6. PHOSPHORUS (P)

Phosphorus (P) fertilization is necessary in order to get economic yields on many crops. Crops vary in their response to phosphorus; responses to phosphorus by tree and vine crops are virtually unheard of while phosphorus fertilization is a standard practice on many vegetable crops because it more than pays it's way.

Phosphorus is used mainly on row crops and here it's greatest beneficial effect to the plant is in the seedling stage and in the early stages of plant development. In most situations, phosphorus must be in the soil before or at the time of planting. Once the crop is well established, the chances for a phosphorus response are slim side dress applications are rarely beneficial.

Phosphorus can promote earlier, more uniform maturity of crops, important in minimizing the chances of crop exposure to attack from pests, diseases and weather.

Deficiency Symptoms

There are no distinct, characteristic phosphorus deficiency symptoms for any crop. P deficient plant are generally more spindly and have a darker green color then plants with adequate P; crop maturity can be delayed. These symptoms are far from striking and as a result, phosphorus deficiency can easily go unnoticed.

Factors Affecting Phosphorus Response and Uptake

A number of factors have a strong influence on the chances of getting a crop response from phosphorus. The 6 major influencing factors are:

1. **Amount of phosphorus already in the soil**

   There is much less chance of a phosphorus response on a soil testing high in phosphorus than on one testing low.

2 **Soil moisture**

   Phosphorus moves more easily and is taken up more easily in moist soils than in drier soils. A good irrigation can sometimes result in as much P uptake as an application of phosphorus.

3. **Soil temperature**

   Phosphorus is more soluble and plants can take up phosphorus more easily as soil temperatures increase.

4 **Soil pH**

   Phosphorus is most available to plants at a pH of 6.5 to 7.0. If pH gets too low, phosphorus can be tied up by the metallic elements (iron, aluminum, zinc) that

are much more active in acid soil; if pH gets much above 7.0, P can be tied up by calcium and magnesium.

5. **Lime and gypsum in the soil**

   Free lime and gypsum in soils will make phosphorus less available by tying it up as insoluble calcium phosphates. Heavy gypsum application (such as is often done for potatoes) can tie up phosphorus.

6. **Amount of zinc and other metallic elements in the soil**

   Metallic elements tie up phosphorus. Zinc-phosphorus interactions have been well established; over application of one can create *a* deficiency of the other.

There is a wide range in reported crop responses to phosphorus a crop will respond to phosphorus on one field, but not on another one which might be just across the road, even though soil types may be the same on both fields. Such response differences can usually be traced to one or more of the above 6 factors.

Written reports of crop yield increases from phosphorus fertilization should quantify each of the above 6 parameters to make the report meaningful, but this is rarely done. The fieldman should be leery about making too wide an application of the results of one test. Because so many variables can affect crop response to phosphorus, the only sure way to determine if a crop response is possible on a particular piece of ground is to apply phosphorus to that particular piece of ground.

Soil Tests for Phosphorus

Soil tests for P can give very good information on which to base a fertilizer recommendation but they are not definitive. For example, a soil reading of 1 5 ppm P might denote an excellent P level if the soil was warm at planting time, but the same level might be low if planting was done in the winter. A good deal of judgment must be used when evaluating soil P tests.

Many crops will respond to P in the starter fertilizer regardless of the soil levels of P mainly due to the fact that the seedling stage is responsive to P because the root system is not well enough developed to forage efficiently for P.

Placement of P

The sum of the knowledge on placement of phosphorus fertilizer was best stated by worker David Dibb: "If all of the P placement experiments in the world were laid end to end, they would all point in different directions."

Phosphorus does not move in the soil, but must be incorporated to come in contact with plant roots. Usually banding is superior to broadcasting-disking. This is

especially true on soils that have a high fixing capacity for phosphorus (e.g., calcareous soils). Much of the variation in P placement results can be attributed to the P fixing capacity of soils. Banding is also more effective when soil temperatures are cool.

Optimum location of the fertilizer band will vary with the crop; it is desirable to have seedling roots intercept the band, thus placement would differ between a tap rooted crop and a lateral rooted crop. For example, a common band placement recommendation for tomatoes (a tap rooted crop) is 2 inches below the seed, while for potatoes it is 2 inches on either side. Using ammonium phosphate fertilizers or banding an ammonium form of N along with the P can significantly increase P uptake because of the acidifying effect that ammonium has on the soil when it is nitrified (converted to nitrate).

When soil P levels are very low (as shown by soil test) it will usually not be possible to band enough material to get a maximum response, and broadcasting most or all of the P fertilizer is recommended. Broadcasting P fertilizers then folding them into the beds is a widely used practice in California and is a cross between broadcasting and banding.

The fieldman should know the characteristics of the particular piece of ground he is working with to be able to make meaningful suggestions on P placement.

Improving Phosphorus Nutrition

Naturally, phosphorus fertilizers should be applied when a need can be demonstrated, however, if it is known that P responding crops are to be continually grown on a particular piece of ground it would pay to do everything possible to turn that piece of ground into a high P supplying soil. This does not necessarily mean adding P; an adjustment in soil pH can have more beneficial effect on P nutrition than the addition of phosphorus itself. Attempt to get the field into the 6.5 to 7.0 pH range through the use of amendments.

On highly calcareous soils it may be impossible to reduce pH below 7.2 (e.g., it could take the equivalent of well over 100 tons of sulfuric acid to do so). Band application of acid or acidifying materials could be used on such soils; such applications have been shown to give a P response.

Manure, particularly poultry manure, can be a good supplemental source of phosphorus.

General Reference

Phosphorus for Agriculture, a 158 page manual published by the Potash/Phosphate Institute (1649 Tullie Circle, N.E., Atlanta, Ga. 30329). 1978.

Khasawneh, et al (ed.) **The role of phosphorus in agriculture.** Amer. Soc. of Agron., Madison, Wis. 1980. (928 pp; $25).