ILLUSTRATED CONCEPTS IN TROPICAL AGRICULTURE

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# SORBED PHOSPHATE AND THE STANDARD PHOSPHORUS REQUIREMENT

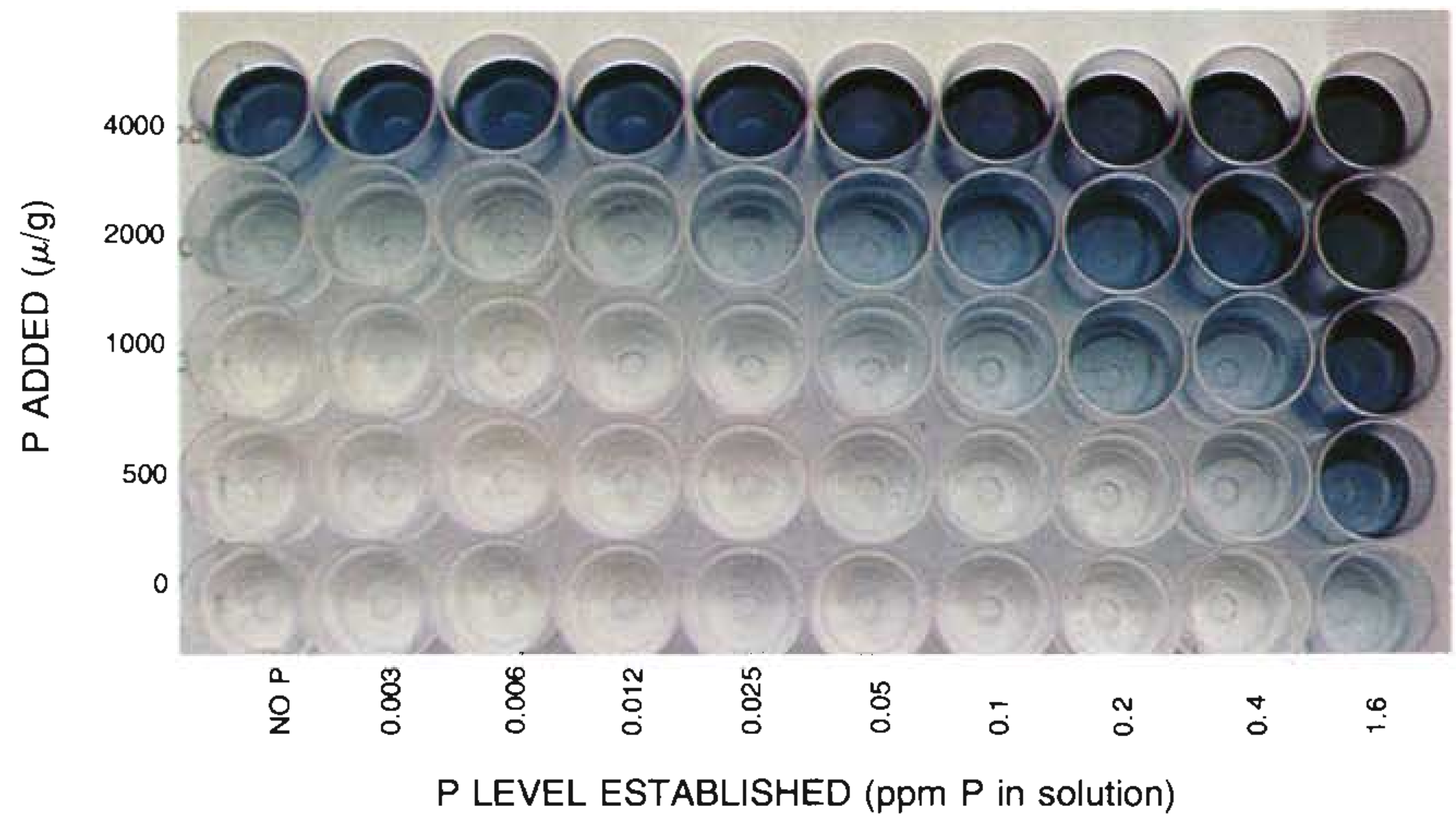


**Fig. 1. Phosphorus in solutions that were equilibrated with a Hydrandept that had been fertilized to establish varying levels of P.**

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 $\mu$g P/ml).

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

A comparison among characteristics of phosphate sorption is important for transferring soil-management information. Valid comparisons require that standard conditions be employed, including the concentration of P in solution. A phosphate concentration of 0.2 ppm P in solutions equilibrated with soils has been suggested as an appropriate standard at which to make comparisons, since that concentration is adequate for the nutrition of most plant species.

Phosphorus adsorption curves can be constructed from data of the type illustrated in the photograph. Curves for soils of different mineralogical composition are illustrated in Figure 2. The dashed, vertical line is the standard P concentration. From the intersection of these curves with the standard concentration line, standard P requirements can be determined by reference to the vertical axis. Fertilizer requirements for specific crops can also be determined from such curves if the external P requirement for each crop is known.

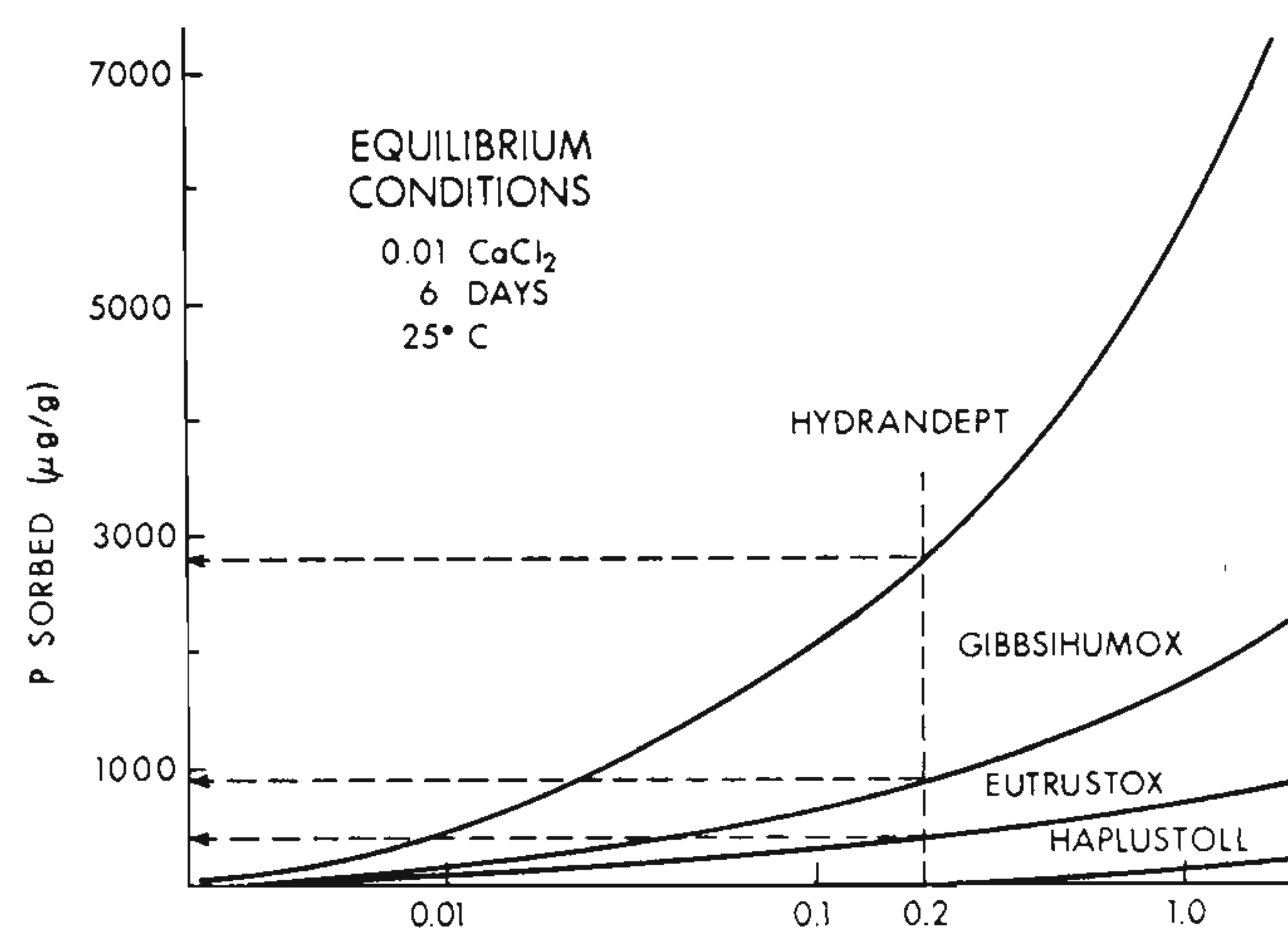


**Fig. 2. Phosphorus sorbed by four Hawaii soils in relation to P concentration in solution.**

Robert L. Fox and Russell S. Yost—No. 10, 1978