IPNI
Plant Nutrition TODAY
Better Crops, Better Environment...through Science

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Spring 2008, No. 2

IS PROMOTION OF ORTHOPHOSPHATES AS MORE PLANT-AVAILABLE COMPARED TO POLYPHOSPHATES JUSTIFIED?

A common question from agronomists and growers in the Northern Great Plains is whether or not P fertilizers containing orthophosphate are more readily available to and better used by crop plants compared to P fertilizers containing polyphosphates. The simple answer is that there is very little difference under most field conditions. It is first important to understand how P fertilizers are manufactured, and the chemical and physical characteristics of these two general types of P fertilizers.

Most P used to make fertilizer originates from rock phosphates that are natural deposits of apatites. These materials are mined in different areas of the world, and are igneous or sedimentary in origin, with sedimentary deposits constituting the majority of world reserves. The mined rock phosphate is treated to increase solubility and availability of the P for crop use. The most common method used is called "Wet-Process Phosphoric Acid" and is simply the acidulation of finely ground rock phosphate with sulfuric acid in the presence of water.

In this method, dilute orthophosphoric acid (28% P_2O_5 equivalent) is separated from the other reaction end-products and normally concentrated by evaporation of water to a 42% P_2O_5 equivalent content. This material can be used to formulate P fertilizers by reaction with ammonia (NH_3) to form mono-ammonium phosphate (11-52-0), or with a K containing solution to form mono-potassium phosphate (0-51-34). Further heating of phosphoric acid causes more loss of water to the point that the P concentration can be increased to around 50% P_2O_5 equivalent and is commonly called "merchant grade" phosphoric acid. The phosphoric acid molecules exist in the singular orthophosphoric form.

Polyphosphoric acid (also called superphosphoric acid) is made when the merchant grade acid is heat-treated until orthophosphoric acid molecules begin linking together with a corresponding loss of water as steam. The water in the steam originates from a combination of a hydroxyl ion (OH^-) and a hydrogen ion (H^+) off the ends of adjoining orthophosphoric acid molecules. There is a loss of one molecule of water for every two orthophosphoric acid molecules that link together.

Ammonium polyphosphate (10-34-0) is a common liquid fertilizer. This product is made by reacting a 68% P_2O_5 polyphosphoric acid with NH_3 under controlled conditions. When the NH_3, a strong base, mixes with the acid the resulting exothermic reaction produces a large amount of heat. This heat produces a high amount of linking of phosphoric acid molecules into polyphosphoric acid. For example, 70% of the P in 10-34-0 is in polyphosphate form.

Plants can absorb P into their roots in both the orthophosphate and polyphosphate forms. In the soil, polyphosphate converts to orthophosphate by hydrolysis (reaction with water). The time required for polyphosphate hydrolysis to occur varies with soil conditions and temperature, and is accomplished by both chemical and biological reaction of polyphosphates with water. Temperature has a great effect on increasing the rate of hydrolysis with the amount of hydrolysis being 42%, 63%, and 84% after 72 hours, respectively, at 5°, 20°, and 35° C (41°, 68°, and 95° F). Under cool, dry conditions, hydrolysis may take longer. The efficiency of polyphosphates with more than 80% water solubility is considered to be equal to, but not better than, orthophosphates.

Polyphosphate-containing fertilizers are generally as effective as orthophosphate fertilizers.

—TLJ—

For more information, contact Dr. Thomas L. Jensen, Northern Great Plains Director, IPNI, 102-411 Downey Road, Saskatoon, SK S7N 4L8. Phone: (306) 956-0619. E-mail: tjensen@ipni.net.

Abbreviations: P = phosphorus; NH_3 = anhydrous ammonia.