# Phosphorus for crop production

*Donald R. Christenson, Department of Crop and Soil Sciences, Michigan State University*

Sources of phosphorus include ortho- and polyphosphate fertilizers. Orthophosphates have one $PO_4$ molecule per molecule of salt. Orthophosphoric acid has the formula $H_3PO_4$. Di-ammonium phosphate $(NH_4)2HPO_4$ and mono-ammonium phosphate $(NH_4H_2PO_4)$ are examples of orthophosphate. Both are solid materials. Polyphosphates are simply orthophosphate molecules joined together by heating and driving off a water molecule. Polyphosphoric acid has the formula $H_4P_2O_7$. The most common polyphosphate fertilizer is 10-34-0. It will generally contain 65-70 percent polyphosphate and 30-35 percent as orthophosphate.

There is no difference in availability between ortho- and polyphosphate or between liquid and dry fertilizers. All sources undergo the same reactions in the soil. These reactions are controlled by the pH of the soil, not by the source of phosphorus. All P fertilizers marketed today are greater than 85 percent water soluble. Research has shown that once water soluble P exceeds 75 percent, there is little difference in final yields that can be attributed to water solubility of the P fertilizer. Data from Iowa showed that 90 percent of the yield increase from water solubility was obtained with materials having 50 percent water solubility. Increasing the solubility to 90 percent added another 10 percent. Differences in water solubility among currently used fertilizer sources should not be a factor in choice of material.

When a phosphorus source is added to the soil, it will dissolve and increase the P concentration is soil solution. From there it will undergo various reactions. These reactions are complex. More than 60 compounds containing P have been identified in various soils. Aluminum and iron phosphates are formed in acid soils. Calcium phosphates are formed in alkaline soils. In neutral soils there may be some aluminum phosphates, some calcium phosphates and another group called taranakites. The latter group may contain ammonium, potassium, calcium, aluminum and magnesium in various proportions.

An important factor concerning P availability is that the compounds formed from these reactions in the soil contribute to P in solution. In turn, plants remove P from the solution phase in the soil. The concentration of P in solution is controlled by the solubility of the reaction products from the added or native P. The soil's capacity to replenish P in solution determines how much P fertilizer should be added.

While a soil test doesn't measure P in solution, it provides the best tool for predicting the soil's capacity to replenish P in solution. A soil test provides an index of the availability of P and gives a prediction of the probability of getting a response to applied fertilizer. Recommendations for the amount of fertilizer to apply may also be developed from the soil test.

The answer to the question "Should I band or broadcast my P fertilizer?" is dependent on the soil test concentration? When the soil test for P is low, often the best results are obtained from banding some of the P requirement and broadcasting the remainder. When the soil test is medium to high, banding and broadcasting often produce equal results. When the soil test P is very high, no P should be applied.

Even though response to starter fertilizers on soils testing greater than 60 Ib. P per acre has not been consistent, the adoption of conservation tillage means plants will be growing in cool soil early in the growing season. Research indicates that a starter fertilizer placed near the seed may increase yields in most years under these circumstances. In conservation tillage systems, there is little chance of getting a yield response to starter fertilizer when the soil test is above 120 Ib. P/. .

There is an advantage to starter fertilizer containing P when Zn and Mn are needed. In order to get the most efficient use of these fertilizer nutrients, banding with the starter fertilizer is recommended. Broadcasting Mn is not an efficient method of application. Research shows that at least 40 Ib. Mn/A must be broadcast to give a yield response on deficient soils. Broadcasting 10 Ib. Zn/A is needed to give a yield response under deficient conditions.

The risk of leaching P from soils testing less than 300 Ib. P/A is low because P compounds have low solubility. P may also be adsorbed on to clay particles. Since the phosphorus bearing compounds are the size of clay, erosion of soil will carry P away from field. Obviously, erosion of soils with high P soil tests will contribute more P to surface water than lower testing soils.

Nutrient management guidelines have been developed for manure and agricultural waste application to the soil in association with Michigan's right to farm law. For compliance, these guidelines suggest that no P be added to soils with a test of greater than 300 Ib/A. In the range of 150 to 300, only the amount removed by the crop should be added.

MICHIGAN STATE UNIVERSITY EXTENSION

MSU is an affirmative-action, equal-opportunity institution. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, marital status, or family status. • Issued in furtherance of Extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Tom Coon, Extension Director, Michigan State University, E. Lansing, MI 48824. • This information is for education purposes only. References to commercial products or trade names do not imply endorsement by MSU Extension or bias against those not mentioned.