PLANT AVAILABILITY OF PHOSPHORUS FROM STRUVITE PRODUCED DURING CORN BIOENERGY PROCESSING

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Abstract

There is strong interest on recovering nutrients from the waste stream of industrial processing of crop biomass for bioenergy so they can be efficiently utilized as fertilizer materials. Phosphorus (P) can recovered as struvite [$NH_4Mg(PO_4).6H_2O$] from the aqueous stream. A low P water-solubility in struvite and previous research with the pure mineral or struvite precipitated from liquid animal manure suggest a slow-release of P from struvite. However, a recent short-term greenhouse study in Iowa (unpublished) with ryegrass found similar P crop-availability for superphosphate (0-46-0) and struvite recovered from the aqueous stream of corn grain processing for bioenergy. Therefore, the objective of this study was to evaluate at the field the availability for corn and soybean of P recovered as this struvite.

The struvite used in this field study had been dried and granulated, and is the same used for the greenhouse study mentioned above. It had 4.7% moisture, 27% total P_2O_5, 1.4% water-soluble P, 16% soluble P in 2% citric acid, and pH 6.9. Field plot trials were established at three Iowa locations with soil series Marcus, Floyd, and Webster. Soil-test P (STP) was low (8 to 12 mg kg^{-1} Bray-1 P and pH was 5.5 to 6.4 (6-inch depth). Each trial was evaluated two years, with corn the first year and soybean the second. Treatments were granulated struvite and granulated triple superphosphate (0-46-0) each applied only before corn at rates of 0, 25, 50, 75, 100, 150, and 250 lb total P_2O_5/ha. The materials were broadcast and incorporated into the soil by disking. No P treatment was applied before soybean planted the second year. Non-limiting rates of nitrogen (N), potassium (K), sulfur (S), and magnesium (Mg) were uniformly applied across all plots the first year. Measurements were corn aboveground dry matter accumulation, P concentration, and P uptake at the V6 growth stage; corn and soybean grain yield; and post-harvest STP in both years measured with the Bray-1, Mehlich-3, and Olsen tests.

There were large P rate effects on crop grain yield at all sites and both years, but no large or consistent P source differences ($P \leq 0.05$). On average across both P sources, the largest corn yield increase ranged from 28 to 38 bu/acre across sites. The second year at the site with Marcus soil was lost due excess rainfall, which resulted in very uneven soybean stand and yield. The largest soybean yield increases at the two harvested sites were 8 and 10 bu/acre. Both P sources had statistically similar effects on plant dry matter yield and P uptake at the V6 growth stage, P removal with grain harvest, and post-harvest STP.

We concluded that contrary to expectations, but confirming results of a previous Iowa short-term greenhouse study, P recovered as struvite from the aqueous stream of corn processing for bioenergy has crop availability similar to inorganic fertilizer in the Iowa soils included in the study and probably most others. This result is relevant for production agriculture because large amounts of struvite could be produced in the Corn Belt in the near future.

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