The Fates of Rock and Superphosphate Applied to a Red Podzolic Soil

LAWRENCE O. FINE AND R. P. BARTHOLOMEW

The low relative availability to plants of rock phosphate when compared to more soluble phosphates has been the cause of much investigation in attempts to determine the reasons for this low availability. Other studies have been made to determine what pre-treatments might increase rock phosphate availability. The present report is concerned with field and laboratory studies made in an effort to determine the fate of phosphorus applied to the soil in rock and superphosphate.

REVIEW OF LITERATURE

Fraps (2) concluded after numerous pot experiments that the availability of finely ground rock phosphate averaged about 40% of that of superphosphate. The availability varied from 0 to 95% with different soils and was not consistently high with acid soils, although such a general trend was observed. A study by Bartholomew (1) of the influence of soil acidity and fluorine content of the applied rock phosphate on its availability to crops, using the same soil series as used in the present investigation, led to the conclusion that the inverse relationship between fluorine content and phosphate availability was closer than the direct relationship between soil acidity and rock phosphate availability. However, at soil pH's of 4.33 and 5.07 two phosphate rocks of 0.41 and 0.70% fluorine yielded approximately the same amounts of phosphorus to sudan grass as did monocalcium phosphate and superphosphate.

Volk (7) noted that rock phosphate and waste pond phosphate were far inferior to superphosphate in producing sorghum yield increases on alkaline Sumter clay. Rock phosphate was about 35% as efficient as superphosphate on slightly acid Decatur clay loam and about 68% as efficient on Hartsells fine sandy loam when applications were made at 48 pounds of P_2O_5 per acre. In general, for cotton, sorghum, hairy vetch, and Austrian peas, superphosphate was far superior to either rock or waste pond phosphate. Volk (8) again in 1944 reported that rock and waste pond phosphate were decidedly inferior to superphosphate, calcium metaphosphate, and fused rock phosphate. However, the use of ammonium sulfate or urea greatly enhanced the availability of the low-solubility phosphates as compared to sodium nitrate, when all sources of nitrogen were mixed with the phosphate. Lime had no effect when mixed with the soil, but precluded the above effect when mixed with the fertilizer.

There is considerable evidence that soluble P_2O_5 in superphosphates may revert to insoluble forms on standing, after contact with lime, or after being in the soil for some time. MacIntyre, et al. (3), in 1937, proposed that fluorapatite is formed during curing and storage of superphosphate and said that the citrate solubility method of determining available P_2O_5 in fertilizers may cause an induced decrease in P_2O_5 solubility where the material carries appreciable amounts of fluorine. Later, MacIntyre and Hatcher (4) reported evidence which led to the conclusion that any fraction of superphosphate, added to a prelimed soil, which is not used by plants or “fixed” will ultimately revert to the fluorophosphate Ca_3F_2(PO_4)_2 which characterizes raw rock phosphate. The results leading to the above conclusion were obtained by the addition of rock phosphate to a limed soil.

EXPERIMENTAL PROCEDURE AND RESULTS

The soil used for this investigation was a very fine sandy loam, a sandstone-shale derived red podzolic upland soil, formerly designated as Clarks ville. Samples taken in 1921 and in 1945 from a plot of a 4-year rotation-fertilizer experiment were used for the analyses. The experiment was arranged in four blocks of 20 plots each so each crop of corn (corn, oats, wheat, clover) occurred once. One block (section 26) was selected for most of the analytical work because it represented the cumulative mean of all sections in respect to available phosphorus. Also it had exactly six complete rotations as far as phosphate fertilization is concerned, rock phosphate having been applied for corn and wheat plots and treatment descriptions concerning these plots are given in Table I.

Readily available phosphate was determined by the Truong (6) method, with the aid of a colorimetric analysis. Determinations made on samples taken in 1921 and 1945 from two check plots which received no superphosphate only; rock phosphate only; K, lime, plus superphosphates; and the N, K, lime, plus rock phosphate plots of all four sections. All determinations were made on samples of plant tissue as soon as the plants had been removed, hence the sampling error was considered negligible. The results of these determinations (Table I) show that the rock phosphate treated plots (Nos. 3 and 70) underwent a great increase in P_2O_5 when determined by this method.

The yield data from plots 1, 2, 3, and 4 for the complete rotations (1921-1944) were used in calculating the efficiency of rock phosphate compared to superphosphate in inducing yield increases of crop plot yields. The rock phosphate-induced yield increases in per cent of superphosphate-induced increases are averaged for all four crops each year and presented in graphic form in Fig. 1. The yield data from plots 1, 2, 3, and 4 for the complete rotations (1921-1944) were used in calculating the efficiency of rock phosphate compared to superphosphate in inducing yield increases of crop plot yields.

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