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DIAGNOSING THE PHOSPHORUS NEEDS OF SOILS BY BIOLOGICAL METHODS

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It is a well-known fact that the total phosphorus content of a soil is not a measure of the amount of available phosphorous. Some soils that contain a low total phosphorus content may be supplied with sufficient available phosphorus for present crop needs. On the other hand, some soils that contain a relatively high total phosphorus content may be deficient in available phosphorus.

The average analyses of 1345 Iowa soils show that the surface six and two-thirds inches contain 0.0655 per cent of total phosphorus. This is a low phosphorus content and when it is considered that a 50 bushel corn crop removes approximately 12.2 pounds of phosphorus per acre, one realizes that many Iowa soils are now in need of phosphate fertilizers for economical crop production. Diagnosing the phosphorus needs of the soil, then, becomes a highly important problem in working out a management program for any soil. A number of methods have been proposed but one which will determine accurately the amount of available phosphorus in all soils has not been found. The purpose of the work reported here was to determine the phosphorus needs of a number of Iowa soils by various biological methods and to compare the results obtained with crop response to phosphate fertilizer on these soils.

Nine soils differing in physical and chemical characteristics and response to phosphate fertilizer were selected from the outlying field experiments of the Soils Subsection of the Iowa Agricultural Experiment Station. These field experiments have been under way for a number of years and the response to phosphate fertilizers has been obtained under a wide range of climatic and soil conditions. The amount of available phosphorus was determined by the *Aspergillus niger* method, the Cunninghamella plaque method, the bacteriological method employing a mixed culture of *Azotobacter vinelandii* and *Clostridium pasteurianium* and the seedling plant method. The results obtained are presented in table I.

The data in the table indicate considerable difference in the amount of available phosphorus in the different soils. However, there was no relation between the amount of available phosphorus

Table I — The Phosphorus Needs of Soils by Various Methods

Soil Type	*A. niger* mgm. Mycelium	Cunning-hamella Diam. in mm.	Mgm. N fixed per 100 gm. soil by mixed culture of bacteria	Mgm. P_2O_5 absorbed by 100 rye seedlings	Average field response to P_2O_5 fertilizer bu. per acre	No. corn crops
Carrington loam	90.2	15.75	3.80	18.8	0.6	5
Carrington silt loam	80.1	12.70	178.50	16.3	.0	8
Grundy silt loam	66.3	38.10	111.00	21.3	5.0	6
Grundy silty clay loam	64.7	50.80	3.40	20.4	2.6	8
Lamoure silty clay loam	126.9	—	45.10	16.9	13.3	6
Marshall silt loam	103.7	44.45	4.20	18.2	1.3	8
Muscatine silt loam	88.2	50.80	35.50	23.2	0.5	5
O'Neill loam	119.7	—	32.10	14.2	5.1	7
Tama silt loam	82.3	15.75	33.90	12.8	11.3	8

in any one soil as measured by the various methods. The Lamoure silty clay loam, according to the *A. niger* test, contained the largest amount of available phosphorus and this soil gave the greatest response to phosphate fertilizer in field tests. The Carrington loam and the Tama silt loam contained about the same amount of available phosphorus according to the Cunninghamella plaque method but field tests indicated a deficiency in available phosphorus in the Tama silt loam and no response to phosphate fertilizer in the Carrington loam. The Carrington silt loam contained a relatively large amount of available phosphorus as measured by the mixed culture of bacteria and this soil did not respond to phosphate fertilizer but the two methods did not correlate so well in any of the other tests. The Carrington silt loam and the Lamoure silty clay loam contained approximately the same amount of available phosphorus by the seedling plant method but the one showed no response to phosphate fertilizer in field tests, whereas, the other soil gave the largest response of any soil to the phosphate fertilizer. These data indicate the necessity for caution in the interpretation of the results obtained by various methods for determining the phosphorus needs of soils.

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