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This Week's Citation Classic®

Fox R L & Kamprath E J. Phosphate sorption isotherms for evaluating the phosphate requirements of soils. *Soil Sci. Soc. Amer. Proc.* 34:902-7, 1970.
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Phosphate sorption curves were used as a basis for fertilizing soils. Yields of millet approached maximum when phosphorus (P) in solution was adjusted to 0.2 mg/l. Phosphate concentrations at which maximum yields were attained were little influenced by soil texture or past fertilizer treatments; but in a soil with low P buffering capacity, yield was greatest if the soil had been fertilized previously. [The SCI® indicates that this paper has been cited in over 185 publications.]

Soil P Adsorption and Fertilizer Requirements

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When Les Swindale, a New Zealand soil scientist, defected to Hawaii, and I was introduced to him as the one in charge of soil fertility research, he abruptly asked, "Why is it that soil fertility specialists are so arbitrary in everything they do?"

At first I discounted the remark as a Down Under rough edge that would wear off. When it did not, and it became obvious that Les would be department chairman, I began to rethink my program. This I shared with a special graduate student, Sheldon Whitney. He called my attention to a paper in which R.S. Beckwith[1] (Australia) used phosphorus (P) sorption curves to estimate standard P needs of soils. The standard he suggested was 0.2 mg P/l, a reasonable requirement for most plants growing in solution cultures. This was a long way from needs of crops in diverse soils, but it was a big step away from arbitrary methods in general use.

But P concentration (intensity of supply) was only one soil factor governing P uptake by plants. What about quantity, capacity, and rate factors and plant factors as well? What would be the residual effects of previously applied phosphate? Would soil texture (sand or clay) have an overriding effect on P diffusion from solid phase to roots? Could a great quantity of sorbed phosphate meet the P requirements of plants even if intensity of P supply were substandard? Would direct interactions between roots and solid phase make the whole matter of solution concentration moot?

Hawaii is an excellent natural laboratory for many soil studies but sandy soils are in short supply (except on "The Beach," of course) and suitable long-term P experiments were not available. North Carolina had plenty of both, and so we went to North Carolina State where long-time friend, E.J. Kamprath, had just published on relationships between P availability and degree of soil saturation with P—a useful approach, but in my view, a step backward from the soil solution approach now proposed.

We spent some time debating the relative merits of water and 0.01 M $CaCl_2$ as support media during equilibration and water *vs.* beer for drinking. On the latter issue, Gene quoted the Apostle Paul (out of context) that a little wine should be taken for the stomach's sake, while I argued from sound scientific considerations against extrapolating from "a little wine for snakebite" to "tankards of beer on every pretext." Oh well, you can't win them all! We selected soils ranging from 4 to 40 percent clay and residual P from 0 to 540 kg P/ha. When soils were adjusted to 0.2 mg P/l based on P sorption curves, relative yields of crops from all soils were almost identical. Similar procedures have been used in the field and P requirements determined for many crops. Requirements differ greatly but they are insensitive to several edaphic factors. The external P requirement can be used with P sorption curves as a rational basis for P fertilizing. This procedure gives hope that much time-consuming and expensive field testing can be avoided; in short, the results are transferable.

The method gives results more closely related to plant needs than some classical work on solubility of P reaction products in soils. This work was published when much effort was directed toward bringing infertile tropical soils into production. Most of these soils are deficient in P; many immobilize much P. In areas with such soils, interest in this paper continues. In a recent year, it was cited in eight states and countries all with high P fixing soils.[2]

1. Beckwith R S. Sorbed phosphate at standard supernatant concentration and an estimate of the phosphate needs of soils. *Aust. J. Exp. Agr.* 5:52-8, 1964. (Cited 25 times.)
2. Lopez-Hernandez D, Coronel I & Alvarez L. The external phosphate requirements of cowpea on five dissimilar soils. *Soil Sci.* 144:339-43, 1987.

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