SORBED PHOSPHATE AND THE STANDARD PHOSPHORUS REQUIREMENT

Fig. 1. Phosphorus in solutions that were equilibrated with a Hydrandept that had been fertilized to establish varying levels of P.

Soil solutions of unfertilized, highly weathered soils usually contain only a few parts per billion of phosphorus. Phosphate solubility decreases with time after such soils have been phosphate-fertilized. Concentration decreases rapidly at first, and then slowly over a period of months or even years. Collectively the reactions are often called "phosphorus fixation" — an overworked term that should probably be replaced. Phosphorus sorption would be a better term to indicate the transfer of P from the solution to the solid phase of soils.

The relationship between phosphate sorption by a Hawaii Hydrandept (Honokaa series) and phosphate solubility is illustrated in Figure 1. The blue color represents inorganic P in solution. The solutions in the vials were equilibrated with soil samples secured from field plots to which P fertilizer had been added over a period of 4 years to establish 10 levels of P in the soil. These P additions had been discontinued 4 years before the plots were sampled. Five rates of P were superimposed in the laboratory on the old phosphate fertilizer treatments. These late additions were made 6 days before the solution was recovered for development of the phosphate blue color. The intensity of the blue color (related to the P concentration in solution) depends on both the quantity of P added to the soil and the time elapsed since the P was applied. The solution obtained from the system to which no P had been applied (lower left corner) contained almost no P (about 0.002 μg P/ml).

Heavily fertilized soil is represented by the column of vials at the right of the photograph. Phosphorus fertilizer totaling 16,000 μg P/g soil had been applied in 4 applications to establish, and reestablish, 1.6 μg P/ml P in solution. During the 4-year interval since fertilizer was last applied, P concentration in solution had declined to 0.15 μg P/ml, represented by the vial in the lower right corner. That same concentration was also obtained when 2000 μg of new P/g soil was added to the previously unfertilized soil (second vial down in the left column).

One concept illustrated here is that P sorption is concentration-dependent. In practical terms this means that the quantity of fertilizer P needed depends upon the concentration of P required in the soil solution. Some of the most demanding crops — tomatoes and lettuce, for example — require about 0.3 μg P/ml for near maximum growth. The requirement for some agronomic crops, such as corn and sorghum, is about one-tenth as great, while some crops, such as cassava, seem to have a facility for extracting adequate P from soils in which the solution concentration is about 0.006 ppm P.

Fig. 2. Phosphorus sorbed by four Hawaii soils in relation to P concentration in solution.