UNIVERSITY OF IDAHO
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Fertilizer Studies on Russet Burbank Potatoes in Southern Idaho

L. I. PAINTER
G. ORIEN BAKER

IDAHO Agricultural Experiment Station

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Recommendations

THE RESULTS obtained from the fertilizer trials on potatoes reported in this bulletin warrant the following general recommendation for similar soil and management conditions:

1. Potatoes following alfalfa where 15 tons or more of manure is applied before plowing—**No commercial fertilizer is recommended.**
2. Potatoes following alfalfa which had not been phosphated or received manure before plowing—**Apply 40 pounds of nitrogen, 80 to 120 pounds of available P_2O_5 per acre.**
3. Second-year potatoes where 15 tons or more manure has been applied—**No commercial fertilizer is recommended.**
4. Second-year potatoes where no manure is used—**Apply 80 pounds of nitrogen, 60 to 120 pounds of available P_2O_5 per acre.**
5. Potatoes on new land just cleared from sagebrush—**Apply 80 pounds of nitrogen per acre.**
6. Potatoes on new land previously dryfarmed to wheat—**Apply 80 to 120 pounds of nitrogen and 60 pounds of available P_2O_5 per acre.**
7. Potatoes grown on land which has a high level of available P_2O_5 by the soil test—**Apply 80 to 120 pounds of nitrogen per acre.**

For Complete Information See---

Fertilizer Studies on Russet Burbank Potatoes in Southern Idaho

L. I. PAINTER[1] and G. ORIEN BAKER[2]

THE use of commercial fertilizers to supply plant nutrients for potatoes has increased five-fold during the last 10 years. Intensified farming practices, in conjunction with declining soil fertility, have forced the farmer to supplement barnyard manure and crop rotations with commercial fertilizers.

Nitrogen (N) and phosphate (P_2O_5) have been the fertilizers primarily used, but in some areas potash (K_2O) has been incorporated into the general fertilizer treatment. Crop responses to the nitrogen and phosphate fertilizers have been quite evident, but to date there has been very little justification for the application of potash in southeastern Idaho. Calculations based on the K_2O content of water obtained from the Snake River and wells on the Snake River plain have shown that approximately 70 pounds K_2O per acre (6) are supplied to the soil by a season's irrigation water, assuming 3 acre feet of water are applied. Under these conditions it is very improbable that K_2O will become a limiting nutrient for potato production for a number of years.

Detailed studies of the influence of various fertilizer treatments on the yield and quality of potatoes were begun at the Aberdeen Branch Station in 1948. The data presented in this bulletin are the results of the trials conducted since that time.

Additional research (9) on potato fertilization was conducted at the Aberdeen Branch Station previous to the initiation of the investigations reported in this publication. Between 1939 and 1944, three tests were made on station land and four on farmers' land. Five of the test areas were plowed out of alfalfa or red clover, turning under the spring growth as green manure. The other two tests were on second-year potato land. The influence of manure, as well as commercial fertilizer, was determined in six of the experiments. Nitrogen and phosphorus were the main nutrients applied; the rate of application ranged from 35-50 pounds for nitrogen and 40-100 pounds P_2O_5 per acre.

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[1] Formerly Assistant Agronomist, Aberdeen Branch Station, University of Idaho.

[2] Professor of Agronomy (Soils), University of Idaho, Moscow.

The authors wish to acknowledge the assistance of C. A. Simkins, formerly Assistant Agronomist, Aberdeen Branch Station, in conducting the fertilizer tests in 1950 and 1951; and to E. T. Bullard, formerly Associate Horticulturist, Parma Branch Station, for supervising the test there in 1951.

The application of 8-10 tons of manure per acre had a greater influence on increasing potato yields than did the commercial fertilizer applied. A greater increase in yield following the application of manure was obtained on the second-year potato ground than where legumes were plowed down in the spring before planting.

The greatest response from fertilizer was obtained with the second-year potatoes on the unmanured land. A combination of nitrogen and phosphorus resulted in the greatest increase in yield. There was little response from fertilizer on either the manured or unmanured land which had legumes plowed under in the spring before planting.

Literature Review

Results obtained from 71 nitrogen tests conducted on farms at various locations in Idaho (7) revealed marked responses to fertilizer applications. Yield increases of 18-20 cwt. per acre were obtained by high rates of nitrogen fertilizer alone, but yields were increased an additional 20-30 cwt. per acre when P_2O_5 was applied with the nitrogen. Toevs and Baker (10) found that maximum response to nitrogen could be obtained only when the soil was well supplied with available phosphate. Soil tests performed by Ensminger and Larson (3) indicated that soils well supplied with available phosphorus contained at least 25 pounds an acre of CO_2 soluble P_2O_5 and would seldom respond to additional applications of phosphate.

Studies in Montana (4, 5) showed that nitrogen and potash fertilizers delayed the maturity of potatoes, but that phosphate alone hastened maturity. Other effects of phosphate applications were: early emergence in spring, larger root development combined with earlier and heavier set of tubers, smoother tubers of better shape and proportion, and heavier netting on the Russet Burbank variety.

In Nebraska (11) where manure and alfalfa sod were incorporated under irrigated rotations, no increase in yield was obtained with commercial fertilizers. Without manure or alfalfa, however, profitable responses were obtained from applications of nitrogen and superphosphate.

Tests conducted on the irrigated soils of the Kansas River Valley indicated that 150 pounds per acre of 15-30-0 produced a profit more consistently than did any other commercial fertilizer tested (1). The application of potash did not increase the yields sufficiently to pay for the added cost of the plant nutrient.

Most of this literature indicates that nitrogen and phosphorus fertilizes are usually the limiting fertilizer elements for potato production in the Intermountain Region of the Pacific Northwest. Potash is probably the third critical element, but becomes limiting only after periods of prolonged intensive cultivation.

Experimental Procedure

The tests were conducted on land of cooperating farmers, and no control was exercised over the planting, cultivation, and irrigation procedures. The fertilizer treatments were banded on either side of the seedpiece immediately after planting and the cooperating farmer then carried out his customary farming practices. Care was taken to select soil types and crop sequences representative of the potato culture of the area.

In all tests, nitrogen, phosphate, and potash fertilizers were applied in various combinations. The tests were designed to show the main effect of each fertilizer nutrient and to indicate the desirable ratios necessary for maximum yield and highest tuber quality.

Soil tests were made on representative samples of the experimental plots and compared to fertilizer response. Chemical determinations made in the soil tests were pH, total nitrogen and available P_2O_5.

The tubers were harvested with a one-row digger, picked up by hand, and stored for approximately 60 days. Grade determinations were then made for U. S. No. 1, undersized, pointed-end and bottle neck, growth-cracked, and knobby tubers. Specific gravity determinations of the tubers were made on representative samples from each plot. The specific gravity calculations were made by the air and water weight method. That is, the weight in air divided by the weight in air minus the weight in water.

Results

Fertilizer Study—Southwestern Idaho

The fertilizer test was established in southwestern Idaho in 1951 on the Henry Iverson farm near Notus. Soil analysis of the Greenleaf silt loam was as follows: pH,8.3; total nitrogen 0.12%; and CO_2 extractable P_2O_5, 100 pounds per acre. Fertilizer material was banded 2 inches from the seed piece and at about the same depth as the seed piece. The yield data are given in Table 1.

Significant increases in total yield and U. S. No. 1 tubers were obtained by the use of nitrogen. Eighty pounds of nitrogen was as effective in increasing yields as the 120- and 160-pounds application. Phosphate fertilizers did not significantly increase the yield as would be expected with the large amount of available P_2O_5 already present in the soil. The addition of potash with nitrogen and phosphate did not significantly increase the total yield of potatoes over the corresponding treatment without potash. The same was true for U.S. No. 1 with the exception that with the 160-pound

rate of nitrogen the addition of potash did significantly increase the yield.

The fertilizer treatment had no significant influence on the percentage of culls, pointed-end and bottleneck tubers. It was observed that the plots not receiving nitrogen resulted in many undersized potatoes. The high application rates of nitrogen significantly increased the amount of knobby tubers.

The specific gravity of the tubers was significantly decreased by the use of 120 and 160 pounds of nitrogen. There was an indication that the addition of 40 pounds of K_2O reduced the specific gravity but the difference was not significant.

Table 1.—Effect of nitrogen, phosphate and potash fertilizers on total yield and yield of U. S. No. 1 potato tubers.
Henry Iverson Farm, Notus, Idaho, 1951

Treatment Lbs/Acre			Yield of tubers	
N	P_2O_5	K_2O	Total Cwt/A	U. S. No. 1 Cwt/A
0	0	0	244	187
80	0	0	319	248
120	0	0	312	237
160	0	0	317	224
0	0	40	260	202
80	0	40	274	214
120	0	40	319	242
160	0	40	319	274
120	80	0	306	231
120	80	40	324	222
L.S.D. 5% level			39.0	28.0
L.S.D. 1% level			52.3	36.0

Fertilizer Placement Studies

The two common methods of applying fertilizer to potatoes are: (1) broadcasting on the field and working it into the soil prior to planting, and (2) banding on either side of seed pieces simultaneous with the planting operation or immediately after planting. Both methods have had strong advocates in different areas, but little has been known as to which method afforded the most efficient utilization of the fertilizer.

The two methods of fertilizer placement were compared in 1951 on the Craig Hansen farm near Aberdeen. The experimental land had been previously cropped to alfalfa for 3 years and during this time had received an annual application of 200 pounds of treble superphosphate per acre. The soil was classified as a Declo silt loam and had the following chemical characteristics: pH, 8.2; total nitrogen, 0.15%; and CO_2 extractable P_2O_5, 40 pounds per acre.

A second trial was conducted in 1954 on the Aberdeen Branch Station. The soil utilized for this test was classified as a Declo loam and Declo sandy loam, slope phase. Soil tests on representa-

tive samples collected at the time of planting showed the following values: pH, 7.8; total nitrogen, 0.12%; and CO_2 extractable P_2O_5, 30 pounds per acre.

Observations on vine growth during the growing season indicated an apparently greater response to band fertilizer application than broadcast applications. This apparent response, however, was not evident in either total yields or yield of U. S. No. 1 tubers produced as shown in Table 2.

The land utilized for the 1951 test was quite high in fertility, and there was no response to either fertilizer applications or method of placement. The land used in 1954 was lower in fertility and both

Table 2.—Comparison of broadcast with banding method of applying nitrogen and phosphate fertilizers on total yield* of Russet Burbank potatoes.

Craig Hansen Farm—Aberdeen—1951			
Fertilizer applied— pounds per acre.		Yield of tubers, cwt./acre Method of placement	
N	P_2O_5	Broadcast	Band
0	0	252	257
40	0	257	263
80	0	257	233
120	0	256	259
40	80	253	257
80	80	268	270
120	80	255	267

No significant difference in method.

Aberdeen Branch Station—1954				
Fertilizer applied— pounds per acre.			Yield of tubers, cwt./acre Method of placement	
N	P_2O_5	K_2O	Broadcast	Band
0	0	0	225	230
80	60	0	269	317
160	120	0	264	286

No significant difference in method.

* Average of 3 replications.

total yield and yields of U. S. No. 1 tubers was significantly increased by fertilizer applications, but no differences resulted from method of placement.

Under the experimental conditions of these two trials, broadcast and band placement proved equally effective for fertilizer applications.

Studies with "Tagged" Treble Superphosphate[1]

Potatoes fertilized with commercial phosphate obtain phosphorus from both the supplied material and that phosphorus native in the soil as minerals and organic matter. Tagged P_2O_5, treble superphosphate containing radioactive P^{32}, can be used to determine what portion of the plant's phosphorus came from the applied material and what part came from the native soil phosphorus.

[1] This work conducted under the supervision of J. V. Jordan, Department of Agricultural Chemistry, University of Idaho.

In 1950, a test was established at the Aberdeen Branch Station to determine what portion of the tuber's phosphorus was supplied by native soil phosphorus and what portion from treble superphosphate, broadcast or banded on the test plots. The soil utilized for the test was a Declo loam which had a pH, 7.8; total nitrogen content, 0.09%; and CO_2 extractable P_2O_5, 12-40 pounds per acre.

Tagged treble superphosphate was applied by two methods: (1) band treatments were placed 4 inches to one side and 4 inches below the seed piece; and (2) broadcast treatments were applied 3 feet on each side of the row and incorporated into the surface 4 or 5 inches by disking. Non-radioactive treble superphosphate treatments were similarly applied.

Potato tubers supplied with P_{32} tagged treble superphosphate, obtained significantly more phosphorus from the broadcast treatment than the band (Table 3). The results also indicated that the tubers obtained significantly more native soil phosphorus from the plots that had received the broadcast application of tagged treble superphosphate. The yield of tubers was not significantly affected by placement or fertilizer applications. The soil test indicated that nitrogen was probably more limiting than phosphate, hence the absence of response to phosphate fertilization.

In 1954, another test was conducted to determine the effect of applied nitrogen fertilizer on tuber uptake of tagged P_2O_5. This test was conducted on land which had a pH of 7.8; total nitrogen, 0.12%; and CO_2 extractable P_2O_5, 30 pounds per acre. The field had been in grass for several years and had not been cropped to potatoes for at least eight years. Nitrogen and tagged treble superphosphate were banded near the seed piece immediatly after planting.

The total yield of tubers in this test was significantly increased by the nitrogen treatments but was not affected by the phosphate applications. Analysis of the tubers (Table 4) showed that the P_2O_5 content of the tubers was significantly increased by both phosphate and nitrogen applications. The greatest uptake of tagged P_2O_5 was found in tubers fertilized with 60 pounds of nitrogen and 120 pounds of tagged P_2O_5 per acre.

The results of this test indicated that potatoes heavily fertilized with nitrogen utilized significantly more phosphate than those receiving no nitrogen. Under such conditions, phosphate deficiencies would rapidly occur and the soil would require phosphate fertilization for maximum production.

Fertilizer Studies on Second-Year Potato Ground

The production of potatoes for two successive years on the same land is a common practice in southeastern Idaho. The usual practice, when manure is available, is to apply10-15 tons of barnyard manure per acre just prior to planting the second crop of potatoes. Although the addition of barnyard manure has proven to

Table 3.—Uptake of P_2O_5 by Russet Burbank Potatoes from band and broadcast placement of tagged treble superphosphate, Aberdeen Branch Station, 1950.

P_2O_5 content of tubers at harvest time	Method of placement and rate of P_2O_5 applied (lbs/acre)		
	Check	40 Band	40 Broadcast
P_2O_5 recovered from fertilizer (lbs/A)	.....	0.121	0.211
P_2O_5 uptake from soil (lbs/A)	8.53	18.52	25.21

L.S.D. for fertilizer recovered 5% = 0.057; 1% = 0.132
L.S.D. for P_2O_5 uptake from soil 5% = 10.05; 1% = 13.90

Table 4.—Effect of nitrogen and phosphate applications on P_2O_5 uptake of Russet Burbank tubers from Aberdeen Branch Station, 1954.

Nitrogen applied (lbs/acre)	Uptake of P_2O_5 by tubers from applied fertilizer (lbs/A)	
	P_2O_5 applied (lbs/acre) 60	120
0	9.36	15.39
60	15.02	33.88
120	21.45	30.76

L.D.S. 5% = 7.51; 1% = 10.24

be profitable, there still remained the question as to whether similar or additional benefits could be obtained by the application of commercial fertilizers in lieu of or in addition to the manure.

In 1951, a test was established on the Ferd Dalke farm near Aberdeen. The land on which this experiment was conducted had been in potatoes the preceding year and 15 tons of manure per acre had been applied prior to planting. Soil analysis of this Declo silt loam revealed the following characteristics: pH, 8.2; total nitrogen, 0.15%; and CO_2 extractable P_2O_5, 16-24 pounds per acre. Fertilizer materials were banded 2 inches to the side and 4 inches below the seed piece immediately after planting.

The fertilizer applications resulted in definite differences in vine growth almost immediately after the potato plants emerged from the soil. Phosphorus treatments appeared to produce the healthiest and most vigorous plants, although nitrogen treatments produced plants which were superior in vigor and color to the check plants. Nitrogen and phosphate treatments also appeared to delay the onset of early dying (Verticillium wilt) which eventually caused the potato vines to die.

The increased vine growth from nitrogen and phosphate fertilizer did not affect the production of potato tubers (Table 5). Evidently the application of 15 tons manure per acre supplied plant nutrients in amounts adequate for tuber production. The percentage of U. S. No. 1 tubers was very low on this test, but was probably not a result of the fertilizer treatments as unfavorable weather conditions prevailed throughout the growing season and the majority of potatoes produced in the Aberdeen area were rough and knobby.

Table 5.—Effect of nitrogen, phosphate, and potash fertilizers on total yield and yield of U. S. No. 1 tubers of Russet Burbank potatoes grown on second-year potato land which received manure, Fred Dalke Farm, Aberdeen, 1951.

Treatment	Yield of tubers	
lbs/acre N-P_2O_5-K_2O	Total cwt/A	U. S. No. 1 cwt/A
0-0-0	240	73
80-0-0	248	62
120-0-0	224	58
80-80-0	282	72
120-80-0	280	67
80-80-40	280	79
120-80-40	269	62
160-80-40	280	56
0-80-40	264	63
0- 0-40	250	78

No significant differences

The production of two successive crops of potatoes without manure is practiced extensively in various parts of Idaho. Consequently, in 1954, a test was established on the Marvin Parrish farm at Aberdeen to determine optimum fertilizer rates for maximum production under such cropping conditions. The land selected for test was a Sagemoor silt loam which had been cleared of sagebrush in 1952. The land had been cropped to potatoes in 1953 and had received a nitrogen application of approximately 60 pounds per acre at that time. Soil analysis from the plot area had the following chemical characteristics: pH, 7.7; total nitrogen, 0.12%; and CO_2 extractable P_2O_5, 42 pounds per acre.

Three rates of nitrogen, phosphate, and potash were applied in a factorial completely radomized block design. The fertilizers were banded on either side of the seed piece immediately after planting.

The total yield and yield of U. S. No. 1 grade tubers were significantly increased by both the nitrogen and phosphate applications (Table 6). The best fertilizer treatment, based on yield of U. S. No. 1 tubers produced, appeared to result from 80 pounds of nitrogen (15.2 cwt/A) and 60 pounds of P_2O_5 (13.6 cwt/A). Total increase from the application of both nitrogen and P_2O_5 was 28.8 cwt of U. S. No. 1 tubers per acre. An additional 60 pounds of P_2O_5, a total of 120 pounds per acre, increased the yield of U. S. No. 1 tubers, but it is doubtful if the increased yield justified the increased expenditure for fertilizer.

The data from Table 5 and previous tests showed that applications of commercial fertilizers were not beneficial on second-year potato land when manure was applied at the rate of 15 tons per acre. When manure was not utilized, however, highly economical responses were obtained with an application of 80 pounds of nitrogen and 60 pounds of P_2O_5 per acre.

Fertilizer Studies on Potatoes after Alfalfa

The general crop rotation in the Aberdeen area has been alfalfa

Table 6.—Effect of nitrogen, phosphate, and potash fertilizer* on total yield and yield of U. S. No. 1 Russet Burbank potatoes. Potatoes grown on second-year potato land without manure. Marvin Parrish farm, Aberdeen, 1954.

	Fertilizer applied	Total yield (cwt/A)	Yield U.S. No. 1 tubers (cwt/A)
		N as Ammonium Sulfate	
	0	201.8	125.4
	80	224.3	140.6
	160	215.9	133.8
L.S.D. 5% level		15.0	11.6
L.S.D. 1% level		18.9	14.5
		P_2O_5 as Treble Superphosphate	
	0	196.5	122.9
	60	220.9	136.5
	120	224.6	140.6
L.S.D. 5%		15.0	11.6
L.S.D. 1%		18.9	14.5
		K_2O as Sulfate of Potash	
	0	210.0	131.2
	20	214.4	134.1
	40	216.8	134.8
L.S.D. 5%		no sig. diff.	no sig. diff.

* Fertilizers applied in a factorial completely randomized block design.

for 3 years, potatoes, potatoes or sugar beets, and then grain seeded as a companion crop with alfalfa. The Idaho recommendation has been to apply 200-300 pounds of treble superphosphate annually to the alfalfa and have the potatoes pick up the residual phosphate (10). Furthermore, the increased growth of alfalfa due to heavy phosphate fertilization results in more roots and crowns which supplies more organic material to the soil when the crop is plowed out. When this increased organic matter decomposes in the soil, more nitrogen is released for the row crop. When phosphate has not been applied to the alfalfa, it is necessary to apply either manure, or phosphate and nitrogen directly to the potato crop. The Idaho recommendation under such circumstances has been 40 pounds of nitrogen and 40-60 pounds of available P_2O_5 per acre (8).

Two trials were established on the J. W. Slaugh farm at Aberdeen in 1954 to determine the desirable rates of commercial fertilizer for potatoes planted after 3 years of alfalfa which had not been fertilized with phosphate. Commercial fertilizers were applied on unmanured land in one test by banding on either side of the seed piece immediately after planting. The soil was classified as Declo silty clay loam and had the following chemical characteristics: pH, 7.8; total nitrogen, 0.12% and CO_2 extractable P_2O_5, 15 pounds per acre. The analysis indicated that this soil was low in nitrogen and phosphorus.

The greatest increase of total yield and yield of U. S. No. 1 tubers

on unmanured land was affected by phosphate applications (Table 7). Phosphate applied at 80 or 160 pounds per acre significantly increased the yields over that of the check. Forty and 120 pounds of nitrogen per acre significantly increased the yields but the 80-

Table 7.—Effect of nitrogen, phosphate and potash fertilizers* without manure on total yield and yield of U. S. No. 1 Russet Burbank potatoes. Field had previously been in alfalfa and had not been fertilized with phosphate. J. W. Slaugh Farm, Aberdeen, 1954.

Fertilizer applied	Total yield (cwt/A)	Yield U.S. No. 1 tubers (cwt/A)
N as Ammonium Sulfate		
0	255.3	155.2
40	273.0	168.1
80	257.7	152.3
120	268.6	161.2
L.S.D. 5% level	11.6	8.3
L.S.D. 1% level	14.4	8.8
P_2O_5 as Treble Superphosphate		
0	241.5	143.0
80	270.3	163.9
160	279.2	171.1
L.S.D. 5% level	9.9	8.8
L.S.D. 1% level	12.4	11.0
K_2O as Sulfate of Potash		
0	264.6	159.5
40	267.6	163.6
80	258.5	154.8
L.S.D. 5% level	no sig. diff.	no sig. diff.

* Fertilizers applied in a factorial completely randomized block design.

pound application decreased the yields. Examination of the tubers for quality in terms of color and shape showed that 40 pounds of nitrogen was the best treatment. The 120-pound rate produced irregular shaped tubers that were very light in skin color.

Potash applications did not significantly affect the total yield or yield of U. S. No. 1 tubers.

The above data indicated that the most economical application of fertilizer for potatoes following alfalfa which had not received phosphate fertilizer was 40 pounds of nitrogen in conjunction with 80 pounds of available P_2O_5. Increased increments of fertilizer were not justified in terms of tuber yield and quality.

The same rates of fertilizer were applied along with 15 tons of manure per acre in the other test. The manure was incorporated into the soil prior to planting and the fertilizer treatments were banded on either side of the seed piece immediately after planting. Th soil was classified as Declo silty clay loam and had the following chemical characteristics: pH, 7.9; total nitrogen, 0.14%; and CO_2 extractable P_2O_5, 25 pounds per acre.

The application of commercial fertilizer in conjunction with 15 tons per acre of barnyard manure was not beneficial in terms of total yield or yield of U. S. No. 1 tubers (Table 8). Evidently 15 tons of manure supplied adequate nitrogen and P_2O_5 for the potato crop. Applications of nitrogen greater than 40 pounds per acre produced a light colored tuber that was very irregular in shape.

Table 8.—Effect of nitrogen, phosphate, and potash fertilizers* in combination with manure on total yield and yield of U. S. No. 1 Russet Burbank potatoes. Field had been previously in alfalfa and had not been fertilized with phosphate. J. W. Slaugh Farm, Aberdeen, 1954.

	Fertilizer applied	Total yield (cwt/A)	Yield U.S. No. 1 tubers (cwt/A)
		N as Ammonium Sulfate	
	0	232.7	140.3
	40	235.7	141.6
	80	235.4	141.6
	120	233.2	139.4
L.S.D. 5% level		no sig diff.	no sig diff.
		P_2O_5 as Treble Superphosphate	
	0	239.3	144.4
	80	237.1	142.7
	160	226.1	135.0
L.S.D. 5% level		no sig diff.	no sig diff.
		K_2O as Sulfate of Potash	
	0	229.4	139.4
	40	238.4	142.7
	80	234.9	140.0
L.S.D. 5% level		no sig diff.	no sig diff.

* Fertilizers applied in a factorial completely randomized block design.

Fertilizer Studies on New Land Under Sprinkler Irrigation

A large area of dry land west of Aberdeen has been placed under sprinkler irrigation during the last 5 years. The soils of this area are light in texture and are considered to be excellent for potato production. The general fertility of the area, however, has been considered to be low and commercial fertilizers, mainly nitrogen, have been utilized extensively.

Two experiments were conducted on the T. S. Vanderford farm west of Aberdeen. One test was established in 1953 on land which had been dry-farmed to wheat previously. The soil was classified as Sagemoor fine sandy loam and had the following chemical characteristics: pH, 8.0; total nitrogen, 0.10%; CO_2 extractable P_2O_5, 45 pounds per acre.

The total yield and yield of U. S. No. 1 tubers was significantly increased by the application of 80 and 160 pounds per acre of nitrogen and by 60 pounds of available P_2O_5 (Table 9). The yield with 120 pounds of P_2O_5 was significantly greater than the check,

Table 9.—Effect of nitrogen, phosphate and potash fertilizers* on total yield and yield of U. S. No. 1 tubers of Russet Burbank potatoes. Field previously cropped to dryland wheat. First crop under sprinkler irrigation. T. S. Vanderford Farm, Aberdeen, 1953.

	Fertilizer applied (lbs/A)	Total yield (cwt/A)	Yield U.S. No. 1 tubers (cwt/A)
		N as Ammonium Sulfate	
	0	172.5	103.3
	80	220.6	138.5
	160	236.3	142.2
L.S.D. 5% level		6.20	8.4
L.S.D. 1% level		9.36	10.9
		P_2O_5 as Treble Superphosphate	
	0	189.7	115.1
	60	220.6	140.4
	120	219.3	128.5
L.S.D. 5% level		6.20	8.4
L.S.D. 1% level		9.36	10.9
		K_2O as Muriate of Potash	
	0	209.7	131.1
	20	208.7	125.7
	40	211.3	127.4
L.S.D. 5% level		no sig. diff.	no sig. diff.

* Fertilizers applied in a factorial completely randomized block design.

but not significantly greater than the 60-pound application. The greatest increase in salable tubers resulted from an application of 80 and 160 pounds of nitrogen per acre in conjunction with 60 pounds of available P_2O_5. Potash fertilizer, even in combination with high rates of nitrogen and phosphate, did not significantly affect the yield of potatoes.

The second test, 1954, was conducted on the first crop after clearing the land of sagebrush. The soil was classified as Sagemoor loam and had the following chemical characteristics: pH, 7.8; total nitrogen, 0.13%; CO_2 extractable P_2O_5, 27 pounds per acre.

A significant increase in yield was obtained from the use of nitrogen (Table 10). The use of phosphate and potash did not increase the yield of tubers. The chemical tests indicated that the soil contained only 27 pounds per acre of CO_2 extractable P_2O_5 which is considered a level where a response for phosphate is usually expected. Intensive row cropping probably will soon deplete the available P_2O_5 in the soil and the land then will respond to phosphate applications.

Effect of Fertilizer Treatments on Quality of Potato Tubers

The market value of the Russet Burbank potato has been greatly influenced by the color and quantity of russeting, or netting, on the skin and by the specific gravity of the tuber which is an indi-

Table 10.—Effect of nitrogen, phosphate, and potash fertilizers* on total yield and yield of U. S. No. 1 tubers of Russet Burbank potatoes, newly cleared land under sprinkler irrigation, T. S. Vanderford farm, Aberdeen, 1954.

Fertilizer applied	Total yield (cwt/A)	Yield U.S. No. 1 tubers (cwt/A)
N as Ammonium Sulfate		
0	202.5	138.4
80	244.3	161.7
160	248.5	160.7
L.S.D. 5% level	18.8	13.2
L.S.D. 1% level	23.7	16.7
P_2O_5 as Treble Superphosphate		
0	223.7	150.2
60	231.1	150.2
120	240.5	160.3
L.S.D. 5% level	no sig. diff.	no sig. diff.
K_2O as Sulfate of Potash		
0	230.7	151.9
20	227.6	152.3
40	237.0	156.5
L.S.D. 5% level	no sig. diff.	no sig. diff.

* Fertilizers applied in a factorial completely randomized block design.

rect measurement of the starch content. Since starch is one of the important factors affecting mealiness, a measure of cooking quality, it can be assumed that specific gravity may be taken as a measure of this character (2). The importance of specific gravity determinations in terms of tuber quality warranted its calculation on all fertilizer trials conducted. The determinations were made by dividing the weight of the tubers in air by their weight in air minus their weight in water. The results from each individual test were inconclusive, but the results from all tests did indicate a general trend.

Nitrogen applications greater than 80 pounds per acre appeared to decrease the specific gravity of the tubers. This effect was greatly influenced by the cropping practices preceding fertilizer trials. High nitrogen applications on alfalfa land or in conjunction with manure resulted in greater decreases in specific gravity than identical treatments on second year potatoes or new land.

Phosphate applied in conjunction with nitrogen appeared to reduce the undesirable effects of higher rates of nitrogen.

Potash did not appear to affect the specific gravity of the tubers, consistently, but when applied with high rates of nitrogen, greater than 80 pounds per acre, it reduced the specific gravity in two of four tests.

Russeting, or netting of tubers, was visually observed on a number of trias. The general conclusion from these observations were that high rates of nitrogen reduced the russeting of tubers to some

extent. This effect was especially noticeable on soils originally high in nitrogen fertility. Phosphate alone did not improve netting on the tubers as compared with the check. Phosphate applied in conjunction with high rates of nitrogen produced tubers with better netting than that produced with high nitrogen alone. Potash fertilizer did not appear to affect the russeting of the tubers on any of the trials conducted.

Summary

A series of fertilizer trials were conducted on Russet Burbank potatoes in southern Idaho. The objectives of the trials were to determine the optimum amounts of nitrogen, phosphate, and potash fertilizers necessary for the production of maximum yields of high quality tubers. The majority of the trials were conducted in cooperation with local farmers in the area. A wide variety of soil types and cropping conditions were encountered.

The results of these trials were as follows:

1. Broadcast and band placement proved equally effective for fertilizer applications.
2. Utilization of applied and native soil phosphate was increased by nitrogen applications.
3. Nitrogen applications greater than 80 pounds per acre on fertile soils appeared to reduce the specific gravity of tubers and reduce skin netting.
4. Phosphate applied in conjunction with nitrogen appeared to reduce the undesirable effects of higher rates of nitrogen.
5. Yield increases were obtained with nitrogen and phosphate fertilizer only. The application of potash did not affect either yield or quality of tubers.

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