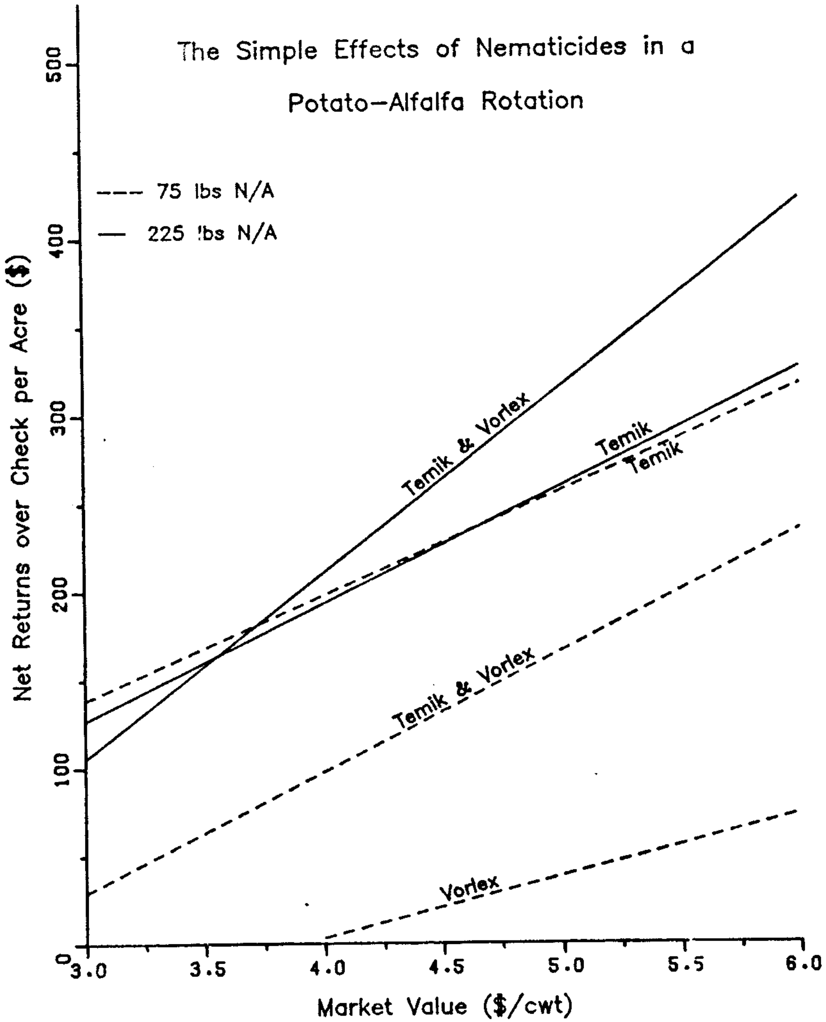


Figure 2.

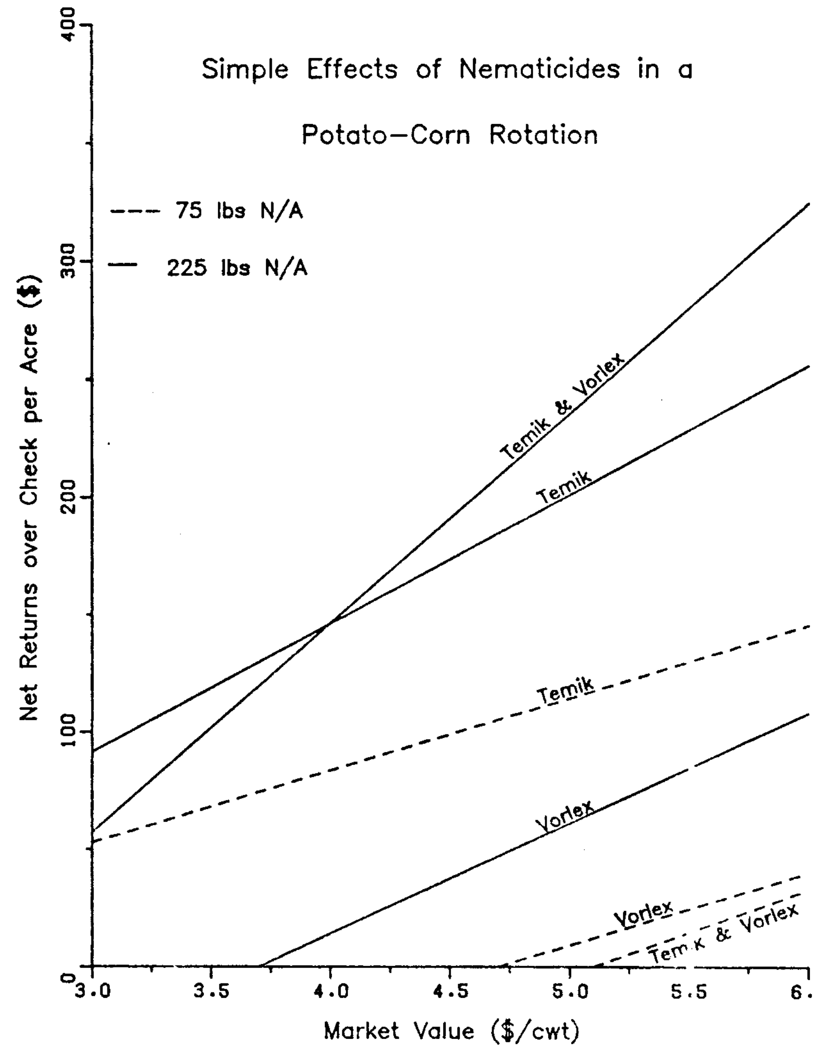


Figure 3.

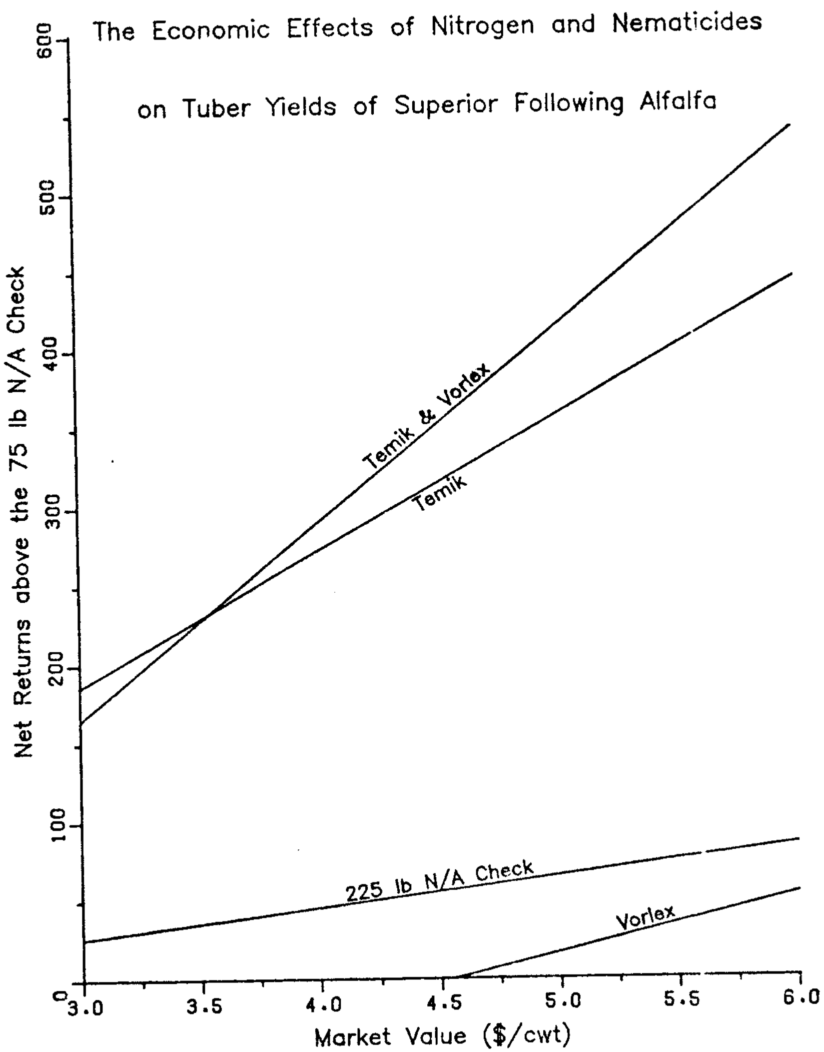


Figure 4.

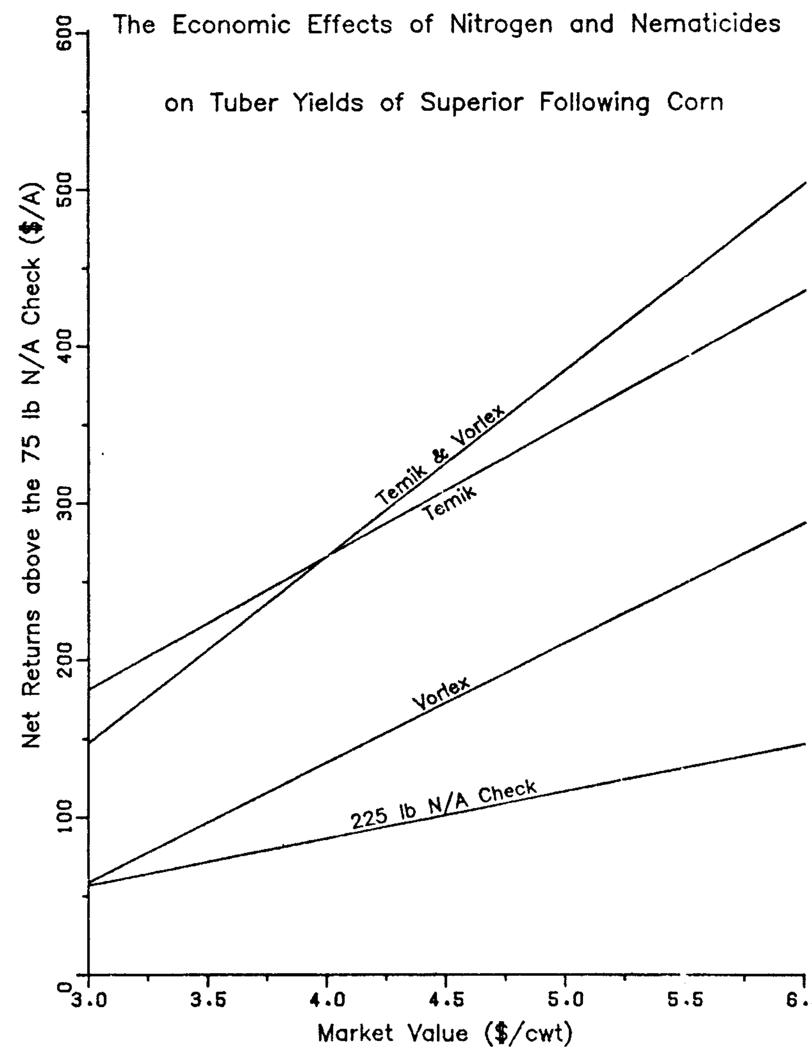
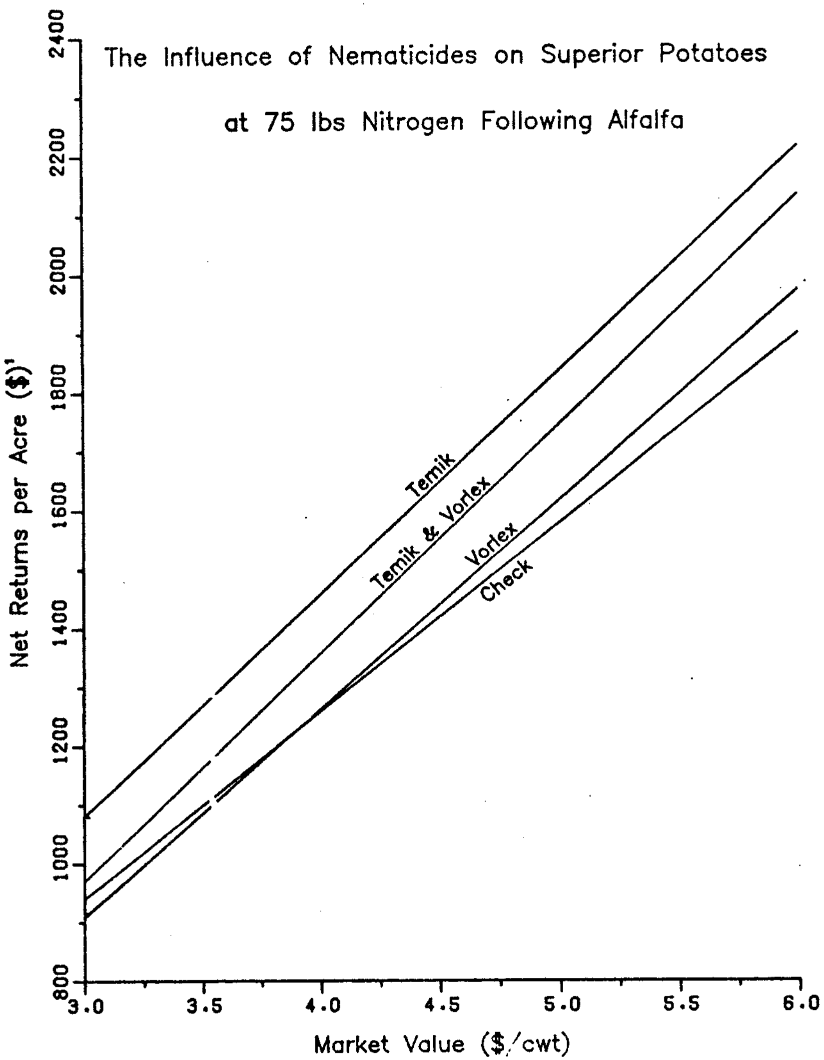
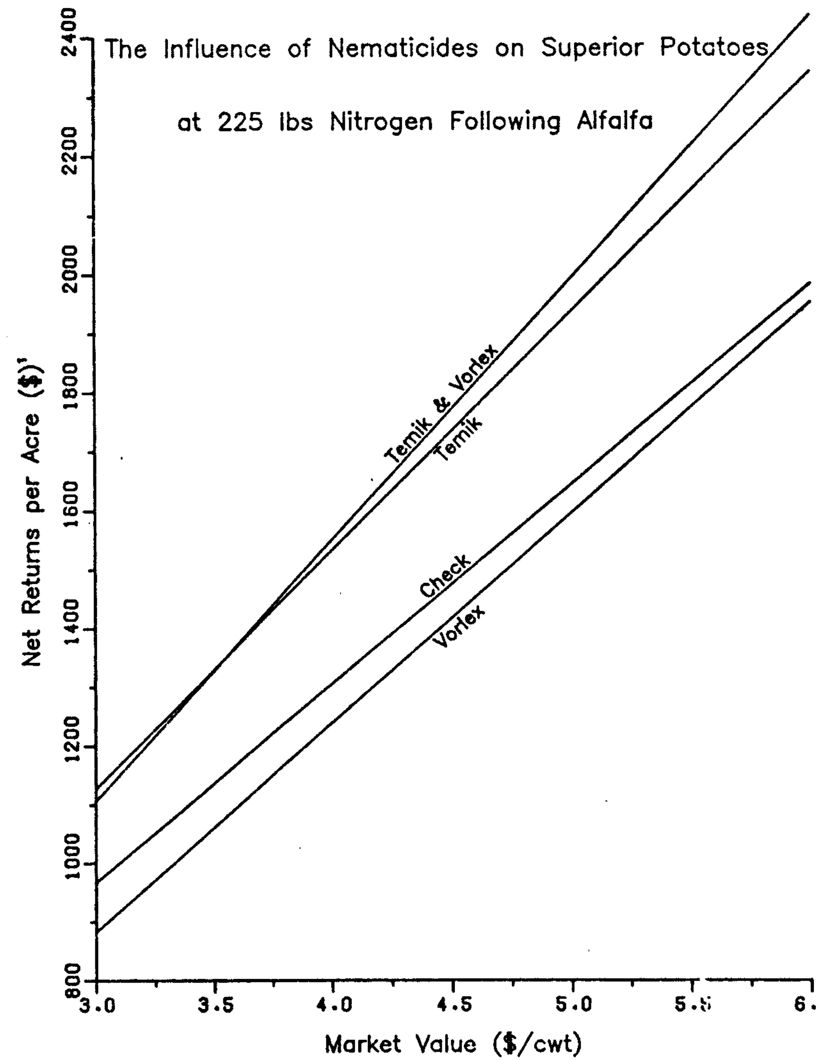


Figure 5.



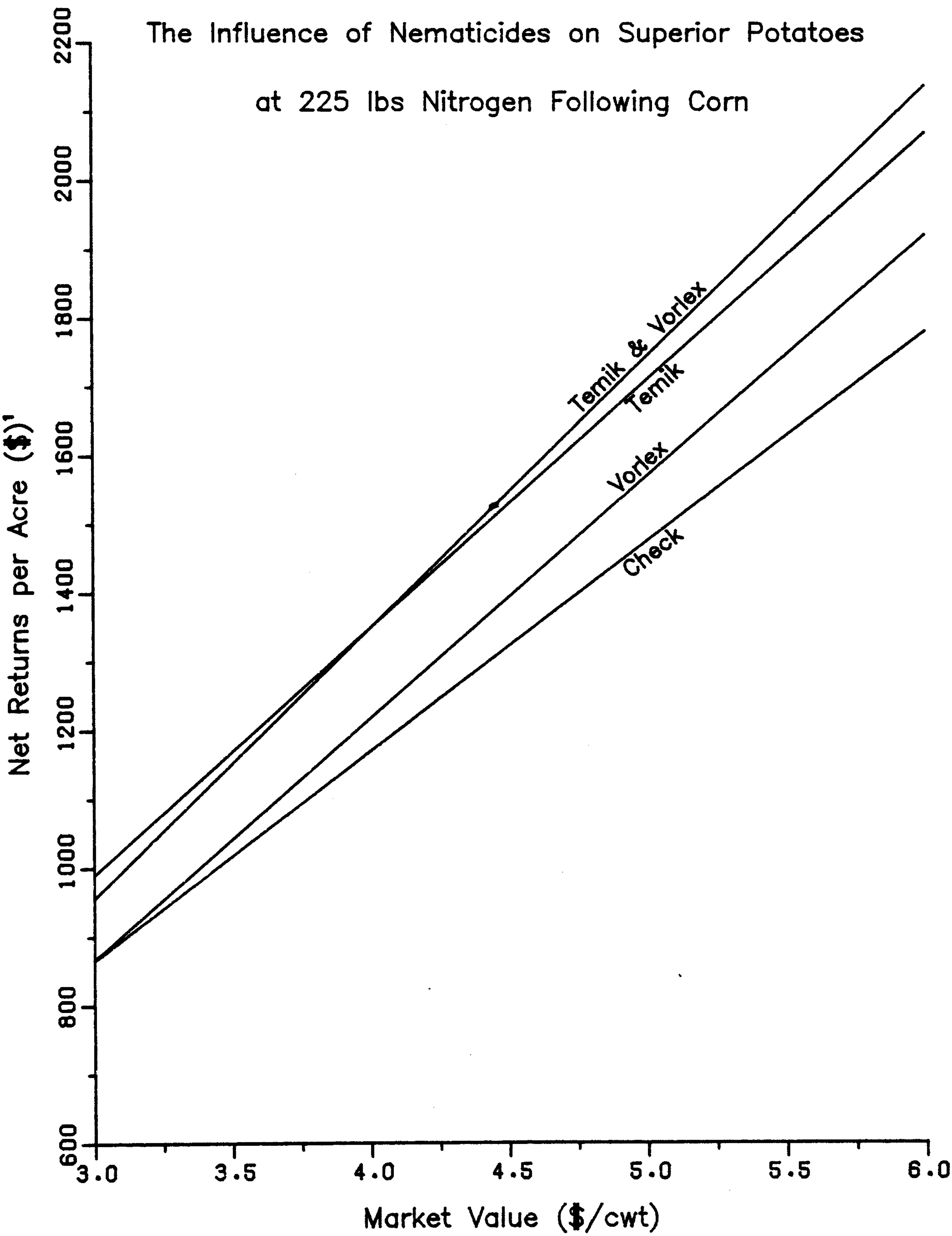
¹ Accounting for the costs of nitrogen and nematicides only.

Figure 6.



¹ Accounting for the costs of nitrogen and nematicides only.

Figure 7.



¹ Accounting for the costs of nitrogen and nematicides only.

THE INFLUENCE OF SELECTED PRODUCTION MANAGEMENT INPUTS ON WEIGHT LOSS AND MARKET QUALITY OF SUPERIOR POTATOES STORED UNDER VARIOUS STORAGE ENVIRONMENTS.

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INTRODUCTION

The MSU Integrated Potato Research Project is a joint project involving various departments at MSU basically Crop and Soil Sciences, Entomology, Botany and Plant Pathology, Food Science and Agricultural Engineering. The project is conducted in three phases:

Production Phase:
- Entomology
- Crop and Soil Sciences

Storage Phase:
- Agricultural Engineering

Market Quality Analysis Phase:
- Agricultural Engineering
- Botany and Plant Pathology
- Food Science

Superior potatoes were planted at the MSU Montcalm Potato Research Farm under the supervision of Dr. Richard Chase, Crop and Soil Sciences. There potatoes were planted using nine production management programs--basically an analysis of the influence of various levels of potassium (K_2O). The nine treatment plots were replicated five times. The production management team of researchers programmed, managed and analyzed the production phase through harvest. The results of the production phase were evaluated by crop yields and are reported by the production researchers.

The storage phase of the Integrated Project begins at harvest. Superior potatoes from the nine treatments and five replications were stored on the MSU campus in storage cubicles at Food Science. Environmental conditions are monitored daily and periodic evaluations for weight loss and market quality are made throughout the storage season from harvest (August 19, 1980) until spring planting (May 8, 1981).

One technique for evaluation of storability is seed viability. Representative samples of Superior potatoes from the nine treatments were planted at the Montcalm Potato Research Farm on May 8, 1981 and harvested September 15, 1981. Therefore, the storability phase of the MSU Integrated Project is <u>one year out of phase</u> of the other MPIC sponsored MSU potato projects.

*The production phase of the Integrated Project which provided the potatoes for the storage phase involved MSU researchers M.L. Vitosh, G.W. Bird, E. Grafius, R.W. Chase, H.C. Olsen, H.S. Potter and others basically in the Departments of Crop and Soil Sicences, Botany and Plant Pathology and Entomology.

PROCEDURE

There are four basic evaluations for the storability connected with this phase:

1. Sucrose ratings at harvest
2. Weight loss during storage
3. Market quality after storage
4. Seed viability

Seed Viability Phase: The Superior potatoes were harvested August 19, 1980. Two sample bags of approximately 25 lbs. each were obtained from three of the five replications and nine treatments (54 bags total). These bags were weighed at harvest and after suberization at 60°F (15.6°C) for 14 days. After suberization the storage temperature was lowered 5°F per week to 40°F. The potatoes were stored until May 4, 1981 (258 days). Weight loss and market quality determinations were made at the end of the storage period (May 4). Seventy-five sound tubers were randomly selected from each of the three replications and nine treatments (25 tubers from each of the three replications). The tubers from the three replications for a given treatment were combined into one bagged sample. These potatoes were planted May 8, 1981 at the MSU Potato Research Farm. The production management practices for the seed viability phase were supervised by the Crop and Soil Sciences Department. The results are reported later in this report.

Weight Loss Phase: Superior potatoes were stored for this phase at 40° and 50°F (4.5° and 10°C) and 95% relative humidity. All the bagged samples were weighed at harvest, after suberization, and upon termination of storage. Bags from the nine treatments (3 replications) were specifically stored for weight loss determinations. These bags were weighed at three intervals during storage (at 133 days, 180 days and 227 days) and upon termination of this phase (May 4, 1981 at 258 days). Weight loss samples were removed from storage, weighed, and returned to storage immediately. This is in contrast to market quality sample bags which were removed, evaluated, and discarded. The weight loss data is reported later in this report.

Market or Tuber Quality Phase: Twelve sample bags (approximately 25 lbs. each) were obtained from each of the three replications and nine treatments (324 bagged samples were stored for the market or tuber quality evaluation). Storability for market quality was observed at two storage temperatures 40° and 50°F (4.5° and 10°C) and 95% relative humidity.

Market quality evaluations were made periodically during storage at both 40° and 50°F. Quality examinations were made at 133, 180, 227, and at storage termination (258 days). Market quality is a subjective determination. Each tuber is inspected (cut if needed) for dry rot and soft rot (both potential storage disorders). Disorders not attributable to storage did not disqualify a potato from the marketable catagory (for example, a small hole eaten out by a white grub, the presence of a large scab, or a growth disformed potato were not disqualified from the marketable catagory).

Market quality evaluations were divided into the following catagories:

1. Marketable
2. Dry rot
   0.0 to 5.0%
   5.1 to 10.0%
   10.1 to 25.0%
   over 25.0%
3. Soft rot
   0.0 to 5.0%
   5.1 to 10.0%
   10.1 to 25.0%
   over 25.0%
4. Miscellaneous
   (Other reasons like scab, deformity, insect chewing, etc. but not attributable to a storage disorder).

Market quality evaluations destroy the sample; therefore, all marketable quality data reported are specifically for the predesignated lot sample only (the sample is not returned to the storage cubicle).

Sucrose Ratings: At the time of harvest representative samples of tubers are randomly selected from the five replications and nine treatments. Tubers from the five replications for a given treatment are combined for the sucrose evaluation. Immediately after harvest on August 19, 1980 these bagged samples (1 bag each for the nine treatments) were delivered to Food Science where the sucrose evaluation was supervised by Dr. Jerry Cash. These sucrose ratings will be presented later in this report.

DISCUSSION AND RESULTS

Production Phase: The nine production management practices used for the 1980 Integrated Project are as follows:

Treatment Number	Potassium Rate	Pesticide
1	0 lbs K_2O/A	Check
2	50 lbs K_2O/A	Check
3	150 lbs K_2O/A	Check
4	0 lbs K_2O/A	Temik
5	50 lbs K_2O/A	Temik
6	150 lbs K_2O/A	Temik
7	0 lbs K_2O/A	Terrachlor Super X
8	50 lbs K_2O/A	Terrachlor Super X
9	150 lbs K_2O/A	Terrachlor Super X

The objectives of the production phase were to evaluate the interactions of three potassium levels subjected to three pest control measures and their effect on yield, quality and storability of Superior and to monitor nematodes, fungi and insects to determine their effect on yield response to the inputs.

Seed pieces were planted on May 12, 1980 in a McBride sandy loam soil at the Montcalm Potato Research Farm in Entrican, Michigan. Each plot consisted of four rows 50 feet long having a 34 inch row width and 8-12 inches between seed pieces. Three levels of potassium 0, 50 and 150 pounds K_2O/A were subjected to three different pest control treatments: Temik 15G 3.0 lbs. a.i./A, Terrachlor 8.0 lbs. a.i./A, and a check. Each of the nine treatments were replicated five times. A 3x3x5 split factorial design was used. All plots received the standard rate of nitrogen and phosphorus fertilizers. 50 and 150 lbs. per acre of potassium were broadcast prior to planting. Temik 15G was banded with the starter fertilizer at a rate of 3.0 lbs. a.i./A. Terrachlor was broadcast as a granular at 8.0 lbs. a.i./A and disked in. Insects were monitored weekly and sprays were applied when deemed necessary. Soil and root population densities of the root lesion nematode (P. penetrans) were determined by sampling at planting and every two weeks thereafter. Nutrient levels were monitored by preplant soil samples plus petiole sampling twice during the growing season. The center two rows of each plot were harvested, graded and weighed.

Table 1 presents the results obtained by the researcher for the production phase. The range in yield per acre is from 228 cwt/acre (check treatment #1) to 295 cwt/acre (treatment #6). Specific gravity ranged from a low of 1.0664 (treatment #9) to 1.0718 (treatment #8).

Sucrose Rating Phase: The sucrose rating at harvest has been discussed as a potential guide for storability. The lower the sucrose rating the higher the storability potential. Potatoes having a sucrose rating above 2.5 mg sucrose per gram of tuber weight should not be stored for processing potatoes. The sucrose ratings for the 1980 Superior potatoes at harvest were measured and are presented in Table 2. The ratings are all below 2.5 and range from a low of 0.87 mg sucrose/g tuber (treatment #7) to a high of 1.34 (treatment #4).

Weight Loss During Storage: Weight loss information for the 1980 Superior potatoes is presented in Tables 3 to 7. The potatoes were harvested and stored at 40° and 50°F (4.5° to 10°C) at 95% relative humidity. They were harvested August 19, 1980 and placed in a 60°F cubicle at 95% RH for 14 days then lowered at 5°F per week to the designated storage temperature. The bagged samples (approximately 25 lbs. per bag) were weighed at harvest and after suberization. They were also weighed at intervals during storage of 133 days, 180, 227, and at termination (258 days). Tables 3 and 4 show the weight loss (%) for Superior potatoes stored for 258 days at 40°F. Both lots of these potatoes showed excessive sprouting at 258 days due to the fact no sprout inhibitors had been applied. The average loss in Table 3 ranges from 9.4 (treatment #1) to 10.5 (treatment #9) and averages 9.9%. Weight loss from comparable potatoes from the same integrated plots is shown in Table 4. The average loss ranges from 8.4 (treatment #1) to 11.2 (treatment #4). Weight loss is important to a potato grower and storage owner because potatoes are sold by weight. Weight loss is also an indication of processability. Excessive weight loss (above 10%) may present the potato chip processor a problem in maintaining raw product slice thickness. During the past years of research one goal has been to develop a weight loss factor for various storage periods and environments. The weight loss factor is "weight loss per day in percent." The WLF in Table 3 for 40°F, 258 days is 0.038% and for equivalent potatoes in Table 4 is 0.037.

Table 5 shows the weight loss for Superior potatoes equivalent to the potatoes in Table 4 but stored at 50°F (10°C). The weight loss is excessive at 227 days as shown by the 24.1% average loss. These potatoes were beyond the point for processability. The weight loss factor (WLF) is 0.105 for 50°F, 227 day storage for Superior

TABLE 1

Influence of Selected Management Practices on Final

Tuber Yield and Specific Gravity of Superior

1980

	TUBER YIELDS (CWT/A)				
	A	JUMBO	B	(A+JUMBO)	SPECIFIC GRAVITY
1. 0 lbs K_2O/A - check	228.24[a][1]	1.06[a]	17.68[a]	227.62[a]	1.0710[bc]
2. 50 lbs K_2O/A - check	236.84[a]	1.54[a]	15.54[a]	238.38[a]	1.0700[abc]
3. 150 lbs K_2O/A - check	234.86[a]	2.14[a]	16.60[a]	237.00[a]	1.0696[abc]
4. 0 lbs K_2O/A - Temik[2]	269.74[bc]	5.54[b]	18.16[a]	275.28[b]	1.0678[ab]
5. 50 lbs K_2O/A - Temik	273.58[bc]	8.60[c]	15.82[a]	282.20[b]	1.0674[ab]
6. 150 lbs K_2O/A - Temik	294.96[c]	8.92[c]	16.38[a]	303.90[b]	1.0672[a]
7. 0 lbs K_2O/A - Terraclor[3]	233.30[a]	0.94[a]	18.44[a]	234.24[a]	1.0692[abc]
8. 50 lbs K_2O/A - Terraclor	242.40[ba]	1.52[a]	15.98[a]	243.94[a]	1.0718[c]
9. 150 lbs K_2O/A - Terraclor	241.92[ba]	1.38[a]	16.28[a]	243.32[a]	1.0664[a]

[1] Treatment means within column followed by the same letter are not significantly different at the .05 probability level based on Student-Newman-Keuls multiple range test.

[2] (3.0 lbs. a.i./A)

[3] (8.0 lbs. a.i./A)

Table 2. Sucrose ratings at harvest for 1980 Superior potatoes grown in the integrated plots at the MSU Potato Research Farm and harvested August 19, 1980.

Production Treatment[1]	Sucrose Ratings mg Sucrose/g tuber
1	1.18
2	1.15
3	0.93
4	1.34
5	1.09
6	1.06
7	0.87
8	1.09
9	1.15
Average	1.10

1. Refer to page 3 for description of the nine production treatments.

Table 3. Weight loss from 1980 Superior potatoes grown on the MSU Potato Research Farm under nine production treatments and stored (for seed viability) in MSU cubicles at 40°F (4.5°C) and 95% relative humidity for 258 days.

Production Treatment[1]	Replication I	Replication II	Replication III	Average
	Weight Loss, %			
1	9.2	9.4	9.7	9.4
2	9.2	9.7	9.6	9.5
3	9.3	9.0	10.1	9.5
4	8.5	11.2	10.9	10.2
5	9.9	9.4	9.4	9.6
6	9.3	11.5	10.2	10.3
7	10.7	9.5	10.4	10.2
8	9.4	9.9	9.9	9.7
9	9.3	9.7	12.4	10.5
Average	9.4	9.9	10.3	9.9
	Weight Loss Factor (wt. loss/day, %)			0.038

1 Refer to page 3 for description for the production treatments.

Table 4. Weight loss from 1980 Superior potatoes stored (for weight loss determination) in MSU cubicles at 40°F (4.5°C) and 95% relative humidity for 258 days.

Production Treatment[1]	Replication[1] I	II	III	Average
	Weight Loss, %			
1	7.4	7.9	10.0	8.4
2	8.9	9.3	8.8	9.0
3	8.4	10.2	11.9	10.2
4	9.2	11.4	13.1	11.2
5	8.3	9.6	11.2	9.7
6	9.2	10.1	10.4	9.9
7	8.5	8.7	11.8	9.7
8	8.6	9.8	9.7	9.4
9	8.3	8.7	9.6	8.9
Average	8.5	9.5	10.7	9.6
	Weight Loss Factor (wt. loss/day, %)			0.037

[1] Refer to page 3 for description for the nine production treatments and replications for the 1980 Superior potatoes grown in the integrated plots at the MSU Potato Research Farm.

Table 5. Weight loss from 1980 Superior potatoes stored for weight loss determination in MSU cubicles at 50°F (10°C) and 95% relative humidity for 227 days.

Production Treatment[1]	Replication[1] I	II	III	Average
	Weight Loss, %			
50F[2]				
1	26.4	23.0	19.3	22.9
2	24.1	21.7	23.8	23.2
3	25.2	24.6	27.3	25.7
4	*	23.5	25.1	24.3
5	24.2	*	24.6	24.4
6	23.9	21.3	24.8	23.3
7	24.6	25.0	23.2	24.3
8	23.6	24.7	21.8	23.4
9	27.9	24.7	24.6	25.7
Average	25.0	23.6	23.8	24.1
	Weight Loss Factor (wt. loss/day, %)			0.106

[1] Refer to page 3 for description for the nine production treatments.

[2] Percent weight loss was calculated with sprouts removed due to excessive sprouting.

* No data recorded for these samples.

Table 6 illustrates the progressive weight loss during storage periods from 133 days to 227 days and compares weight loss at 40° to 50°. Excess sprouting occurred in the 227 day 50°F storage, therefore, growers should not attempt to hold Superior potatoes that are not sprout inhibited at 50°F for periods beyond 200 days. It is interesting to note that the WLF at 133 days at 40° and 50° is very similiar, 0.046 (40°) and 0.047 (50°) and 133 days.

The weight loss factor appears to change from one years potatoes to another. The attempt is to store Superior potatoes over enough years that a reliable WLF can be developed. The WLF for 40° and 50°F storage temperature for 133, 180, and 227 days are shown in Table 7.

Weight loss factors were calculated for 1979 Superior potatoes stored at 40°. Data from 1979 and 1980 40° storage are compared:

Storage Days	1979	1980
118	.039	
133		.046
167	.036	
180		.041
195	.040	
227		.037
233	.041	

Market Quality: The Superior potatoes grown for the MSU Integrated Project were harvested August 19, 1980 and stored for market quality evaluations. The harvested potatoes were suberized at 60°F 95% RH for 14 days. After suberization temperature was reduced 5°F per week to the designed storage temperature of 40° or 50°F.

Bags of Superior potatoes for market quality evaluations, were removed from storage at intervals of 133 days, 181 days, and 258 days. Each individual tuber from a lot was evaluated for quality after the designated storage period. The tuber quality evaluation was determined by Dr. H.S. Potter, MSU Botany and Plant Pathology. Each potato was classified as either marketable, dry rot, soft rot, or miscellaneous. If a tuber was classified "miscellaneous" but the disorder was not storage orientated it could be counted marketable (for example, a potato with white-grub damage but no dry or soft rot would be reclassified as marketable). Under the classification of dry and soft rot there were four degrees of rot (0 to 5%; 5 to 10%; 10 to 25%; and over 25%). These latter degrees of rot are meerly academic because any level of rot should not be classified as marketable. In a 25 pound bagged potato sample marketable quality, in percent, can vary due to method of evaluation of the tuber; whether by tuber weight or number of tubers in the sample. Therefore, for evaluation it is necessary to express market quality in percent good tubers based on weight and numbers of good tubers.

Table 6. Influence of storage duration on weight loss from 1980 Superior Potatoes using nine different production treatments and stored at 40°F (4.5°C) and 50°F (10°C) and 95% relative humidity.

Production Treatment[1]	Storage Period, Days 133[2]	180[3]	227[4]
	Weight Loss, %		
40° 1	5.9	7.3	9.2
2	6.4	6.7	8.3
3	5.5	6.8	7.8
4	6.8	8.0	8.3
5	6.1	7.3	8.3
6	6.3	7.9	8.8
7	6.3	8.0	8.3
8	6.2	7.5	8.9
9	5.6	6.8	8.1
Average	6.1	7.4	8.4
Weight Loss Factor	0.046	0.041	0.037
50° 1	5.2	9.5	23.3[5]
2	6.3	9.2	23.1
3	6.0	9.6	25.2
4	7.1	10.5	23.0
5	6.5	10.0	23.9
6	6.3	9.8	24.3
7	6.8	10.2	23.5
8	6.2	9.4	22.2
9	6.0	9.5	24.2
Average	6.3	9.7	23.6
Weight Loss Factor	0.047	0.054	0.104

[1] Refer to page 3 for description of the nine production treatments.

[2] Average weight loss determined from 6 separate bags of approximately 25 lbs. each.

[3] Average weight loss determined from 4 separate bags of approximately 25 lbs. each.

[4] Average weight loss determined from 2 separate bags of approximately 25 lbs. each.

[5] Percent weight loss was determined with sprouts removed due to excessive sprouting from 50°F potatoes stored for 227 days.

Table 7. Influence of storage duration on the weight loss factor from 1980 Superior potatoes stored in MSU cubicles at 40°F (4.5°C) and 50°F (10°C) and 95% relative humidity.

Temperature	Weight Loss Factor, %[1] 133 days[2]	180 days[3]	227 days[4]
40°F	.046	.041	.037
50°F	.047	.054	.104

[1] The weight loss factor is weight loss/day in percent of original weight.

[2] The average weight loss factor is determined from 54 sample bags approximately 25 lbs. each.

[3] Average weight loss factor from 36 sample bags approximately 25 lbs. each.

[4] Average weight loss factor from 18 sample bags approximately 25 lbs. each.

Table 8 presents the market quality, percent good, for two lots of similiar Superior potatoes produced under the nine production management programs and stored at 40°F for 258 days. There appears to be no apparent difference in market quality due to the nine production management programs for the Superior potatoes stored at 40°F and 95% RH for 258 days.

Table 9 shows a considerable overall degradation in market quality for potatoes stored for 227 days at 50° in contrast to potatoes shown in Table 8 (40°F for 258 days). Average quality reduced from 92.9 to 88.6% (by weight) and 92.7 to 90.4% (by numbers). Again there appears to be no apparent difference in market quality due to the nine production management programs.

Table 10 compares 1980 Superior potatoes stored at two temperatures (40° anf 50°F) and three storage durations (133, 181, and 258 days). An analysis of the 40°F lots indicates that the market quality of Superior potatoes can be fairly well maintained by storing bruise-free quality at 40°F. A similiar analysis appears for the 50°F lot. However, the 50°F 258 day figures of 91.3% (weight) and 92.4% (number) do not tell the visual story. Excessive sprouting, weight loss, and shriveling camouflaged the visual observation of storage and market quality degradation. Visual observation during the market quality evaluation indicated to the author that the average market quality figure of 91.3% (by weight) and 92.4% (by number) are not true indications of market quality and these data should be disregarded. These figures are presented in Table 10 to illustrate this very point.

The comparison in Table 10 between the 40°/50° and 133 days data needs further clarification. This illustrates an important criteria in potato storage management; it is more important in short term storage to maintain a constant temperature than to rapidly reduce the temperature and be unable to maintain the storage temperature. Potatoes degrade more due to a fluctuating temperature than they do in a slightly higher constant storage temperature.

Table 8. Marketable quality of 1980 Superior potatoes grown on the MSU Potato Research Farm under nine production treatments and stored in MSU cubicles at 40°F (4.5°C) and 95% relative humidity for 258 days.

Production Treatment[1]		Marketable Quality[2], % good[3] By Tuber Weight	By Number of Tubers
	1	94.2	95.9
	2	92.3	90.2
	3	92.9	93.1
	4	87.6	87.9
40°F[4]	5	91.1	91.3
	6	94.2	92.5
	7	93.3	94.1
	8	96.6	96.3
	9	94.1	93.2
Average		92.9	92.7
	1	93.4	93.1
	2	95.5	95.6
	3	96.1	95.9
	4	95.8	95.2
40°F[5]	5	92.4	89.7
	6	95.5	94.6
	7	97.1	96.8
	8	94.2	92.3
	9	95.3	96.4
Average		95.0	94.4

[1] Refer to page 3 for description of the nine production treatments.

[2] All data is the average of three bags of potatoes.

[3] Equivalent to a U.S. grade A designation.

[4] This lot of Superior potatoes was stored specifically for weight loss determination.

[5] This lot of Superior potatoes was stored specifically to determine the influence of storage environment and production treatment on seed viability. These potatoes were evaluated for market quality upon removal from storage.

Table 9. Marketable quality of 1980 Superior potatoes grown on the MSU Potato Research Farm under nine production treatments and stored in the MSU cubicles at 50°F (10°C) and 95% relative humidity for 227 days.

	Production Treatment[1]	Marketable Quality[2], % good[3] By Tuber Weight	By Number of Tubers
	1	90.0	93.9
	2	94.1	94.1
	3	91.9	94.7
	4	82.3	87.5
50°F[4]	5	90.2	88.2
	6	87.9	88.2
	7	80.9	81.7
	8	86.6	90.2
	9	93.6	95.3
	Average	88.6	90.4

[1] Refer to page 3 for description of the nine production treatments.

[2] All data is the average of three sample bags.

[3] Equivalent to a grade A designation.

[4] This lot of potatoes was stored specifically for weight loss determinations.

Table 10. Marketable quality of 1980 Superior potatoes grown on the MSU Potato Research Farm under nine production treatments and stored at two environmental conditions, 40° and 50°F (4.5° and 10°C) and 95% relative humidity, and three different storage durations.

Production Treatment[1] and Storage Temp.	Marketable Quality[2], % good[3] Storage Duration, days 133		181		258	
	By Tuber Weight	By Number of Tubers	By Tuber Weight	By Number of Tubers	By Tuber Weight	By Number of Tubers
40°F (4.5°C)						
1	92.7	94.0	94.2	94.9	93.9	94.1
2	90.9	93.2	94.6	95.8	93.3	93.1
3	98.2	98.5	96.2	97.4	94.4	96.2
4	95.5	96.6	94.0	91.9	96.6	97.7
5	91.8	93.3	90.8	95.4	96.0	96.2
6	93.2	93.8	91.6	92.3	95.1	95.8
7	96.3	96.9	93.2	93.8	96.1	95.9
8	96.5	96.4	95.1	96.1	96.1	95.9
9	92.9	93.4	94.1	94.5	96.9	97.3
Average	94.2	95.1	93.8	94.7	95.4	95.8
50°F (10°C)						
1	96.4	96.6	95.9	94.8	90.4	92.1
2	98.2	97.4	88.6	86.4	88.6	94.4
3	97.6	98.2	86.8	86.6	90.0	89.2
4	93.1	94.1	82.9	80.7	85.6	87.9
5	93.8	96.5	85.3	86.8	89.0	89.2
6	98.0	97.4	88.3	89.1	92.4	92.5
7	99.0	99.0	90.0	87.8	96.2	95.8
8	97.6	98.2	89.1	88.0	94.0	95.5
9	99.6	99.0	88.8	87.4	95.9	94.8
Average	97.0	97.4	88.4	87.5	91.3	92.4

[1] Refer to page for description of the nine production treatments.

[2] All data is the average of two sample bags.

[3] Equivalent to a grade A designation.

An important storage management point is that growers strive to lower pulp temperature too rapidly in their fall storage procedure. The recommended storage management procedure is to slowly and continuely lower the storage temperature at a rate that can always be maintained. Fluctuating storage temperatures degrade the storage life of a potato.

Seed Viability Phase: Random samples of 1980 Intergrated Project Superior potatoes were selected from each of nine production management practice lots and stored at 40°F and 95% RH specifically for a seed viability check. The objective was to observe if any of the nine production management treatments influenced seed viability. Storage variability was eliminated as a variable due to the fact potatoes from all nine treatments were stored in the same environment, and planted and grown under one 1981 production management treatment. Table 11 shows the results of the 1980 potatoes grown during 1981 at the MSU Potato Research Farm. Total yield ranges from 309 cwt/acre (treatment #5) to 382 cwt/acre (treatment #8). The yield of No. 1 potatoes ranged from 287 (#5) to 356 (#6). The nine production treatments do not appear to influence seed viability.

Table 11. Superior potatoes grown under the nine production management practices of the 1980 MSU Integrated Project were harvested and stored for 258 days at 40°F (4.5°C) and 95% RH. These potatoes were planted in 1981 for a seed viability analysis.[1]

			Percent Size Distribution			
Treatment No.	Total cwt/A	No. 1 cwt/A	Under 2"	Pick outs	Over 3 ¼"	2-3¼
1	354	324	7.9	0.5	0	91.6
2	346	315	8.6	0.5	1.3	89.6
3	346	314	8.1	1.3	2.3	88.3
4	359	326	7.8	1.3	1.3	89.6
5	309	287	6.6	0.5	0	92.9
6	381	356	6.1	0.5	1.2	92.2
7	371	346	6.7	0	1.7	91.6
8	382	348	8.6	0.2	1.2	90.0
9	368	332	8.5	1.2	3.4	86.9

Superior - cut seed
Planted: May 8, 1981
Harvested: September 15, 1981

[1] Seed pieces from each of the nine treatments were planted in one plot where all plants received one recommended production management practice during the 1981 season.

ALCOHOL PRODUCTION FROM POTATO PROCESSING WASTES

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INTRODUCTION

Lare volumes of wastes are generated at various stages during the processing of potatoes. The quantities of solids in the waste streams vary significantly depending on the product being manufactured and the quality of the raw potato. The magnitude of product solids are highest in waste streams from peeling, trimming and cutting. It has been estimated that the potato processing industry as a whole generates about four billion kg of wastes annually in the U.S.A. This large volume of wastes represents a costly disposal problem and a wastage of enormous quantities of starch. Utilization of potato processing wastes for alcohol production would eliminate the costly disposal problem and would potentially yield 130 million gallons of alcohol per annum. Thus, the potato processing wastes, if properly utilized, could bring an economic boon to potato processing plants in the state.

Little is known about the fermentation of potato wastes to alcohol. However, theoretical calculations indicated that 25 gallons of alcohol per ton of potatoes could be produced. Preliminary analyses by Dr. Heldman at MSU showed that up to 0.7 gallons of ethanol could be expected from potato processing waste streams from every 220 lbs of raw potatoes entering the processing plant; however, this appears to be a conservative estimate. The objective of our present investigation was to develop relatively simple and efficient fermentation procedures for the production of alcohol from potato processing wastes.

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

In most existing processes for the production of alcohol from starchy feeds (such as corn) the starch is initially hydrolyzed to glucose by a two step enzymatic process using industrial starch digesting enzymes. Hence, this procedure was used to hydrolyze the starch in PPW and the glucose obtained was fermented with six most promising strains of saccharomyces species. The results of this study showed that Saccharomyces cerevisiae, strain ATCC 26603, was the most desirable organism in that it fermented the PPW-derived glucose to ethanol with about 80% efficiency. Hence, this particular strain was used in all later fermentations. Optimization of the fermentation of enzymatically hydrolyzed PPW to alcohol is currently being investigated by a team headed br Dr. Jerry Cash of the Department of Food Science at MSU.

In an effort to increase the efficiency and economy of the overall fermentation, we directed our efforts at this stage to eliminating the enzymatic hydrolysis step and to accomplish direct fermentation of PPW to alcohol. To achieve this objective, we used a synergistic mixture of a starch-digesting yeast or fungus which hydrolyzes starch in PPW to glucose, and a second organism which ferments the glucose to alcohol.

The results presented in Table 1 showed that starch utilization by Aspergillus niger (a starch digester) alone or that by A. niger plus S. cerevisiae combination was comparable but ethanol production was substantially higher by the mixed culture. A. niger in pure culture produced only small amounts of ethanol but substantially larger amounts of cell mass compared to the mixed culture. Further cell mass and ethanol production were roughly proportional to the PPW concentration. These results clearly indicated that the basic idea of using synergistic mixed culture for the direct fermentation of PPW is a viable one, but the yields were relatively low (60%). Hence, a large number of combinations of a starch digesting fungus or yeast plus Saccharomyces cerevisiae were examined to identify the most efficient combination for the fermentation. The results shown in Table II indicated that aspergillus strains in pure culture consistently produced small amounts of ethanol and showed relatively low amylolytic activity, whereas Aspergillus plus Saccharomyces combinations consistently showed greater ethanol production, lower residual carbohydrate and higher amylolytic activity. Rhizopus in pure culture produced respectable amounts of ethanol; little improvement was seen when this organism was grown with saccharomyces. Lipomyces and S. fibuligera gave substantially higher yields of ethanol than when they were grown in pure culture. Based on the results of this experiment, A. niger was selected for further study.

The results presented in Table II showed that the low amylolytic activity observed in pure cultures of Aspergillus coincided with higher residual carbohydrate concentrations in these cultures. These results suggested that the amylolytic activity is being inhibited by the sugar accumulating in these fermentations. To see if this was true, A. niger was grown alone and in mixed culture with S. cerevisiae in 1% PPW and 5% PPW medium (Table III). One would expect less accumulation of sugar and little inhibition of amylolytic activity in 1% PPW medium, whereas in 5% PPW medium one would expect substantial accumulation of sugar and severe inhibition of amylolytic activity. As expected, severe inhibition of amylolytic activity was seen in A. niger pure culture in 5% PPW medium; in the same medium little inhibition of amylolytic activity was seen when A. niger and S. cerevisiae mixed culture was grown. These results clearly indicated that PPW-derived sugar inhibits starch digestion by A. niger. Therefore, it appeared that one may be able to improve this fermentation by increasing the level of yeast inoculum and thus keeping the glucose concentration relatively low. These experiments are in progress.

The results presented in Table IV showed that aeration has a profound effect on ethanol yield. The culture in flasks with no aeration gave ethanol yields up to 70% of the theoretical which was considerably higher than that observed in aerated flasks.

Further studies are currently in progress to optimize the level of inoculum of A. niger and S. cerevisiae, to optimize the pH, concentration of PPW, temperature and other important process parometers.

CONCLUSIONS

1. Enzymatically hydrolyzed potato processing wastes can be fermented to alcohol with about 80% efficiency.

2. A synergistic mixture of A. niger, a starch digester, and S. cerevisiae, a nonamylolytic sugar fermenter, could be employed for the direct fermentation of unhydrolyzed PPW to alcohol. A fermentation efficiency of 70% has been achieved to date.

Table 1. Effect of PPW Concentration on Ethanol Production*

PPW (g/100 ml)	A. niger			A. niger + S. cerevisiae		
	Starch used (g/100 ml)	Cells (g/100 ml)	EtOH (g/100 ml)	Starch used (g/100 ml)	Cells (g/100 ml)	EtOH (g/100 ml)
1	0.9	1.0	0.17	0.96	0.9	0.18
2	1.9	1.5	0.17	0.96	1.0	0.48
3	2.5	1.8	0.29	2.9	1.1	0.70
4	3.7	2.1	0.29	3.8	1.4	1.03
5	4.2	2.7	0.30	4.8	1.6	1.33

Limited aerobic conditions; pH 5.5; temperature 30°C; incubation time 7 days

Table 2. Production of Ethanol from PPW (5%) by Certain Amylolytic Fungi in Pure Culture and in Mixed Culture with _S. cerevisiae_*

Organism	_S. cerevisiae_	Ethanol (g/100 ml)	Residual (g/100 ml)	Amylolytic Activity (μ/ml)
A. niger	-	0.27	0.92	4.4
A. niger	+	1.21	0.10	10.6
A. foetidus	-	0.40	1.76	-
A. foetidus	+	0.71	0.81	10.6
A. awamori	-	0.23	2.0	-
A. awamori	+	0.87	0.54	10.0
Rhizopus sp.	-	1.03	0.14	8.8
Rhizopus sp.	+	1.03	0.42	7.4
Lipomyces kononenkoae	-	0.24	1.06	8.9
Lipomyces kononenkoae	+	1.27	0.32	8.8
S. fibuligera	-	0.45	0.23	2.5
S. fibuligera	+	1.15	0.17	10.6

*Time of incubation is 5 days; temperature 30^{o}C; pH 5.5.

Table 3. Correlation Between Sugar Concentration in the Culture Filtrate and the Amylolytic Activity Observed

Days	1% PPW				5% PPW			
	A. niger		A. niger + S. cerevisiae		A. niger		A. niger + S. cerevisiae	
	Sugar (mg/ml)	AA* (U/ml)	Sugar (mg/ml)	AA* (U/ml)	Sugar (mg/ml)	AA* (U/ml)	Sugar (mg/ml)	AA* (U/ml)
1	6.0	5.0	2.8	8.3	5.3	6.1	3.0	6.6
3	7.2	7.8	1.5	10.0	17.4	-	12.2	-
5	5.2	8.3	0.9	12.8	18.0	-	8.6	7.8
7	0.7	11.7	0.6	11.7	18.6	-	3.0	8.3
9	0.6	11.7	0.5	12.8	20.4	-	1.0	12.2
12	0.5	11.4	0.5	11.1	17.8	-	1.0	10.9

*AA = amylolytic activity. 1 unit = μmole glucose liberated/3 min/ml of culture.

Table 4 Effect of Different Aeration Conditions

Treatment	Starch Utilized	Ethanol (g/100 ml)	Cells
Air	4.8	0.78	1.43
Limited air	4.6	1.35	0.90
No air	4.7	1.59	0.77
N_2 [a]	-	1.59	0.93

[a] Aspergillus niger was grown aerobically for 24 hr followed by flushing under N_2.

CORN HYBRIDS, PLANT POPULATION AND IRRIGATION

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Performance data for 90 commercial corn hybrids evaluated in 1981 with and without irrigation are presented in Table 1 along with two and three year averages for those tested in 1980 and 1979. Bouyoucous soil moisture blocks were placed at 6, 12, 18 and 24 inch depths in both irrigated and unirrigated plot areas. 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 28.0 bushels more than nonirrigated--115.4 vs. 87.4, an increase of 32%. Hybrids ranged from 85.0 to 140.6 bushels per acre with irrigation and 62.2 to 111.4 without irrigation. Hybrids significantly better than average yield (arranged in order of increasing grain moisture content at harvest) are listed below. Sixteen of the 21 hybrids were in the highest yielding group for both irrigated and nonirrigated plots.

Irrigated	Not Irrigated
Pioneer 3901 (2X)	Pioneer 3901 (2X)
Pioneer 3906 (2X)	Dairyland DX1096 (2X)
Amcorn ZX5500 (2X)	Pioneer 3906 (2X)
Diaryland DX1004 (2X)	Amcorn ZX5500 (2X)
Great Lakes GL-455 (2X)	Dairyland DX1004 (2X)
Pride 4461 (2X)	Great Lakes GL-455 (2X)
Pioneer 3744 (2X)	Pride 4461 (2X)
Super Crost 2350 (2X)	Pioneer 3744 (2X)
Great Lakes GL-477 (2X)	Dairyland DX1003 (2X)
Great Lakes GL-522 (2X)	SuperCrost 2350 (2X)
McKenzie 409 (2X)	Great Lakes GL-477 (2X)
Super Crost 2410 (2X)	Great Lakes GL-522 (2X)
Super Crost 2396 (2X)	Super Crost 2410 (2X)
Payco SX788 (2X)	Super Crost 2396 (2X)
Stauffer Seeds B606 (2X)	Payco SX788 (2X)
Migro M-2018X (2X)	Stauffer Seeds B606 (2X)
Custom CFS6007 (2X)	DeKalb XL32A (2X)
Custom CFS W4000 (2X)	Migro M-2018X (2X)
	Custom CFS6007 (2X)

The correlation of irrigated with unirrigated yields was highly significant, .794, indicating that the hybrids tended to respond alike in both situations. During the 14-year period, 1968-1981, 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 14-year period, 1968-1981, 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 27 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 a trend toward more stalk lodging without irrigation, 5.9% vs. 8.6% (Table 1) but not for all hybrids. In most (but not all) of the previous years, there was less lodging on the irrigated plots. Generally, stressed weaker plants on unirrigated plots have been more susceptible to lodging. In 1981, the highest lodging was 17.8% stalk breakage when irrigated compared to 36.7% when unirrigated.

PLANT POPULATION X HYBRIDS

Five adapted hybrids at four plant populations irrigated and not irrigated have been grown in each of 14 years, 1968-1981, Table 3. Over the 14-year period, a harvest plant population of 23,300 has given the highest average yield (164 bushels per acre) when irrigated while 19,300 has given the highest yield (109 bushels) without irrigation. The 23,300 population irrigated has given the highest yield in 11 out of 14 years (1973, 1979 and 1981 being the exceptions). The yields in 1981 were 122, 132, 130 and 119 bushels per acre for harvest populations of 15,300, 19,400, 23,100 and 27,200, respectively. The difference 132 vs. 130 was not significant; the other differences were significant. The 14-year average increase due to irrigation has been 64 bushels per acre at the 23,300 population.

Stalk lodging has increased with increased plant population. In 1981, there was 3-4 times more lodging at 27,200 than there was at 15,300. Moisture content of grain at harvest has averaged .5 - 1.0% higher for the higher populations.

TABLE 1. NORTH CENTRAL MICHIGAN — Zone 3

Montcalm County Trial - Irrigated vs. Not Irrigated
One, Two, Three Year Averages - 1981, 1980, 1979

Hybrid (Brand-Variety)	% Moisture 1981	% Moisture 2 yrs.	% Moisture 3 yrs.	Bushels Per Acre 1981 Irrig	Bushels Per Acre 1981 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 1981 Irrig	% Stalk Lodging 1981 Not Irrig	% Stalk Lodging 2 Years Irrig	% Stalk Lodging 2 Years Not Irrig	% Stalk Lodging 3 Years Irrig	% Stalk Lodging 3 Years Not Irrig
McKenzie 858 (2X)	20.2	--	--	102.6	74.8	--	--	--	--	1.5	3.3	--	--	--	--
Asgrow RX355 (3X)	20.7	--	--	103.4	68.6	--	--	--	--	16.8	15.9	--	--	--	--
Stauffer Seeds S2202 (2X)	21.2	--	--	92.8	64.8	--	--	--	--	6.2	12.3	--	--	--	--
Great Lakes 81201 (2X)	21.5	--	--	87.5	65.1	--	--	--	--	7.7	10.9	--	--	--	--
P.A.G. SX157 (2X)	21.6	--	--	98.1	66.9	--	--	--	--	7.3	19.4	--	--	--	--
Stauffer Seeds S3306 (2X)	21.8	--	--	118.7	95.1	--	--	--	--	2.9	4.9	--	--	--	--
Migro HP-201 (2X)	21.8	--	--	91.2	70.3	--	--	--	--	9.8	5.2	--	--	--	--
Wolverine W126 (2X)	21.9	23	--	86.6	64.5	102	82	--	--	17.8	19.3	13	14	--	--
Great Lakes GL-422 (2X)	22.0	23	--	125.1	95.0	128	106	--	--	5.2	3.9	8	10	--	--
Warwick W901 (2X)	22.1	22	--	108.2	80.1	108	86	--	--	10.5	16.0	14	20	--	--
Garno S-88 (2X)	22.1	--	--	105.3	73.3	--	--	--	--	6.8	1.8	--	--	--	--
Garno S-85X (2X)	22.3	--	--	107.2	84.1	--	--	--	--	12.2	13.2	--	--	--	--
DeKalb XL14AA (2X)	22.3	23	--	118.8	91.5	125	111	--	--	6.3	7.2	9	7	--	--
Migro M-0101 (2X)	22.3	23	23	103.8	77.0	109	91	107	82	7.8	19.0	10	16	10	14
Garno S-86 (2X)	22.4	--	--	94.9	70.1	--	--	--	--	4.1	5.8	--	--	--	--
Great Lakes GL-456 (2X)	22.5	--	--	111.8	87.7	--	--	--	--	7.5	13.8	--	--	--	--
+*Pioneer 3901 (2X)	22.5	23	23	128.9	97.0	141	118	139	110	0.7	2.0	5	5	5	5
Hyland HL-2456 (2X)	22.5	--	--	104.6	81.8	--	--	--	--	9.4	8.1	--	--	--	--
DeKalb XL13 (2X)	22.6	--	--	102.7	62.2	--	--	--	--	16.3	36.7	--	--	--	--
Payco SX637 (2X)	22.7	--	--	114.1	89.6	--	--	--	--	5.8	7.7	--	--	--	--
Pioneer 3958 (2X)	22.8	23	24	101.4	69.0	101	83	104	80	7.9	19.9	7	17	7	14
+Dairyland DX1096 (2X)	22.8	23	--	122.1	100.5	130	117	--	--	11.3	14.4	11	13	--	--
Garno S-90 (2X)	22.9	23	23	120.3	93.3	122	107	122	102	3.0	3.8	10	9	11	9
Pride 3332 (2X)	23.0	--	--	90.1	77.4	--	--	--	--	15.8	15.4	--	--	--	--
Gutwein 2085 (2X)	23.0	--	--	114.2	92.6	--	--	--	--	5.1	8.0	--	--	--	--
+*Pioneer 3906 (2X)	23.1	--	--	130.4	97.6	--	--	--	--	2.3	6.6	--	--	--	--
McKenzie 927 (MSX)	23.1	--	--	88.8	68.8	--	--	--	--	6.4	5.8	--	--	--	--
Amcorn PSX3100 (2X)	23.1	--	--	119.1	90.2	--	--	--	--	5.8	5.1	--	--	--	--
Custom CFS 1450 (2X)	23.2	--	--	114.5	88.5	--	--	--	--	3.3	5.5	--	--	--	--
Payco SX619 (2X)	23.2	--	--	98.2	81.5	--	--	--	--	7.4	7.0	--	--	--	--
+*Amcorn ZX5500 (2X)	23.2	24	--	132.8	97.7	136	111	--	--	6.3	5.6	9	9	--	--
+*Dairyland DX1004 (2X)	23.2	24	--	138.9	111.4	136	117	--	--	5.9	12.7	14	16	--	--
Garno S-92 (2X)	23.2	--	--	110.3	77.7	--	--	--	--	2.9	12.2	--	--	--	--
Migro HP-277 (2X)	23.3	--	--	114.4	82.4	--	--	--	--	2.1	1.1	--	--	--	--
+*Great Lakes GL-455 (2X)	23.4	24	--	127.9	97.6	140	116	--	--	8.6	12.9	14	18	--	--
Funk G-4256 (3X)	23.5	24	--	114.2	87.6	109	91	--	--	1.5	10.0	12	15	--	--
Stauffer Seeds S4402 (2X)	23.6	--	--	122.6	84.9	--	--	--	--	5.0	12.0	--	--	--	--
Great Lakes GL-466 (2X)	23.6	--	--	118.0	83.8	--	--	--	--	2.5	9.0	--	--	--	--
P.A.G. SX181(2X)	23.7	25	--	124.4	93.7	128	107	--	--	3.8	17.8	13	21	--	--
Pioneer 3780 (2X)	23.7	25	25	119.5	90.6	130	111	127	104	5.1	11.8	6	10	10	9
Gutwein 2210 (2X)	23.8	--	--	113.1	94.8	--	--	--	--	5.3	11.4	--	--	--	--
Garno S-95Y (2X)	23.8	--	--	123.7	89.0	--	--	--	--	8.1	11.5	--	--	--	--
+*Pride 4461 (2X)	23.8	--	--	129.7	97.9	--	--	--	--	1.8	7.0	--	--	--	--
Payco SX620 (2X)	23.9	--	--	121.6	92.7	--	--	--	--	7.1	3.3	--	--	--	--
Wolverine W166 (2X)	24.0	24	--	110.7	91.6	126	113	--	--	5.8	11.4	6	11	--	--
Dairyland DX1099 (2X)	24.0	25	25	115.9	76.5	111	84	109	78	3.6	11.6	10	14	15	14
+*Pioneer 3744 (2X)	24.0	--	--	129.0	107.8	--	--	--	--	3.1	4.7	--	--	--	--
Pickseed 6688 (2X)	24.0	--	--	85.0	73.6	--	--	--	--	13.5	16.1	--	--	--	--
Payco SX611 (2X)	24.1	--	--	125.4	88.2	--	--	--	--	4.3	10.2	--	--	--	--
DeKalb EX1213 (2X)	24.1	--	--	103.8	85.7	--	--	--	--	8.9	8.7	--	--	--	--
Trojan T950 (2X)	24.1	--	--	95.6	68.4	--	--	--	--	4.1	3.0	--	--	--	--
Stauffer Seeds S4800 (2X)	24.1	--	--	113.2	90.2	--	--	--	--	2.8	5.3	--	--	--	--
+Dairyland DX1003 (2X)	24.1	25	--	122.8	99.1	125	110	--	--	6.9	3.7	7	7	--	--
Garno S-94E (2X)	24.4	--	--	116.1	91.6	--	--	--	--	7.5	8.8	--	--	--	--
+*Super Crost 2350 (2X)	24.7	25	25	140.6	100.6	141	119	136	104	4.5	11.0	5	8	7	7

(continued)

TABLE 1. (Continued)

Hybrid (Brand-Variety)	% Moisture 1981	% Moisture 2 yrs.	% Moisture 3 yrs.	Bushels Per Acre 1981 Irrig	Bushels Per Acre 1981 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 1981 Irrig	% Stalk Lodging 1981 Not Irrig	% Stalk Lodging 2 Years Irrig	% Stalk Lodging 2 Years Not Irrig	% Stalk Lodging 3 Years Irrig	% Stalk Lodging 3 Years Not Irrig
Custom CFS 4004 (2X)	24.7	--	--	121.1	94.9	--	--	--	--	4.5	9.2	--	--	--	--
DeKalb XL23 (2X)	24.8	27	27	115.1	93.1	125	108	124	96	2.4	10.6	8	12	7	10
Stauffer Seeds B507 (2X)	24.8	26	26	116.0	95.0	130	113	129	101	9.6	3.7	11	9	11	9
+*Great Lakes GL-477 (2X)	24.8	25	--	132.0	99.0	143	122	--	--	7.5	10.8	8	11	--	--
Funk G-4224 (MSX)	24.9	25	25	110.6	89.0	110	96	110	84	4.6	6.3	13	14	10	13
Kaltenberg KX54A (2X)	24.9	--	--	119.8	91.8	--	--	--	--	3.2	1.5	--	--	--	--
Pickseed 6655 (2X)	24.9	--	--	102.4	70.4	--	--	--	--	4.8	7.6	--	--	--	--
Pride 4488 (2X)	25.2	26	27	122.4	89.5	135	114	134	101	3.6	1.9	5	2	4	1
Gutwein 2190 (2X)	25.2	--	--	99.4	74.4	--	--	--	--	10.3	12.9	--	--	--	--
Payco SX756 (2X)	25.5	--	--	99.4	74.5	--	--	--	--	4.3	5.2	--	--	--	--
+*Great Lakes GL-522 (2X)	25.6	--	--	128.8	102.4	--	--	--	--	0.8	2.4	--	--	--	--
Stauffer Seeds S5602 (2X)	25.7	--	--	122.5	88.8	--	--	--	--	3.6	11.6	--	--	--	--
Payco SX844 (2X)	25.8	--	--	125.2	83.9	--	--	--	--	2.4	5.6	--	--	--	--
*McKenzie 409 (2X)	25.9		--	128.3	93.6	--	--	--	--	4.2	13.3	--	--	--	--
Hyland HL-2454 (2X)	26.0	--	--	119.4	86.4	--	--	--	--	8.7	9.9	--	--	--	--
Garno S-99 (2X)	26.1	--	--	108.6	87.8	--	--	--	--	3.4	2.4	--	--	--	--
Kaltenberg KX55 (2X)	26.3	--	--	117.0	83.9	--	--	--	--	8.4	6.9	--	--	--	--
Migro HP-23R (2X)	26.3	27	27	110.8	86.6	130	108	125	93	3.6	1.7	9	6	10	6
+*Super Crost 2410 (2X)	26.4	--	--	130.6	98.2	--	--	--	--	6.9	4.1	--	--	--	--
Custom CFS W3610 (2X)	26.5	--	--	124.4	92.6	--	--	--	--	4.3	17.3	--	--	--	--
+*Super Crost 2396 (2X)	26.5	27	--	130.9	101.6	132	108	--	--	3.8	9.7	8	12	--	--
+*Payco SX788 (2X)	26.5	--	--	131.8	101.4	--	--	--	--	8.5	13.1	--	--	--	--
Gutwein 2180 (2X)	26.7	--	--	107.5	85.7	--	--	--	--	7.5	9.3	--	--	--	--
Golden Harvest Exp.436 (2X)	27.0	--	--	113.3	89.4	--	--	--	--	8.5	5.3	--	--	--	--
Trojan T1000 (2X)	27.2	--	--	122.1	89.6	--	--	--	--	4.5	9.1	--	--	--	--
+*Stauffer Seeds B606 (2X)	27.3	27	28	134.8	105.2	150	128	147	114	6.8	2.4	8	6	6	4
Kaltenberg KX68 (2X)	27.9	--	--	126.2	95.9	--	--	--	--	4.6	0.8	--	--	--	--
+DeKalb XL32A (2X)	28.1	--	--	125.0	97.0	--	--	--	--	3.9	5.6	--	--	--	--
+*Migro M-2018X (2X)	28.1	29	29	134.0	107.9	145	124	140	111	3.1	1.5	4	5	5	4
+*Custom CFS 6007 (2X)	28.1	--	--	128.2	108.7	--	--	--	--	3.1	0.0	--	--	--	--
Stauffer Seeds S5260 (2X)	28.2	--	--	107.2	84.7	--	--	--	--	2.0	5.1	--	--	--	--
Migro HP-360 (2X)	28.4	--	--	101.7	80.1	--	--	--	--	2.6	8.3	--	--	--	--
Amcorn PSX7480 (2X)	29.1	--	--	122.7	95.2	--	--	--	--	9.1	20.5	--	--	--	--
*Custom CFS W4000 (2X)	29.3	--	--	128.0	95.6	--	--	--	--	3.1	6.8	--	--	--	--
Payco SX860 (2X)	32.3	--	--	113.7	90.5	--	--	--	--	1.5	6.9	--	--	--	--
Average	24.5	25	25	115.4	87.4	127	107	124	96	5.9	8.6	9	11	8	8
Range	20.2 to 32.3	22 to 29	23 to 29	85.0 to 140.6	62.2 to 111.4	101 to 150	82 to 128	104 to 147	78 to 114	0.7 to 17.8	0.0 to 36.7	4 to 14	2 to 21	4 to 15	1 to 14

(continued)

TABLE 1. (Continued)

Hybrid (Brand-Variety)	% Moisture 1981	2 yrs.	3 yrs.	Bushels Per Acre 1981 Irrig	1981 Not Irrig	2 Years Irrig	2 Years Not Irrig	3 Years Irrig	3 Years Not Irrig	% Stalk Lodging 1981 Irrig	1981 Not Irrig	2 Years Irrig	2 Years Not Irrig	3 Years Irrig	3 Years Not Irrig
Least Significant Difference	1.6	1.0	0.7	12.3	9.3	9	7	6	5	--	--	--	--	--	--

***Significantly better than average yield, irrigated,** in 1981.

+Significantly better than average yield, not irrigated, in 1981.

	1981	1980	1979
Planted	*May 2*	*May 12*	*May 19*
Harvested	*November 6*	*November 11*	*November 19*
Soil Type	*Montcalm-McBride sandy loam*	*Montcalm-McBride sandy loam*	*Montcalm-McBride sandy loam*
Previous Crop	*Alfalfa*	*Alfalfa*	*Alfalfa*
Population	*20,850*	*20,700*	*20,800*
Rows	*30"*	*30"*	*30"*
Fertilizer	*323-143-143*	*315-155-155*	*213-80-80*
Irrigation	*4 inches*	*3 inches*	*6 inches*
Soil Type: pH	*5.9*	*6.9*	*5.4*
P	*512 (very high)*	*528 (very high)*	*493 (very high)*
K	*284 (high)*	*290 (high)*	*336 (very high)*

Farm Cooperator: *Theron Comden, Montcalm Experimental Farm, Lakeview*

County Extension Director: *James Crosby, Stanton*

Table 2. Average, highest and lowest yields for corn hybrids irrigated and not irrigated for 14 years, 1968-1981.

Year	No. of Hybrids Tested	AVERAGE Irrigated	AVERAGE Not Irrigated	HIGHEST Irrigated	HIGHEST Not Irrigated	LOWEST Irrigated	LOWEST Not Irrigated
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		136	92	174	117	90	59

Table 3. Average yield at four plant populations irrigated and not irrigated for 14 years, 1968-1981.

Year	15,200 Irrigated	15,200 Not Irrigated	19,300 Irrigated	19,300 Not Irrigated	23,300 Irrigated	23,300 Not Irrigated	27,400 Irrigated	27,400 Not Irrigated
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	138	96	157	109	164	100	149	92

COLORED BEAN VARIETY AND STRAIN TESTING--1981

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The field was planted on June 4. Fertilization consisted of 240 pounds per acre of 14-37-0 plus 5% Mn and 2% Zn. A tank mix of Eptam, Treflan and Amiben was pre-plant incorporated. Ten pounds/acre of Temik was also applied at planting.

Four different experiments were planted:

Expt. I. This consisted of 512 entries in 16-foot long single row plots of lines of various seed classes received by Dr. A.W. Saettler from the USDA-ARS program at Prosser, Washington, which were to be evaluated for halo-blight reaction. Dr. Saettler inoculated this test twice with Psuedomonas phaseolicola but the disease did not develop satisfactorily so he did not obtain the desired data.

Expt. II. This test consisted of 70 selections in the F_3 generation of the Montcalm x Charlevoix cross, which was made to recombine the better test weight of Charlevoix with the halo-blight resistance of Montcalm. Some 38 selections were retrieved from this experiment in Fall 1981, with emphasis in field selection being placed upon visual appearance of plant and seed.

In addition, we had 18 miscellaneous entries of kidneys, whites and cranberry beans, to make a total of 88 rows in all. Among the cranberry entries, one row (row #41, entry F706) produced seed of unusual color quality--the seed had not undergone the typical after-ripening browning reaction of most cranberry beans. This entry will be watched closely in 1982.

Expt. III. This planting consisted of early generation material (kidney and blacks) being screened by Dr. A. Ghaderi for anthracnose and halo blight resistance. A seed advance was secured on this material.

Expt. IV. This test (#1227) consisted of 18 entries of kidney and cranberry beans in 4-row, 4-replicate plots. Table 1 gives days to flowering and yield in pounds/acre of these lines.

Table 1. Days planting to 50% flowering and seed yield of commercial varieties and experimental strains of kidney beans (red and white) and cranberry beans at the Montcalm County Research Farm, 1981.

Entry	Days planting to 50% flowering	Plant type	Yield in lbs/acre
Experimental Cran. 422	36	bush	2570
Experimental Cran. 423	35	bush	2469
Experimental Cran. 424	37	bush	2575
Experimental Cran. 425	37	bush	2677
Cran 028	42	bush	2721
Michicran	44	vine	2198
White kidney 5408	37	bush	2301
White kidney 61144	35	bush	2396
Light red kidney 9482	40	bush	2622
Mecosta	41	bush	2468
Manitou	40	bush	2245
70684	35	bush	2674
70700	35	bush	2477
70688	35	bush	2678
Redkloud	35	bush	2505
Sacramento	36	bush	2772
Charlevoix	40	bush	2213
Montcalm	40	bush	2295

The experimental cranberry line 422, 423, 424, 425 are early maturing bush types that yielded quite well, in comparison to the later vine Michicran. Cran 028 also yielded quite well in this test, well above Michicran.

The new light red kidney strain 9482 has continued to look unusually attractive in the field--plants are upstanding, vigorous, abundantly podded, and pods at maturity are not discolored. Yield has been excellent, exceeding the older standards Manitou and Mecosta. The early light red kidneys represented by 70688 also performed well. MSU #70688 is now under increase and consideration for release as a halo-blight resistant early maturing light red. The early Sacramento was the highest yielding entry in this test.

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