CLAY MINERALS AND PHOSPHATE AVAILABILITY: III. SOLUBILITY OF RETAINED PHOSPHATE*

H. F. MURPHY, Stillwater

It has been reported (1, 2, 3, 5, 6) that the clay minerals and colloids found in soils affect the degree of availability of applied soluble phosphates. Certain soils have a very high adsorbing capacity for such phosphates, and, if the plant is to benefit from an application of a soluble phosphate fertilizer, the amount applied per acre must be rather high. Certain methods of application have been suggested, and pellet or granulated phosphate fertilizers (2) have been recommended for these soils. It is known that the higher the degree of saturation of the colloid with phosphate, the easier it is for the plant to secure the phosphorus necessary for growth (2, 4).

This paper reports the solubility of the phosphate withheld by two recognized types of clay minerals found in soils, namely, kaolinite and montmorillonite, KH_2PO_4 solutions of three different strengths (27.22 g, 13.61 g, and 2.72 g per liter) were made. Three 100-gram samples of finely ground montmorillonite and a like amount and number of finely divided kaolinite samples were placed in one-half-gallon mason fruit jars. To each of these samples, one liter of KH_2PO_4 solution was added. The bottles were sealed and shaken thoroughly several times each day for a period of three weeks. The kaolinite samples were filtered, agitated, and washed thoroughly with distilled water until the leachate showed no test for phosphate. The montmorillonite samples could not be filtered because of their highly colloidal condition; consequently each of these three samples was subdivided into 5 aliquot-parts and centrifuged. After each centrifugation the liquid was decanted off, fresh distilled water was added, and the system was thoroughly agitated and recentrifuged. This procedure was repeated until one liter of water had been used in washing each aliquot. The decanted liquid from the last centrifugation was not entirely free from water-soluble phosphate. However, except for an aliquot from the montmorillonite treated with the highest concentration of KH_2PO_4 solution, the samples were dried in an oven at 105° C. for 24 hours and analyzed for total phosphorus (A. O. A. C. 1940). Table I shows the results.

TABLE I

Phosphate retained by clay minerals after prolonged removal of water-soluble phosphate

Concentration of KH_2PO_4	Phosphate retained by 1 gram of clay	
	Kaolinite	Montmorillonite
g/liter	*mg*	*mg*
27.22	101.1	22.0*
13.61	50.1	15.5
2.72	19.0	10.3

* A representative portion of this sample was used for further removal of soluble phosphate.

Continued centrifugation and decantation were carried out with the sample of montmorillonite mentioned above. At no time was the decanted liquid entirely free from phosphate. This procedure was discontinued after approximately two liters of distilled water had been used. The sample then retained approximately one-half the phosphate shown in the table for the original.

* Contribution from the Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma

Further studies are being made on montmorillonite and other clay minerals in relation to phosphate fixation and availability.

CONCLUSION

The phosphate retained by Montmorillonite is more soluble in water than that held by kaolinite. It is likewise more available to plants.

REFERENCES

1. Gile, P. L., 1933. The effect of different colloidal soil materials on the efficiency of superphosphate, U. S. D. A. Tech. Bul. 371.
2. Murphy, H. F., 1939. The role of kaolinite in phosphate fixation. Hilgardia 12: 341-382.
3. Murphy, H. F., 1940. Clay minerals and phosphate availability: I. Adsorption of phosphate ions by clay minerals. Proc. Okla. Acad. Sci. 20: 79-81.
4. Murphy, H. F., 1940. Clay minerals and phosphate availability: II. The utilization of adsorbed phosphate by plants. Proc. Okla. Acad. Sci. 20: 83-86.
5. Roszmann, C. A., 1927. Retention of phosphorus by soil colloids. Soil Sci. 24: 465-474.
6. Scarseth, G. D., 1935. The mechanism of phosphate retention by natural aluminosilicate colloids. Jour. Amer. Soc. Agron. 27: 596-616.

A. O. A. C., 1940. Tentative and official methods of analysis. 5th ed.