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Phosphorus: A Farmer's Analysis in Soil Phosphorus Chemistry

FOR IMMEDIATE RELEASE: Agricultural producers know their soil fertility. They know how much of what to apply and when to achieve the production yields they desire. Of course, the large part of yield is left to nature's whims, but the capability of soil fertility is there. While there are some definite improvements that could be had, most crop producers have a good basis of their field soil fertility. Agronomist like myself often never get into the gritty details of soil chemistry with producers. We often focus on the "how much," rather than the "why." We don't get into the gritty details of why because they are not really important to producer yields…but maybe we should. Farmers are smart enough for it and maybe something can be found in the finer details.

Phosphorus from a producer's point of view is likely the simplest nutrient. However, chemically, it is far from simple.

- Phosphorus in 3 pools– Phosphorus (P) in soil can generally be divided into the groups; solution P, active P, fixed P. Solution P is by far the smallest of these pools (as in less than one lb. per acre) and the only one that plants can use immediately. P_2O_5 is the form that is represented in fertilizers but plants adsorb only orthophosphates, $H_2PO_4^-$ and HPO_4^{2-}. This conversion from fertilizer to orthophosphate is very fast in most soils. The active P pool is that which is easily released when solution P is depleted. Calcium, iron, and aluminum in soil form soluble compounds with P that adsorb and desorb while the solution P pool. Organic P (plant residue and manure) form part of this active P pool. A soil test, such as Bray or Olson, uses a weak acid to dissolve and quantify the P in the solution and certain percentage of active P. Therefore, a soil test is JUST AN INDEX - Not the actual quantity in soil. Fixed P is normally the largest pool by a great margin but it very insoluble. It is complexed in soil clay layers, hard to dissolve minerals, and stubborn organic matter. It can take years or centuries for this P to dissolve. A total P soil test can tell you how much P is in all three pools (most of it) but it involves boiling soil in strong acids for hours. Not a test useful for produce.

- Phosphorus and pH-

  As long as there is enough water in the soil to get allow chemicals to move around, pH is the controller of P forms (along with nearly all minerals). Soils with a low pH (below 6) results in P fixed to aluminum that won't desorb into the soil solution (figure 1). Soils with a high pH (above 7.5) result in P fixed to calcium. This is why fields with plenty of P in the soil can still result in deficient P symptoms.

- Phosphorus as a bank

  Phosphorus can be stored in the soil and used later. As long as soil loss is controlled, the P is stored for the next crops. Potassium (K) is similar in that it can be stored in the soil but crops will tend to "luxury consume" K. This effect is not dramatic but something to consider in hay and silage production. In crop production most of the K is stored in the debris that is left on the field so not much K is lost from luxury consumption. As a very general average it takes 18lbs of added P fertilizer to increase background P one ppm. At low P levels (below 10 ppm), acidic soils (below 6), and heavy clay soils, take more fertilizer to increase background P levels. A good P background goal is 20 ppm. While there are likely actual differences in crops or pasture types, fertilizer recommendations tend to go with the "optimum at 20 ppm" across the board, but there are small differences of opinion among state extensions.

- Phosphorus and the environment

  As previously mentioned, very little P is in solution and P absorbs readily onto a number of soil components. This leads to P being a very immobile nutrient. Most P losses are associated with the loss of soil itself in erosion events. Although new research is showing that higher concentrations of P at the soil surface can lead to P losses in the runoff solution rather than the soil itself, an important note for no-till producers. This is likely to be a rate of a few lbs. per acre so more of an environmental loss rather than production loss. A common environmental threshold for P is to not go above 50 ppm. This is environmentally too simplistic but still a good producer guideline.

This crash course article in phosphorus chemistry will likely not change anyone's production habits, but I hope it will at least provide some enlightenment on the "why." If you have any questions over soil fertility or even the finer details of soil chemistry, please give me a call. Be warned though, I do love soil chemistry.

On March 18th a special soil program, Dirt Day, will be held in the Neodesha Civic Center from 3:00 p.m. to 8:00 p.m. This program won't cover the normal area of production crop fertility, but important soil topics often missed such as poultry litter management, cover crops, geology of SE Kansas, erosion control, and pasture fertility. The program for both crop and cattle producers and is free. Please call (620)378-2167 to RSVP.

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