

# Phosphate Test for Grain Land

## Bingham soil phosphate test enables accurate prediction of yield response of cereals to phosphorus fertilization

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**Grain fertilizer tests** with uniform fertilizers were applied in over 200 separate field tests in 40 counties during the past three seasons—covering most grain-growing areas of the state and representing a wide range of soil series.

In 43% of the tests significant yield increases were obtained from the addition of phosphorus. Soil samples were taken from 159 locations and used to test the value of the Bingham Soil Phosphate Method as a means of accurately predicting where grain will respond to additions of phosphate fertilizers.

The soil samples were taken at the time the fertilizer test was established and in most instances were composites of eight soil tube cores one foot deep.

In the earlier sampling or where no soil tube was available, samples were taken by mixing together six or more shovelfuls of soil and usually represented the 8- to 10-inch depth.

The field test usually was set up and the soil sample taken at the time of planting. In a few instances, soil samples were taken and fertilizer materials applied when the grain was two to three inches high.

### Correlation of Tests

Field results of phosphate fertilization are expressed in this report on a qualitative basis only. A phosphate response has been recorded in cases where nitrogen plus phosphate gave greater yields than equivalent nitrogen alone, or where phosphate alone gave greater yields than the untreated areas.

The value of soil analysis for phosphate in predicting grain fertilizer response is

#### Method of Phosphate Determination

Ten grams of air dry soil which had passed through a 2 mm. sieve are weighed into an Erlenmeyer flask containing 100 mls. of distilled water. The mixture is shaken for a period of five minutes and then filtered through a No. 12, 24 cm. folded filter paper. The filtrate is centrifuged 15 to 20 minutes. A 50 ml. aliquot of the centrifuged filtrate is used to determine phosphate colorimetrically. The phosphate extracted is expressed in parts per million phosphate in the filtrate.

shown in the accompanying graph. The proportion of field tests showing response to phosphorus are plotted against the corresponding soil phosphate values.

Where values were below .2 ppm—parts per million—phosphate in the water extract, 93% of the tests showed yield increases from phosphate fertilization. In the range of .2 ppm to .3 ppm, 76% of the tests showed benefit of phosphorus.

As the soil phosphate values increased further, the proportion of tests showing response decreased rapidly. The range .3 ppm to .4 ppm was one of uncertainty where 50% of the tests showed benefit from phosphorus.

Above .4 ppm phosphate few cases of response were observed; only 13% in the .4 ppm to .5 ppm range and about 5% where phosphate values were above .5 ppm.

Soils showing phosphate values of below .3 ppm may be judged deficient for grain. In this range, the use of this test correctly predicted response in 64 of 76 tests, or an accuracy of 84%.

Soils with phosphate extract values of above .4 ppm may be considered adequately supplied with phosphate as far as grain is concerned. Here the soil tests predicted the result correctly in 62 of the 65 cases, or an accuracy of 95%.

Samples below .3 ppm and above .4 ppm included 18 samples, or 11% of the

entire group. Here no safe prediction of likely response could be made on the basis of soil analysis alone.

### Accuracy of Prediction

The field trial soils used in these tests were divided into broad groups on the basis of the Storie and Weir classification of California soils. The results are shown in the larger table on page 12.

The claypan and hardpan soils of Groups IV, V and VI and the hill and mountain soils of Groups VII, VIII and IX generally were poorly supplied with available phosphorus and about 80% of field tests showed response to phosphate.

The deep, recent alluvial soils of Groups I and II were well supplied with phosphate and only six of the 46 field tests, or 13%, showed benefit of added phosphate.

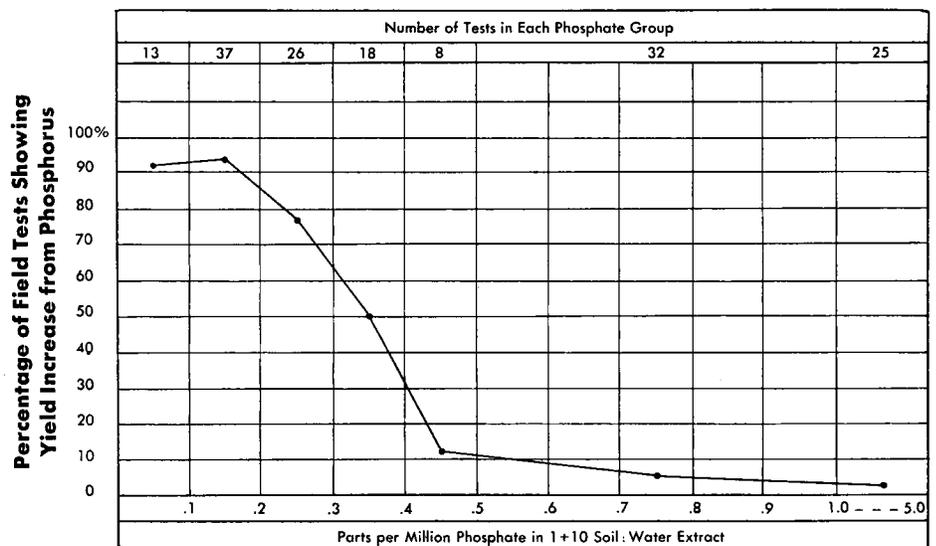
Group III soils exhibited a wide variation in phosphate supply and 34% of the tests showed field response.

Soils in Groups I and II showed field increase in yield from phosphate fertilization only when the Bingham phosphate values were below .3 ppm.

With soils of Groups III to IX it would appear that the threshold value of phosphate deficiency should be at .4 ppm since nine out of the 11 soils of these groups

Continued on page 12

Relation of Soil Phosphate Values to Fertilizer Response of Cereals as Measured by Yield Data from 159 Field Tests



## PHOSPHATE

Continued from page 7

in the .3 ppm to .4 ppm range gave a field response to fertilization.

It would seem reasonable that the deep, permeable soils of Groups I and II would provide a greater root zone than the shallower soils in the other groups and that the plants could obtain sufficient phosphate even though the level of available phosphate were slightly lower.

Setting the threshold phosphate values of .3 ppm for Groups I and II and .4 ppm for other soils groups, it may be predicted that soils above these values would be adequately supplied while those below would be deficient for cereal production, thus eliminating the zone of uncertain response.

Using these values, field response was obtained in 73 of the 88 soils—83%—predicted to be deficient, while there was no response in 68 of the 71 soils—96%—predicted as adequately supplied with phosphate. The average accuracy of prediction of results would be correct in 89% of the 159 soils in this study.

### Soil Acidity and Alkalinity

Soil pH—the measurable acidity and alkalinity—measurements were made on 150 of the soils in this study and the pH values varied from strongly acid to quite alkaline.

On quite acid soils—those below pH 6.0—response occurred in 84% of the cases while in the range between 6.0 and 7.9 only about 38% of field tests showed

benefit of added phosphate. At quite alkaline pH values above 8.0 a somewhat higher proportion of phosphate deficiency was observed. These results with grain tests correspond with those earlier reported in a greenhouse study of 448 California soils.

The 150 soils were divided into two classes: those in which the Bingham test would predict a response, and those in which the test would indicate adequate phosphate supply. Each class was divided into groups on the basis of the pH value of the soil.

In the smaller table on this page the number of predictions for each pH group is indicated in line two. Line three contains the number of correct predictions as determined by field response. On the next or fourth line of the table is shown the per cent of accuracy of predictions.

It is evident from the data obtained in these tests that soil pH has no clearcut effect upon the accuracy of prediction, and that the Bingham test predicts both deficiency and adequacy of soil phosphate supply with reasonable accuracy, both on alkaline and acid soils.

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**Relation of Soil pH to Accuracy of Prediction by Bingham Soil Phosphate Test  
Samples from 150 Grain Fertilizer Tests.**

	87 soils: phosphate deficient according to soil test*				63 soils: adequate phosphate according to soil test**			
	Under 6.0		Over 6.0-6.9		Under 6.0		Over 6.0-6.9	
Soil pH values . . .	6.0	6.0-6.9	7.0-7.9	8.0	6.0	6.0-6.9	7.0-7.9	8.0
Total number of predictions . .	26	36	13	12	5	31	17	10
Number of correct predictions .	25	25	11	11	4	30	17	9
Per cent accuracy . .	96%	69%	85%	92%	80%	97%	100%	90%

\* Deficient if under .4 ppm PO<sub>4</sub> in extract. (.3 ppm for soils in Groups I and II.)

\*\* Adequate if over

**Relation of Soil Profile Group to Accuracy of Prediction by Bingham Soil Phosphate Test**

Soil profile groups	Number and results of field tests	Range of Bingham PO <sub>4</sub> values and response			Accuracy of prediction in each soil group
		Deficient Below .3 ppm	.3-.4 ppm	Adequate Over .4 ppm	
I { Recent and young alluvial soils on fans and flood plains	Number of field tests 46 Per cent showing P response 13%	9	6	31	93%*
II { Older soils on plains, and alluvial fans	Number of field tests 29 Per cent response P response 34%	12	3	14	77%*
III { Old alluvial soils having claypan and hardpan subsoil layers	Number of field tests 50 Per cent showing P response 82%	40	4	6	94%*
IV { Upland soils developed in place	Number of field tests 22 Per cent showing P response 77%	15	4	3	82%*
V { Unidentified soils from unmapped areas	Number of field tests 12 Per cent showing P response None	0	1	11	91%*
VI { All groups*	Number of field tests 159 Per cent showing P response 47%	88	71	89%*	83% 4%

\* Using threshold value of deficiency at .3 ppm in Groups I and II and at .4 ppm in other groups.