Improving Fertilizer Phosphorus Use Efficiency With Fertilizer Applied Resins (Polymers) for Brazil and Idaho Soils

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ABSTRACT

The role of fertilizers has had a great and respected role in the area of food production. The significant role has been documented with long-term field trials in both England and North America. With many, many years of research and observations it has been estimated that the overall contribution of fertilizer to yield is between 50 and 60 %. Therefore, as cereal production increases approaching more of their attainable yields, fertilizer consumption should also increase (FAO and IFA). This has become apparent with world consumption of NPK over the last 50 years moving from 30 Mt in 1960 to about 180 Mt/year in 2012. However, this increase is not necessarily coming from "industrial" nations, but rather from developing regions like East and South Asia, Southern Africa as well as Latin America.

Improvements in P fertilizer efficiency have been researched over the last 50 years with benefits in placement, timing, rates as well as forms of P fertilizer. The limited availability of phosphorus (P) in calcareous and acidic soils can be a major factor that limits crop production. It has been observed that liquid P fertilizer is more mobile and available for plant uptake in highly calcareous soils than granular P fertilizer containing the same P rate.

The objectives of this study were to investigate mobility and availability of P from monoammonium phosphate (MAP), diammonium phosphate (DAP) and ammonium polyphosphate (APP) fertilizers alone or with AVAIL®, a fertilizer enhancement product, on different soil types, and to examine the relationship between both P reaction products and improvements in soil available P. All soils were incubated in petri dishes containing five replicates of each fertilizer treatment at the center for five weeks at 25^{o} C. At the end of the incubation period, four concentric sections of soil surrounding the P fertilizer placement point from each dish were removed and individually analyzed. Measurements included soil pH, total P, resin extractable P, scanning electron microscopy-energy dispersive x-ray analysis of granules and P reaction products using synchrotron based x-ray absorption near-edge structure spectroscopy. The data shows enhanced diffusion and/or solubility of some P sources in a number of soils and increased P availability in P reaction products which are more soluble and plant available.

INTRODUCTION

Nutrient management issues associated with production agriculture are becoming more of a concern and a focal point of discussion. Management considerations are no longer focused on just meeting yield goals or improved crop performance, but now include questions on how their use on agriculture lands impacts surface water, watersheds, soil quality, long-term health benefits and economic viability for the producer.

It has been estimated that 30 to 40 % of production inputs are associated with purchasing and applying commercial fertilizers. Inputs of commercial fertilizer are essential to meeting food requirements of our nation and the global community whose population continues to increase at an alarming rate. Table 1 indicates the comparative relationships between the highly calcareous Idaho soil and the highly acidic Brazil soil (Cerado).

Table 1. Soil Characteristics of two soils evaluated with X-ray Absorption Near Edge Structure Spectroscopy (XANES) Analysis

Sample	pH	Ca ppm	CEC meq /100g	OM %	Fe ppm	Mn ppm	Al ppm	N ppm	P ppm
Calcareous ID	8.0	3376	19.6	0.6	2.4	3.6	ND	403	468
Oxisol BZ	4.3	49	12.4	3.7	52.9	2.2	79.5	1243	237

Table 2. Effect of three phosphorus sources without and with AVAIL copolymer on XANES analysis results (inner-most section, 0-7.5 mm radius from the point of application) on an Oxisol soil (Brazil)

Treatment	Aluminum Phosphate	Alumina Adsorbed P	Ferrihydrite Adsorbed P	Strengite	Vivianite	Red. Chi Square
Control	13.9	-	64.1	-	21.9	0.27
MAP	-	-	72.1	-	27.9	0.32
DAP	-	47.3	-	-	52.7	0.04
APP	-	43.6	-	-	56.4	0.02
MAP + AVAIL	-		24.1	-	75.9	0.02
DAP + AVAIL	-	33.7	-	-	66.3	0.01
APP + AVAIL	-	21.4	-	78.6	-	0.00