Fertilizer Studies with Irrigated Potatoes
Michigan State University Agricultural Experiment Station and Cooperative Extension Service
Research Report
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Issued September 1971
12 pages

September 1971

RESEARCH REPORT 142

FARM SCIENCE

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION EAST LANSING

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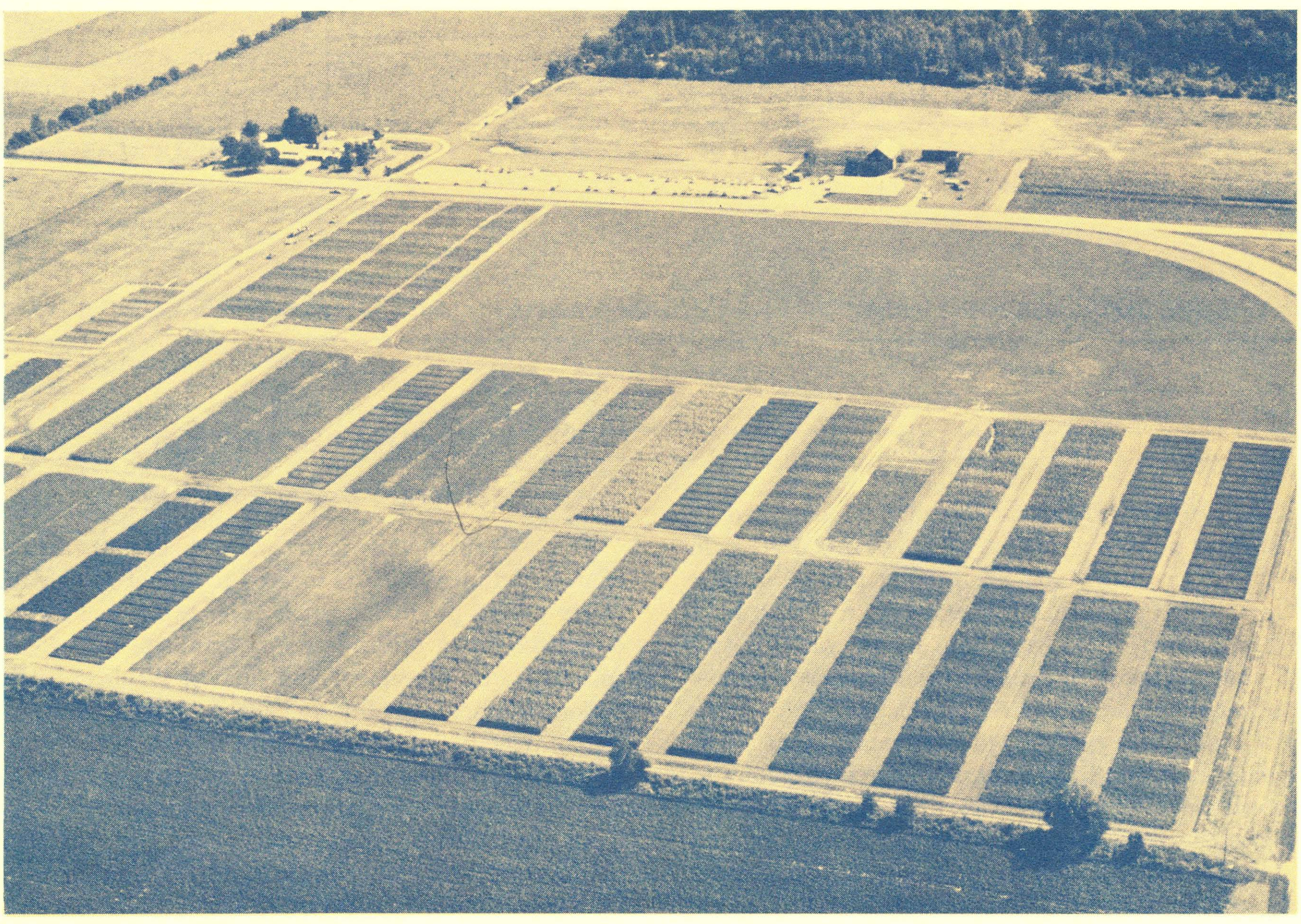

Fertilizer Studies with Irrigated Potatoes

by **Maurice L. Vitosh**

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Cover: Soil fertility research area on potatoes at the Montcalm Experimental Farm.

INTRODUCTION

POTATO PRODUCTION IN Michigan has continued to increase despite a decline of nearly 8,000 acres in the past five years (1966-70). During this same time average yields rose from 189 to a record of 246 hundredweight per acre. Irrigation, better weed, insect and disease control and increased fertilizer use have contributed to the increased production.

The successful potato grower must have some knowledge of fertilizer materials, their reactions in soils and when to use them for best results. This report presents research information which may be used to develop a sound and economical soil management and fertilizer program.

EXPERIMENTAL PROCEDURE

Montcalm Experimental Farm

In 1967 experiments were established at the Montcalm Experimental Farm located in one of Michigan's major potato producing areas. The experiments were established on a McBride sandy loam soil to evaluate sources, rates, placement and time of fertilizer applications on yield, quality and plant nutrient composition of irrigated potatoes. Initial soil tests are reported in Table 1. A three year rotation of potatoes, red kidney beans and sweet corn was established.

All experiments, except zinc, were laid out in a randomized complete block split-plot design with four replications, two varieties and 5 or 10 fertilizer

Table 1. Initial soil tests for the surface soil at the Montcalm Experimental Farm

Soil pH	6.4
Bray P_1 Phosphorus	255 lb/A (a)
Exchangeable Potassium	249 lb/A
Exchangeable Calcium	837 lb/A
Exchangeable Magnesium	161 lb/A
Available Zinc in O.1N HC1	6 ppm

(a) Pounds per acre is equivalent to parts per 2 million.

treatments. One-half of each plot was planted to Russet Burbank and the other half to Sebago. Untreated whole seed (B size) was planted in early May in 32-in. rows with 14 and 10-in. seed spacing for the Russet Burbank and Sebago varieties, respectively. Weeds were controlled with 2 lb. of Linuron (Lorox) applied as a preemerge herbicide. The plants were hilled when they were 12-14 in. tall. A general spray program of insecticides and fungicides was initiated in June and continued weekly for the rest of the season. Yields were harvested in late September or early October. Specific gravity determinations were made by the hydrometer method (11).

Climatological information was recorded daily throughout the growing season. Rainfall for April through September during 1968-70 was 17.3, 17.1 and 25.4 in., respectively. All experiments received supplemental irrigation when soil moisture tentiometers indicated less than 50% available soil moisture. Approximately 8.6, 8.4 and 7.2 in. of irrigation water were used during this same period.

Nitrogen Studies

The basic fertilizer treatment for these studies was 100 lb. of P_2O_5 and 200 lb. of K_2O per acre banded 2 in. to the side and slightly below the seed at planting time. In 1970 the phosphorus application was increased to 150 lb. Treatments for the nitrogen rate, placement and time of application study are shown in Table 2. Nitrogen, applied as ammonium nitrate, was either broadcast on a rye cover crop and plowed under before planting, banded at planting or sidedressed just prior to hilling.

Five nitrogen sources (ammonium nitrate, ammonium sulfate, calcium nitrate, urea and anhydrous ammonia) were also studied. All sources except anhydrous ammonia were applied in split applications. Sixty-five pounds of N were banded at planting and 60 lb. sidedressed before hilling. All of the anhydrous ammonia was sidedressed. To eliminate differences due to time of application, all nitrogen sources in 1970 were applied after planting but prior to emergence. The dry materials were topdressed, while anhydrous ammonia was knifed-in between the rows at a rate of 200 lb. of N per acre.

Potassium Studies

The fertilizer for these experiments consisted of 120 lb. of N and 100 lb. of P_2O_5 per acre. The nitrogen application was increased to 180 lb. in 1969 and 210 lb. in 1970. Phosphorus was also increased in 1970 to 150 lb. P_2O_5 per acre. Potassium applied as muriate

Table 2. Effect of rate, method and time of nitrogen application on yield of irrigated Russet Burbank and Sebago potatoes

Nitrogen Application (a)				Russet Burbank				Sebago				Overall
Broadcast	Banded	Sidedressed	Total	1967	1968	1969	Average	1967	1968	1969	Average	Average
lb N/A				Total Yield (cwt/A)								
0	0	0	0	144	219	166	176	152	218	234	201	188
0	60	0	60	201	235	285	240	239	238	355	277	258
60	60	0	120	236	265	335	279	256	313	401	323	301
120	60	0	180	242	331	360	311	254	343	463	353	332
180	60	0	240	249	318	344	304	301	343	458	367	336
120	0	0	120	173	234	324	244	209	247	404	287	266
0	60	60	120	250	306	366	307	249	351	465	355	331
0	60	120	180	249	336	378	321	247	371	485	368	344
0	120	0	120	300	329	342	324	273	328	423	341	332
Least Significant Difference (.05)				69	56	64	—	69	56	64	—	—

(a) Applied as ammonium nitrate broadcast and plowed down prior to planting, banded 2 in. to the side and slightly below the seed at planting or sidedressed at hilling time.

of potash (0-0-60) was either topdressed in the fall, broadcast and plowed down in the spring or banded 2 in. to the side and slightly below the seed at planting time.

Petiole samples were collected from 40 - 50 leaves (fourth leaf from the growing tip) in each plot at various stages of growth. In 1967-68 the samples were ashed according to the Jackson (6) procedure and analyzed for potassium, calcium and magnesium with an atomic absorption spectrophotometer. Petiole samples in 1969-70 were analyzed by total emission spectrography.

Zinc Studies

This experiment was established as a split-block design with four replications, five zinc treatments and two soil phosphorus levels. The high phosphorus level was established with a broadcast application of 687 lb. of P_2O_5 per acre on one-half of each replication. The low phosphorus treatment received no broadcast phosphorus.

The zinc materials used in the study were zinc sulfate, AZCo C100 and AZCo 12. The AZCo materials were basic slag by-products composed of zinc oxides and silicates submitted by the American Zinc Company for evaluation. The treatments were as follows: no zinc, an initial broadcast application of 25 and 50 lb. of Zn as zinc sulfate and AZCo C100, respectively; and 5 lb. of Zn banded annually as AZCo 12 and zinc sulfate.

Basic fertilizer was 65, 50 and 200 lb. of N, P_2O_5 and K_2O per acre banded, respectively. Additional nitrogen was sidedressed prior to hilling. The Russet Burbank variety was used in this study.

Monroe County Experiment

In 1970 an experiment was established on a Chelsea loamy sand in Monroe County. The experiment included two irrigation levels, three levels of sidedress nitrogen and two varieties. Basic fertilizer was 300 lb. of 0-0-60 broacast and plowed down in the spring and 800 lb. of 14-12-8 banded at planting. A normal irrigation level (4 in. of water during July - September) and an excessive irrigation level (5 in. of water June 12 when the plants were 10-12 in. tall, plus 4 in. of water for the rest of the season) were established.

Sidedress applications of ammonium nitrate at rates of 0, 75 and 150 lb. of N per acre were applied just prior to irrigation in June. Haig and Norchip varieties were planted May 20 in 36-in. rows with 13-in spacing and harvested October 15, 1970. Rainfall for the area was 7.0, 4.0, 1.9 and 2.6 in. for June-September, respectively.

RESULTS AND DISCUSSION

Rate, Placement and Time of Nitrogen Application

The effect of rate, placement and time of nitrogen application on yield and specific gravity of irrigated potatoes is presented in Tables 2 and 3. In 1967 yields were depressed due to inadequate moisture, but specific gravity was higher than usual. Hawkins (4) found specific gravity to be lower when moisture was inadequate, especially at high rates of nitrogen.

Significant yield responses were limited to the first two increments of nitrogen. Russet Burbank and Sebago varieties responded similarily. The highest yields were obtained when 60 lb. of N were banded and 120 lb. sidedressed. Both banded and sidedress applications were superior to the broadcast method (Figure 1). Similar findings were reported by Hawkins (3) and Soltanpour (12).

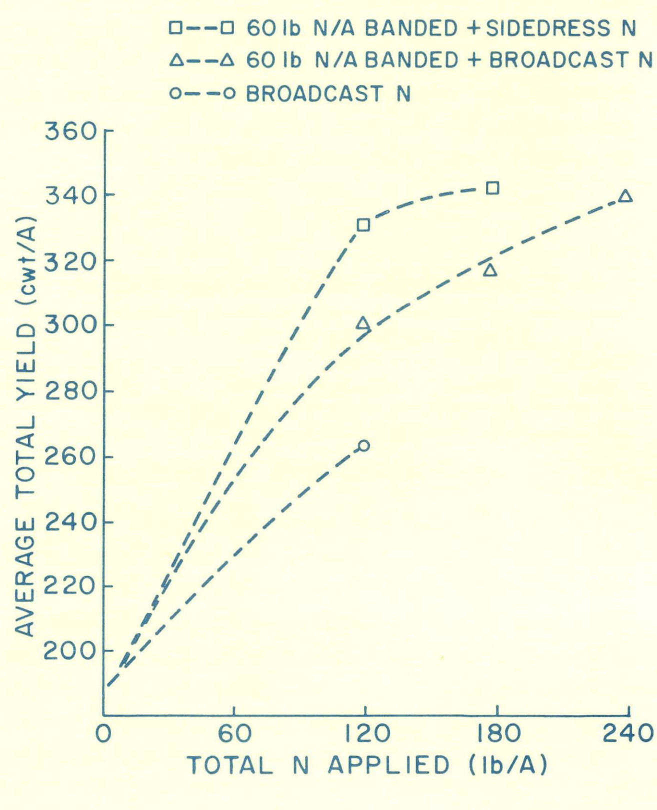

Fig. 1. Average total yield of irrigated Russet Burbank and Sebago potatoes as affected by rate, placement and time of nitrogen application.

Table 3. **Effect of rate, method and time of nitrogen application on specific gravity of irrigated Russet Burbank and Sebago potatoes**

Nitrogen Application (a) Broad-cast	Banded	Side-dressed	Total	Russet Burbank 1967	1968	1969	Average	Sebago 1967	1968	1969	Average	Overall Average
lb N/A				Specific Gravity								
0	0	0	0	1.090	1.081	1.080	1.084	1.086	1.074	1.072	1.077	1.080
0	60	0	60	1.087	1.080	1.080	1.082	1.088	1.073	1.068	1.076	1.079
60	60	0	120	1.087	1.081	1.080	1.083	1.084	1.074	1.072	1.077	1.080
120	60	0	180	1.086	1.083	1.080	1.083	1.088	1.074	1.071	1.078	1.080
180	60	0	240	1.088	1.080	1.078	1.082	1.086	1.073	1.074	1.078	1.080
120	0	0	120	1.090	1.082	1.082	1.085	1.090	1.073	1.072	1.078	1.082
0	60	60	120	1.086	1.081	1.079	1.082	1.086	1.074	1.069	1.076	1.079
0	60	120	180	1.086	1.082	1.081	1.083	1.088	1.074	1.070	1.077	1.080
0	120	0	120	1.089	1.082	1.080	1.084	1.087	1.072	1.072	1.077	1.080
Least Significant Difference (.05)				NS	NS	NS	—	NS	NS	NS	—	—

(a) Applied as ammonium nitrate broadcast and plowed down prior to planting, banded 2 in. to the side and slightly below the seed at planting or sidedressed at hilling time.

Much of the nitrogen applied early in the season may have been lost by leaching. Sidedress nitrogen was more readily available to the potato crop later in the season when the crop required it. Soltanpour (13) found that maximum uptake of nitrogen by potatoes occured 60 to 90 days after planting. Nitrogen should be plentiful at this stage of growth and not depleted for several weeks. Maximum uptake by tubers occurs later in the season, however, nearly all of this nitrogen is translocated from the vines.

Specific gravity of tubers was not significantly affected by rate, placement and time of nitrogen application. However, excessive use of nitrogen may delay maturity and lower specific gravity (4).

Nitrogen Leaching Study

A study was initiated in Monroe County on Chelsea loamy sand to evaluate the effect of two irrigation levels and three rates of sidedressed nitrogen on yield of Haig and Norchip varieties. Since varieties did not respond differently, yields were combined and are shown graphically (Figure 2).

The loss of nitrogen is related to the amount of water filtering through the soil. The 112 lb. of N applied at planting time was nearly sufficient for maximum production on the normal irrigation treatment. However, with excessive irrigation an additional 150 lb. of sidedress nitrogen was required to obtain the same yield.

High rainfall or excessive irrigation early in the season when evapotranspiration (evaporation from soil, plus transpiration from plants) is minimal can cause considerable nitrogen losses on sandy soils. If much of the nitrogen has been leached below 2 ft., a sidedress application or nitrogen applied through the irrigation system may be very beneficial.

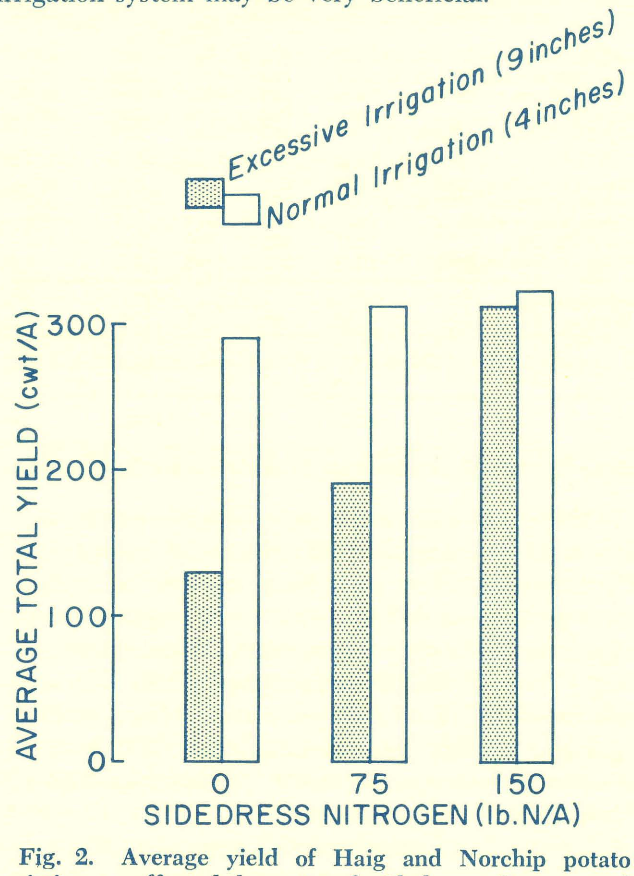

Fig. 2. Average yield of Haig and Norchip potato varieties as affected by rate of sidedress nitrogen and irrigation level (Monroe Co. 1970).

Nitrogen Sources

Many studies have been conducted to evaluate the effect of nitrogen sources on crop production. Lorenz and Johnson (7) reported that ammonium sulfate was a much better source of nitrogen for potatoes than calcium nitrate or sodium nitrate. These studies were conducted on slightly alkaline coarse-textured soils in California. The residual acidity produced by ammonium sulfate increased the water-soluble phosphate in the soil resulting in better phosphorus uptake.

A study was initiated at the Montcalm Experimental Farm to evaluate five nitrogen sources on yield and specific gravity of potatoes. Yield results are shown in Table 4. Some variability due to time of application and placement was observed, however the differences were not significant. Equal yields were obtained with all nitrogen sources. Specific gravity was not affected. Continued use of these nitrogen fertilizers should result in soil pH changes, which may ultimately affect yields and specific gravity.

Table 4. Effect of nitrogen sources on yield of irrigated Russet Burbank and Sebago potatoes

	Total Yield (cwt/A)				
Source of Nitrogen (a)	1967	1968	1969	1970	Average
		Russet Burbank			
Ammonium Sulfate (20.5% N)	203	270	282	282	259
Ammonium Nitrate (33.5% N)	227	256	267	294	261
Calcium Nitrate (16% N)	211	255	226	246	234
Urea (45% N)	183	283	252	294	253
Anhydrous Ammonia (82% N)	—	264	313	257	—
		Sebago			
Ammonium Sulfate (20.5% N)	270	298	340	342	312
Ammonium Nitrate (33.5% N)	249	295	310	362	304
Calcium Nitrate (16% N)	222	308	314	370	304
Urea (45% N)	247	321	340	374	320
Anhydrous Ammonia (82% N)	—	298	388	378	—
Least Significant Difference (.05)	NS	NS	NS	NS	—

(a) Applied at rates of 125 lb N/A in 1967-69 and 200 lb N/A in 1970.

Rate, Placement and Time of Potassium Application

In this study yield differences, specific gravity and plant nutrient composition of potatoes at various rates of potassium fertilizer using three methods of application were measured. Significant yield responses were limited to the first two increments of potassium applied (Table 5). In 1967 the highest yields were obtained with 120 lb. of K_2O per acre, however, in 1969 the highest yields were obtained with 480 lb. The Sebago variety responded better to larger amounts of potassium than Russet Burbank.

Differences due to placement are not readily apparent (Figure 3). Broadcasting appears to be superior at the 60 and 240 lb. rate, while banding was the best method at the 120 lb. rate. Four years of data were not available for the fall applied potassium treatment, but equal yield responses were obtained in 1968-69.

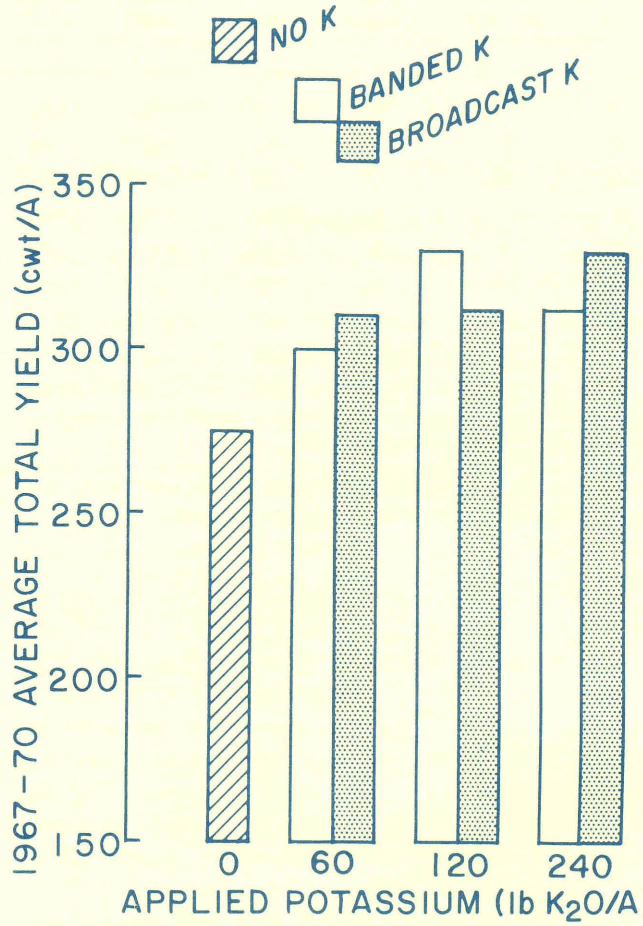

Fig. 3. Average yield of irrigated Russet Burbank and Sebago potatoes as affected by rate and placement of potassium (1967-70).

Proper placement of potassium has been of interest for many years. Cummings and Hougland (2) studied 13 methods of potassium placement from 1931-37. Placement immediately under, above or mixed with the soil around the seed piece delayed emergence of the sprouts and sometimes reduced yields. Proper placement was found to be in bands 2 in. to the side and slightly below the seed. Hawkins (5) found that sidedressing one half of the potassium resulted in slightly better yields than when all of the potassium was banded.

Potato quality as measured by specific gravity shows significant decrease with increasing rates of potassium (Table 6). Similar results have been reported by other workers (8, 10, 15). Specific gravity was not significantly affected by method of application.

Plant analysis, in addition to soil testing, is becoming a valuable tool for assessing the fertilizer require-

Table 5. Effect of rate and placement of potassium on yield of irrigated Russet Burbank and Sebago potatoes

Potassium Application (a) Broad-cast	Banded	Total	Russet Burbank 1967	1968	1969	1970	Average	Sebago 1967	1968	1969	1970	Average	Overall Average
			Total Yield (cwt/A)										
0	0	0	201	218	281	314	254	210	268	360	338	294	274
0	60	60	212	247	311	337	276	226	303	422	383	334	305
0	120	120	275	260	327	346	302	300	325	412	395	358	330
0	180	180	242	240	318	366	292	291	314	427	417	362	327
0	240	240	212	272	320	362	292	208	318	430	423	345	318
360	120	480	228	251	341	351	293	232	294	448	394	342	318
60	0	60	201	262	317	318	274	263	315	413	389	345	310
120	0	120	246	253	331	343	293	233	318	445	416	353	323
240	0	240	253	249	332	340	294	291	307	447	436	370	332
240F (b)	0	240	—	529	329	—	—	—	316	458	—	—	—
Least Significant Difference (.05)			73	44	35	48	—	73	44	35	48	—	—

(a) Applied as muriate of potash (60% K_2O) either broadcast and plowed down prior to planting or banded 2 in. to the side and slightly below the seed at planting time.

(b) Muriate of potash applied to a rye cover crop in the fall preceding potatoes.

Table 6. Effect of rate and placement of potassium on specific gravity of irrigated Russet Burbank and Sebago potatoes

Potassium Application (a) Broad-cast	Banded	Total	Russet Burbank (b) 1967	1969	1970	Average	Sebago (b) 1967	1969	1970	Average	Overall Average
			Specific Gravity								
0	0	0	1.091	1.084	1.082	1,086	1.090	1.074	1.071	1.078	1.082
0	60	60	1.090	1.082	1.081	1.084	1.089	1.073	1.073	1.078	1.081
0	120	120	1.091	1.082	1.082	1.085	1.089	1.071	1.070	1.077	1.081
0	180	180	1.089	1.080	1.078	1.082	1.087	1.072	1.070	1.076	1.079
0	240	240	1.086	1.080	1.080	1.082	1.084	1.070	1.070	1.075	1.078
360	120	480	1.089	1.078	1.075	1.080	1.084	1.065	1.065	1.071	1.076
60	0	60	1.090	1.083	1.084	1.086	1.091	1.072	1.073	1.079	1.082
120	0	120	1.089	1.081	1.081	1.084	1.088	1.074	1.068	1.077	1.080
240	0	240	1.088	1.080	1.078	1.082	1.086	1.072	1.069	1.076	1.079
240F (c)	0	240	—	1.081	—	—	—	1.070	—	—	—
Least Significant Difference (.05)			.003	.004	.004	—	.003	.004	.004	—	—

(a) Applied as muriate of potash (60% K_2O) either broadcast and plowed down prior to planting or banded 2 in. to the side and slightly below the seed at planting time.

(b) Specific gravity data for 1968 are not available.

(c) Muriate of potash applied to a rye cover crop in the fall preceding potatoes.

ments of potatoes. Interpreting plant analyses is difficult because nutrient composition varies with sampling time and the plant part selected for analysis.

The potassium, calcium and magnesium content of petioles at various stages of growth are recorded in Table 7. Early in the season the potassium content of petioles was very high regardless of the potassium treatments. As the season progressed, the potassium content decreased, while calcium and magnesium increased. The opposite trend was observed with increasing rates of potassium (Figure 4). A great deal of variability existed from year to year (96-day sampling in 1967 vs 97-day sampling in 1968).

Figure 5 is based on the yields in Table 5 and the potassium content values in Table 7. The sufficiency range was obtained by plotting the potassium content against the percent of maximum yield for each year and adjusting to average yearly conditions. All yields above the 95% maximum level were included in the sufficiency range. Potassium values below or above

Table 7. Effect of potassium fertilizer and sampling date on nutrient content of potato leaf petioles

Pounds K_2O (a) per acre	1967 56 days	1967 76 days	1967 97 days	1968 60 days	1968 96 days	1969 62 days	1970 71 days	Midseason Average (b)
	% Potassium							
0	9.04	6.32	2.69	9.70	6.27	8.92	4.58	7.38
60	11.30	6.43	3.07	10.05	6.46	10.88	6.80	8.54
120	11.55	7.01	4.01	10.38	7.45	12.54	7.92	9.46
180	12.14	8.21	5.19	10.41	7.53	—	9.42	—
240	12.44	9.38	5.98	12.80	8.61	14.14	9.44	11.44
480	12.78	10.61	7.64	11.61	9.52	14.82	10.84	11.97
Least Significant Difference (.O5)	0.52	0.30	0.23	0.93	0.73	1.66	.88	—
	% Calcium							
0	1.22	1.39	1.59	0.64	0.95	1.08	1.10	1.05
60	0.99	1.35	1.67	0.63	1.11	0.94	0.94	0.96
120	1.09	1.36	1.73	0.64	1.00	0.82	0.87	0.92
180	0.93	1.35	1.71	0.70	0.81	—	0.80	—
240	1.03	1.25	1.61	0.61	0.84	0.81	0.74	0.85
480	1.05	1.22	1.66	0.56	0.83	0.72	0.66	0.79
Least Significant Difference (.05)	NS	NS	NS	NS	NS	0.14	0.12	—
	% Magnesium							
0	0.82	1.38	1.69	0.14	1.19	0.97	1.33	0.96
60	0.61	1.39	1.96	0.10	1.36	0.72	1.02	0.81
120	0.66	1.26	1.68	0.10	1.09	0.63	0.72	0.68
180	0.47	1.14	1.53	0.17	0.99	—	0.60	—
240	0.47	0.87	1.27	0.14	1.00	0.50	0.45	0.49
480	0.49	0.80	1.22	0.14	0.67	0.41	0.39	0.44
Least Significant Difference (.05)	NS	.27	.55	NS	NS	.11	.15	—

(a) All potassium treatments were banded except the 480 lb rate where 360 lb K_2O per acre were broadcast and plowed down.
(b) Average of the 76, 60, 62 and 71 day samplings for 1967-70, respectively.

this range should produce something less than 95% of the maximum yield. The sufficiency range for the midseason average was 8-12% potassium. Similar standards have been developed in California by Tyler and Lorenz (16).

Zinc Study

Zinc deficiency in potatoes has been reported on alkaline soils (1, 14). Boawn and Leggett (1) observed phosphorus induced zinc deficiency on Russet Burbank potatoes.

A study was conducted to evaluate several zinc sources at two phosphorus levels. Yields were not affected by the application of zinc regardless of the phosphorus level or zinc material (Table 8). Some yield depression due to applied zinc was observed at this location with Charlevoix red kidney beans in 1969 and Sanilac navy beans in 1970. Although Sanilac navy beans are more sensitive to zinc deficiency than other varieties or crops, they are also less tolerant of high zinc levels in soils (9).

This soil initially contained 6 ppm (parts per million) of 0.1 N HC1 extractable zinc. Soltanpour *et al.* (14) found no zinc response on alkaline soils with more than 5.5 ppm of extractable zinc. The use of zinc without a soil test can lead to a build up of this element in soils resulting in long lasting detrimental effects.

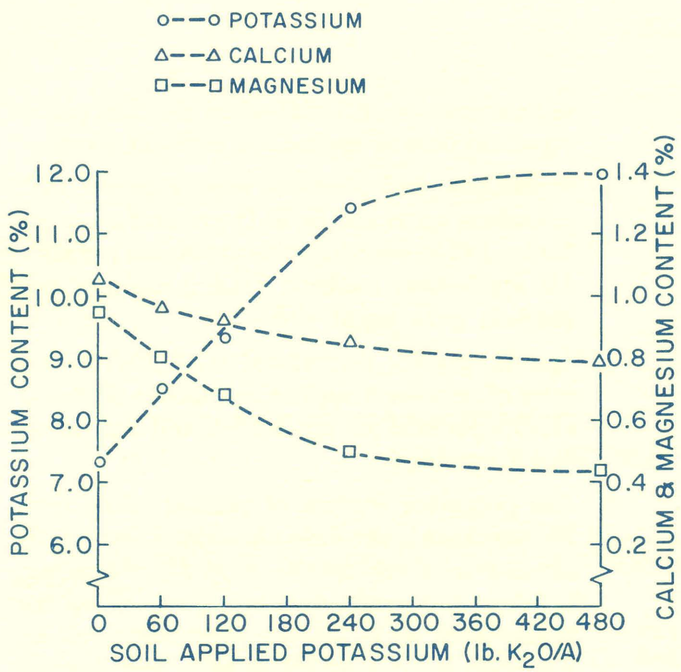

Fig. 4. Potassium, calcium and magnesium content of potato petioles sampled at midseason as affected by rate of soil applied potassium.

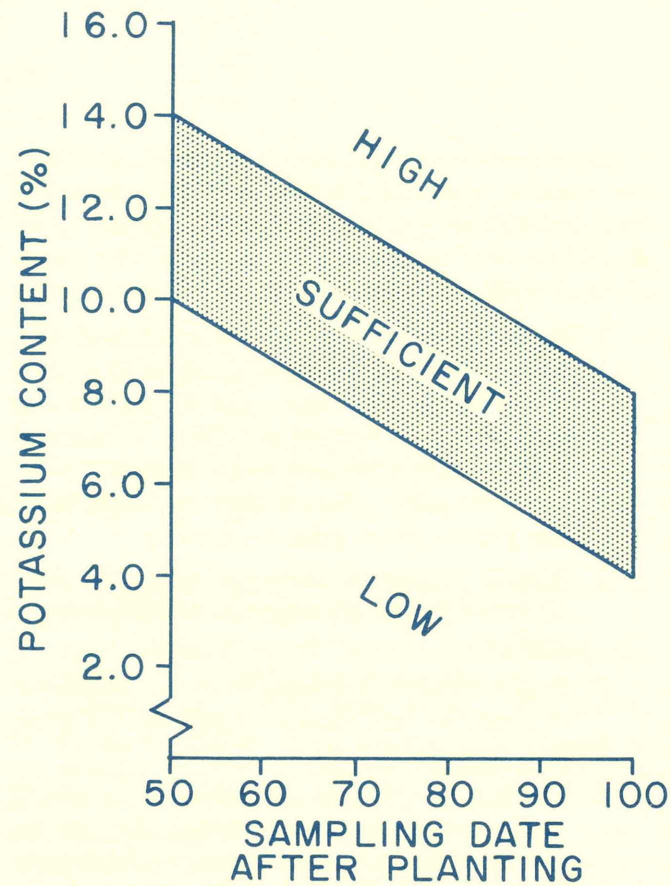

Fig. 5. Suggested guide for interpreting the potassium content of potato petioles taken from the fourth leaf from the growing tip at various sampling dates.

Table 8. Effect of zinc treatments at two soil phosphorus levels on yield and specific gravity of irrigated Russet Burbank potatoes

Zinc Treatment (lb Zn/A)	Year 1967	1968	1969	1967	1968	1969	Overall Average
	High P (a)			Low P (b)			
			Total Yield (cwt/A)				
None	268	356	377	204	330	367	317
25 lb ($ZnSO_4$ Broadcast)	238	333	367	232	305	377	309
50 lb (AZCO C100 Broadcast)	219	347	381	200	295	374	303
5 lb (AZCO 12 Banded)	232	315	385	244	350	372	316
5 lb ($ZnSO_4$ Banded)	235	—	397	198	—	392	—
Least Significant Difference (.05)	NS	NS	NS	NS	NS	NS	NS
			Specific Gravity				
None	1.084	1.084	1.079	1.084	1.083	1.079	1.082
25 lb ($ZnSO_4$ Broadcast)	1.084	1.082	1.075	1.083	1.082	1.077	1.080
50 lb (AZCO C100 Broadcast)	1.088	1.081	1.076	1.086	1.081	1.078	1.082
5 lb (AZCO 12 Banded)	1.086	1.084	1.078	1.084	1.080	1.078	1.082
5 lb ($ZnSO_4$ Banded)	1.088	—	1.078	1.085	—	1.077	—
Least Significant Difference (.05)	NS	NS	NS	NS	NS	NS	NS

(a) High P = 687 lb P_2O_5 per acre broadcast prior to initiation of the experiment.
(b) Low P = 50 lb P_2O_5 per acre banded each year.

SUMMARY

Experiments were conducted in Montcalm and Monroe counties to evaluate source, rate, placement and time of fertilizer application on yield, specific gravity and nutrient composition of potatoes. The results of these studies are summarized as follows:

1. Significant yield increases were obtained with 60 and 120 lb. N per acre regardless of method of application. The highest yields were obtained with 60 lb. of N banded and 120 lb. sidedressed prior to hilling. Banded and sidedressed nitrogen were more efficient than broadcast nitrogen plowed down prior to planting.
2. Specific gravity of tubers was not significantly affected by rate, placement or time of nitrogen application.
3. Russet Burbank and Sebago varieties responded similarly to rate, placement and time of nitrogen application.
4. The loss of nitrogen in sandy soils is related to the amount of water filtering through the soil. Excessive irrigation or heavy rainfall early in the season when evapotranspiration is minimal can cause considerable nitrogen losses on sandy soils.
5. Neither yields nor specific gravity were significantly affected by nitrogen sources. All sources gave equal yields when the rate, placement and time of application were the same.
6. Significant yield increases were obtained with potassium up to 120 lb. K_2O per acre on a soil having 249 lb. exchangeable potassium per acre. All application methods (fall, broadcast and banded) gave equal yields.
7. Specific gravity decreased with increasing rates of potassium applied as muriate of potash (KC1). Method of application did not affect specific gravity.
8. The potassium content of petioles taken from the youngest most fully developed leaves decreased from 50 to 100 days after planting. Calcium and magnesium increased during the same period. Increasing the potassium fertilizer, increased the potassium content, but lowered the calcium and magnesium content.
9. The potassium sufficiency range for a midseason petiole sampling (65 days after planting) was 8-12% potassium.
10. Yields were not affected by the application of zinc regardless of the soil phosphorus level or zinc material. In the McBride sandy loam soil 6 ppm of 0.1N HC1 extractable zinc was sufficient for optimum production.

ACKNOWLEDGMENT

The author expresses his appreciation to James Oaks and Keith Janssen for supervision and care of the crops, to E. C. Doll, R. J. Crabtree and C. Valverde for collection of the data in 1967-68, to the International Minerals and Chemical Corp. for the emission spectrographic plant analysis in 1969-70, the American Zinc Co. and to other fertilizer companies for their support.

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(2) Dunbar Forest Experiment Station, Sault Ste. Marie. Established 1925, forest management.

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(10) Ferden Farm, Chesaning. Plots established 1928. Soil management, with special emphasis on sugar beets. (Land Leased)

(11) Montcalm Experimental Farm, Entrican. Established 1966. Research on crops for processing, with special emphasis on potatoes. (Land Leased)

(12) Sodus Horticultural Experiment Station, Sodus. Established 1954. Production of small fruit and vegetable crops. (Land Leased)

(13) Trevor Nichols Experimental Farm, Fennville. Established 1967. Studies related to fruit crop production with emph sis on pesticides research.

(14) Saginaw Valley Beet and Bean Research Farm, Saginaw. Established 1971. Studies related to production of sugar beets and dry edible beans in rotation programs.

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