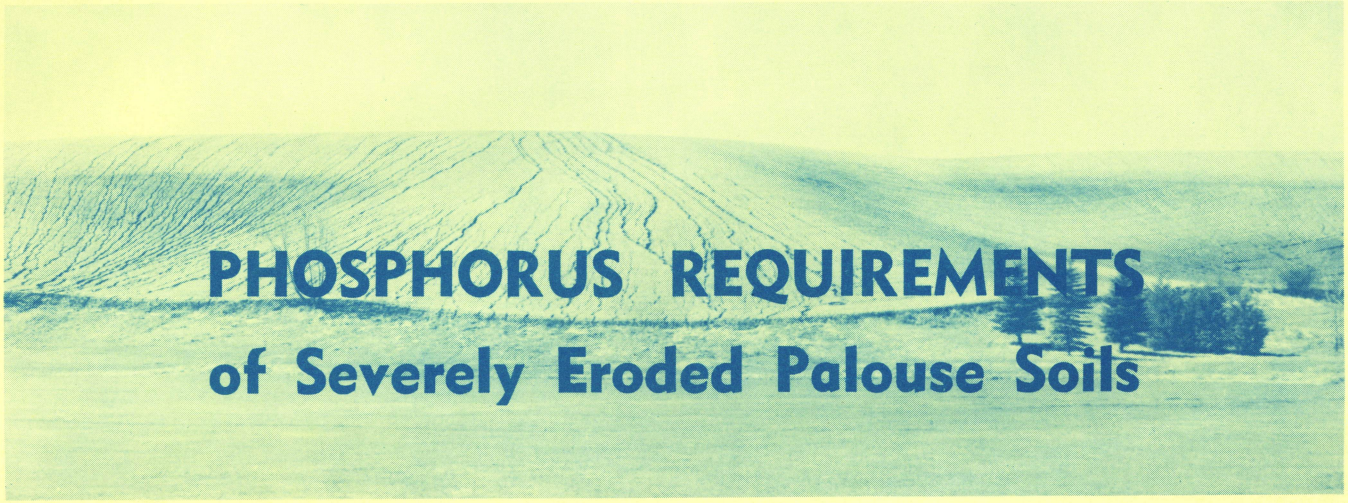

PHOSPHORUS REQUIREMENTS of Severely Eroded Palouse Soils

G. O. Baker, Roger Harder and David Van Houten

Over the years, there has been a gradual reduction in the available phosphorus of soils collected in the Palouse region for soil testing. In conjunction with this trend, a decline in the response of wheat on certain eroded hilltops to nitrogen fertilizer has been observed. This indicates that phosphorus may have become a limiting factor on certain soils in the Palouse.

1961 TRIALS SHOWED RESPONSE TO PHOSPHATE

Five fertilizer tests were set up in the spring of 1961 to determine whether phosphorus with or without nitrogen would increase wheat yields on eroded hilltops. The soil test levels of available phosphate ranged from 4.5 to 10.5 pounds of P per acre (10 to 24 pounds P_2O_5). Two tests showed significant yield increases of grain and straw from the use of phosphate and all 5 gave significant increases from the use of nitrogen fertilizer. The results are given in Table 1.

FURTHER TRIALS ESTABLISHED

For a more complete picture of the problem, a survey was made of the available phosphorus level of the thin, eroded soils between Genesee and Plummer, Idaho. Seventy-seven different locations were sampled in the fall of 1961 and available phosphorus was determined in the soil testing laboratory. Sixteen different soil series and 2 unnamed series were included in the survey.

The range in the available phosphorus content is shown below:

P lb/A	P_2O_5 lb/A	Number of samples
0- 4.4	0-10	14
4.8- 8.8	11-20	29
9.2-13.2	21-30	17
13.6-17.6	31-40	10
over 17.6	over 40	7

Eleven locations testing low in phosphorus were selected from 77 tested in the survey for locating the fertilizer studies to determine

Table 1. Wheat yield response to fertilizer treatments on 5 cooperator farms, 1961

Cooperator Number	Soil Type	Variety	Previous Crop	Fertilizer Treatment 0-0	60-0	120-0	0-60	60-60	120-60
1	Palouse CL	Brevor	Alf-gr	28.0	28.4	39.1	27.9	34.3	41.9
2	Brownlee CL	Brevor	Wheat	14.4	19.6	24.8	16.3	20.2	28.8
3	Garfield CL	Brevor	Sw cl	21.0	24.0	31.5	18.0	22.3	28.1
4	Garfield SiL	Omar	Sw cl	23.9	25.4	25.9	23.8	26.4	30.3
5	Brownlee CL	Omar	Alf-gr-Swcl	7.9	11.1	10.7	10.7	23.1	26.0
	AVERAGE			19.0	21.7	26.4	19.3	25.3	31.0

1. Suffered severe rill erosion in spring
3. Weed population reduced yield

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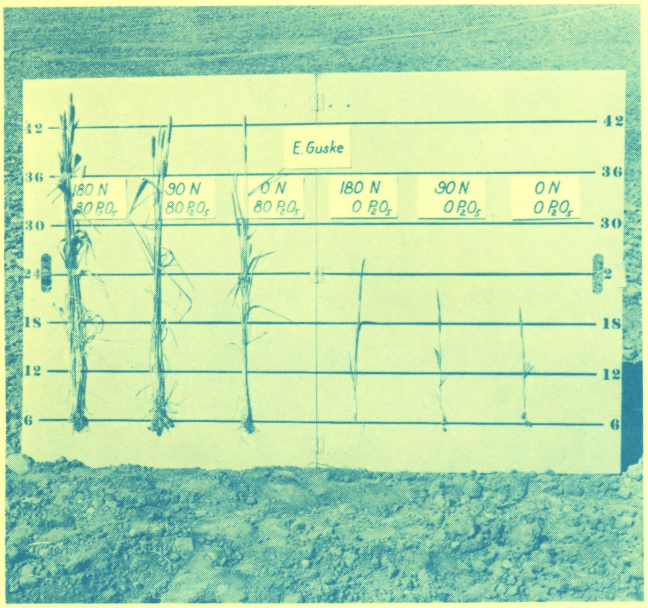

Figure 1. Influence of phosphorus on vigor and tillering of wheat plants on eroded hilltops, June 25, 1962.

whether phosphorus was a limiting factor in yields of winter wheat on eroded hilltops of the Palouse region. A uniform application of gypsum was made on the experimental areas to eliminate a possible sulfur deficiency.

Three rates of nitrogen—0, 90 and 180 pounds per acre—and 2 rates of phosphorus—0 and 35 pounds per acre (80 pounds of P_2O_5 per acre) — were used. Each treatment was replicated 4 times.

The soil test data are shown in Table 2. The phosphorus levels varied from a low of 3.1 pounds per acre of phosphorus (7 pounds P_2O_5) to a high of 7.5 pounds of phosphorus (17 pounds P_2O_5) per acre.

The potassium levels are relatively low but wheat has a very low requirement and except for a single site, potassium would probably not be a limiting factor in yield.

The organic matter is very low, which is normal for a soil that has lost its surface soil by erosion. Since gypsum was applied to the test areas the low sulfur level did not influence the response.

SIGNIFICANT RESPONSE TO PHOSPHATE NOTED

The first response observed to fall-applied phosphorus was in the middle of May when the cooperators reported that phosphorus had increased the resistance of wheat to winter kill. Plant counts showed there were no more plants present with phosphorus than without. This was verified by Professor Harder the spring of 1965. There was, however, a pronounced increase in plant vigor and number of tillers so total ground cover was being mistaken for more plants. Figure 1 shows the influence of phosphorus on plant vigor and tillering.

In spite of the great variability in yield, which is common on eroded hilltops as result of severe erosion, dry soil at planting time and winter kill, 5 of the individual tests showed a significant response to phosphorus, 1 approached significance, 2 were influenced by a serious weed problem and 1 did not fill. Grain yields of the individual locations are given in Table 3.

The combined results show that a lack of phosphorus was limiting crop yields on the eroded hilltops when the soil test levels for phosphorus were low. Nitrogen alone had little effect on increasing yields. Phosphorus alone increased yields but when 90 pounds of nitrogen was applied with phosphorus, additional increases were obtained. This indicates that phosphorus was the first limiting nutrient. After its application, nitrogen then became the next limiting factor.

Table 2. Soil test data for 11 sites selected for fertilizer trials in 1962

Cooperator Number	Soil Type	Slope	Available P_2O_5 lb/A	Available P lb/A	Available K lb/A[1]	Available S lb/A[2]	Organic Matter	pH
1	Southwick SiCL	20	9	4.0	147	6.6	1.53	5.2
2	Joel-Setters SiCL	7	8	3.5	108	6.6	2.01	5.4
3	Brown-like L	6	13	5.7	176	9.9	1.77	5.9
4	Worley SiCL	24	12	5.3	117	3.3	1.10	5.7
5	Larkin SiCL	6	8	3.5	88	3.3	1.12	5.5
6	Thatuna CL	15	7	3.1	117	<3.3	0.79	6.1
7	Larkin SiCL	5	17	7.5	127	<3.3	1.19	5.8
8	Brownlee L	7	8	3.5	117	<3.3	0.98	5.5
9	Naff SiCL	16	10	4.4	147	<3.3	1.65	5.6
10	Santa SiL	17	10	4.4	117	<3.3	1.24	5.3
11	Garfield SiCL[3]	17	13	5.7		3.3	0.98	6.3

[1] To change potassium to potash (K_2O) multiply by 1.2

[2] To change sulfur to sulfate (SO_4) multiply by 3.0

[3] Not harvested because of severe erosion damage.

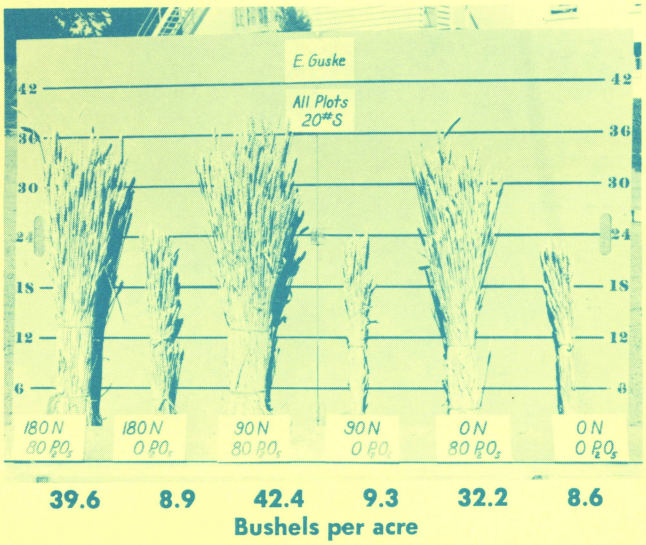

Figure 2. Representative yield bundles of harvested wheat showing response to phosphorous fertilizer.

Figure 2 showing representative bundles and yields taken at harvest time illustrates the response to phosphorus where the soil test level was 3.1 pounds per acre (7 pounds P_2O_5).

The application of nitrogen at 80 and 160 pounds per acre increased the yields of straw over the unfertilized by approximately ⅓ ton per acre. When 35 pounds of phosphorus (80 pounds P_2O_5) was applied there was a further increase of ⅔ ton per acre whether the phosphorus was applied with or without nitrogen. This increased straw can be of value in erosion control and organic matter maintenance on the eroded hilltops.

SUMMARY AND RECOMMENDATIONS

No relationship was observed between the soil series and need for phosphate fertilizers. Apparently *previous management practices, such as rotations, cultural and fertilization, had a greater influence on phosphate need than did soil series.*

Phosphorus was usually the first nutrient limiting yields on eroded hilltop soils with soil test levels of available phophorus less than 7.5 pounds per acre (17 pounds P_2O_5).

When phosphorus was applied, nitrogen became the limiting factor so both phosphorus and nitrogen are required for high production on soils testing low in phosphorus.

The additional yield of straw as a result of applying phosphorus will be of benefit to eroded hilltops in reducing erosion and as an aid in maintaining soil organic matter levels.

The rate of application of phosphorus used in the tests reported here was higher than needed. *An application of 18-22 pounds of phosphorus (40-50 pounds P_2O_5) would have been sufficient and is recommended for eroded hilltops testing low in phosphorus.* Since phosphorus does not move downward in the soil with moisture, it should be mixed with the soil or injected into the soil for best results.

Make soil tests the basis for applying phosphorus. All eroded hilltops will not respond to phosphorus fertilizer.

Table 3. Grain yields for 1962 (Bushels per acre)

Cooperator Number	Variety	Previous	Fertilizer Treatment 0-0	90-0	180-0	0-80	90-80	180-80
1	Brevor	Fallow	21.2	25.4	23.5	43.8	48.5	45.7
2	Omar	Fallow	16.7	18.9	16.6	32.2	27.0	33.1
3	Brevor	Fallow	22.7	28.3	22.8	26.3	24.9	23.7
4	Brevor	Fallow	19.5	21.1	27.1	26.3	30.0	26.7
5	Brevor	Wheat	10.2	23.6	11.8	16.3	32.3	24.2
6	Brevor	Fallow	8.6	9.3	8.9	32.2	42.4	39.6
7	Brevor	Fallow	5.8	5.8	7.8	13.8	21.1	17.2
8	Brevor	Fallow	3.9	11.2	12.2	17.5	30.2	23.4
9	Brevor	Fallow	38.2	32.6	36.0	41.8	36.6	31.0
10	Elmar	Fallow	10.4	9.5	15.6	12.7	23.0	19.3
	AVERAGE		15.7	18.6	18.2	26.3	31.6	28.4

1. Severe erosion
3. Severe weed problem
4. Severe weed problem

THE AUTHORS: G. O. Baker is Soil Scientist and Roger Harder, Associate Soil Scientist, Idaho Agricultural Experiment Station. David Van Houten was a student at the University of Idaho when the research reported by this paper was being conducted.

Published and Distributed in Furtherance of the Acts of May 8 and June 30, 1914, by the University of Idaho Agricultural Extension Service, James E. Kraus, Director; and the U.S. Department of Agriculture, Cooperating.

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P.O. 2442—5M-8-65