Potential for Struvite as an Alternative Fertilizer in Arkansas Agriculture

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POTENTIAL FOR STRUVITE AS AN ALTERNATIVE FERTILIZER IN ARKANSAS AGRICULTURE

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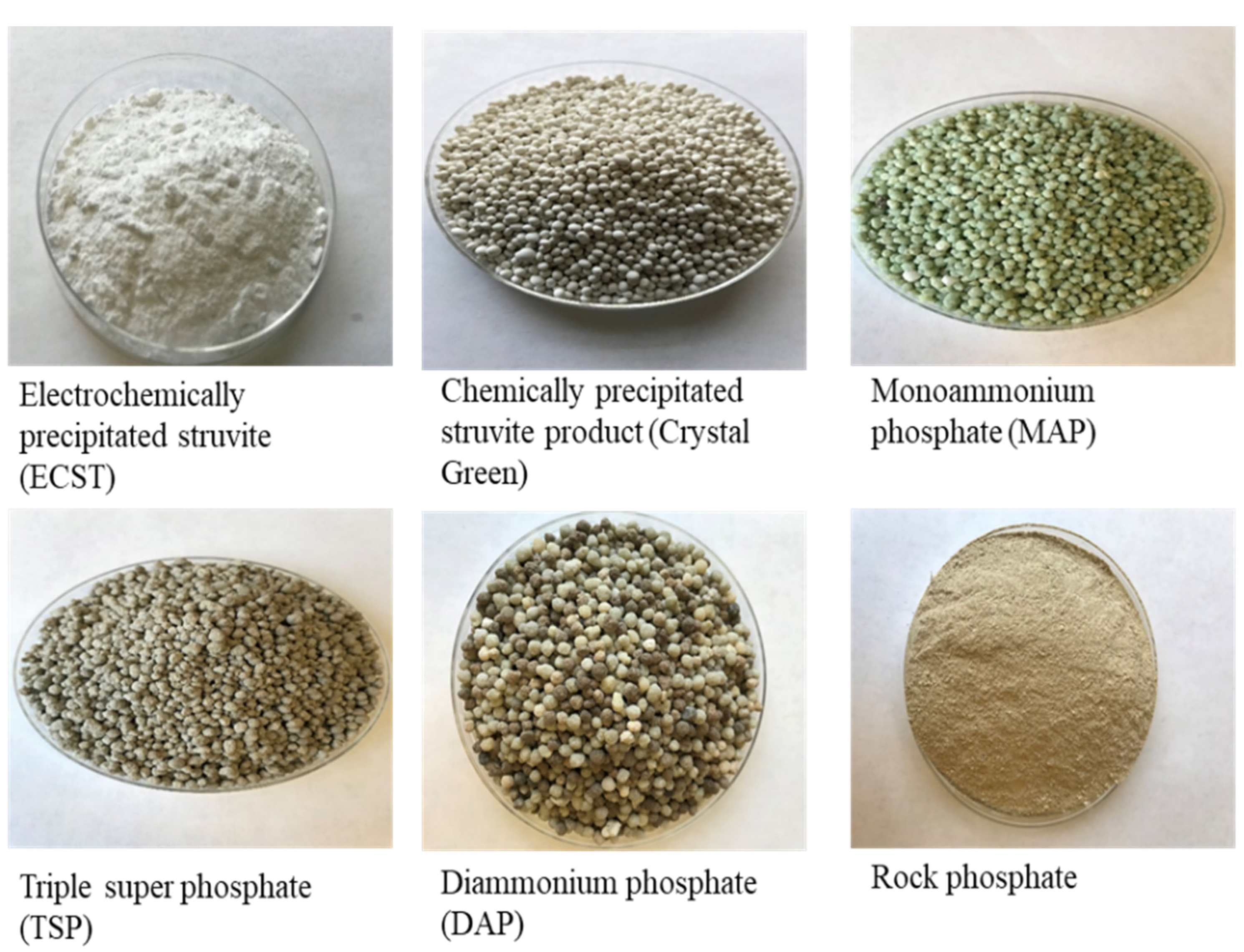
INTRODUCTION

Eutrophication of water systems caused by increasing levels of phosphorus (P) and nitrogen (N) in waste streams has recently gained global attention. Additionally, it is predicted that depletion of non-renewable phosphate rock resources may result in higher fertilizer costs for farmers over the next century. Struvite is a mineral compound commonly found in the piping of wastewater treatment plants (WWTPs) in the form of scale buildup. With a chemical structure $MgNH_4PO_4*6H_20$, struvite is being considered as a potential alternative to traditional phosphate (P) fertilizers (Johnston and Richards, 2003). As a result, wastewater-produced struvite may serve to reduce environmental damage caused by nutrient run-off, while also providing a slow-release fertilizer for farmers. In this study, field trials were performed to compare the efficacy of struvite extracted from wastewater through novel electrochemical precipitation methods (Greenlee et al., 2019). Results of the field trials were used to examine the economic viability of struvite use in three types of Arkansas row crops: corn, soybeans, and rice (Omidire et al., 2020).

METHODS

Field experiments were conducted during summer 2019 to evaluate the effects of electrochemically precipitated struvite (ECST) compared to other common fertilizer-P sources (TSP, MAP, DAP, and rock phosphate) and Crystal Green, a chemically precipitated struvite product (Figure 1). Fertilizer treatments were manually applied at a rate of 26.2 (corn), 39.3 (soybean), and 26.2 lbs P ac^{-1} . Urea was also applied across all treatments to meet target N fertilizations rates (see Figure 2).

FIGURE 1: Fertilizer-phosphorus sources used in field studies



PRELIMINARY FIELD RESULTS

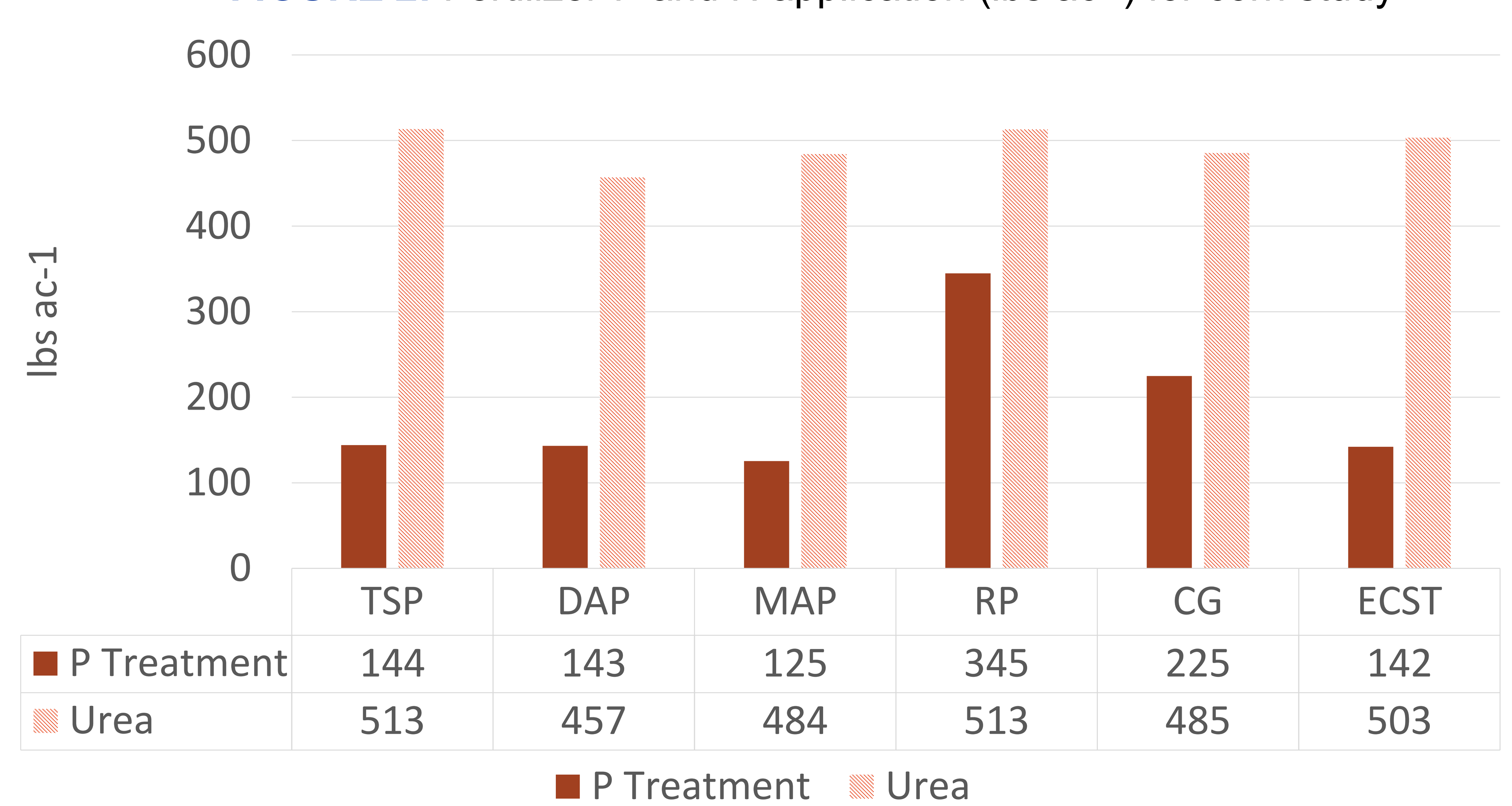
Table 1 summarizes results from preliminary field studies conducted to evaluate the effect of fertilizer-P sources on corn, soybean, and rice yields. Yield results revealed significant differences ($P<0.05$) among fertilizer treatments for corn and rice. Corn yield from ECST (211 bu ac^{-1}) was similar to that for TSP (187 bu ac^{-1}), but was approximately 1.2 times greater than corn yield from all other treatments. Soybean yield did not differ ($P>0.05$) among any fertilizer treatments. Rice yield differed ($P<0.05$) among fertilizer-P treatments. Rice yield from the ECST treatment (228 bu ac^{-1}) was similar to that of TSP, DAP, MAP and RP, all of which were on average 7.1% greater than the yield from the unamended control (Table 1).

TABLE 1: Fertilizer-phosphorus yield results

Fertilizer Treatment	Corn	Soybean	Rice
	bu ac^{-1}		
Triple super phosphate	187 ab	60 ab	232 a
Electrochemically precipitated struvite	211 a	67 a	228 ab
Diammonium phosphate	171 b	59 ab	226 ab
Monoammonium phosphate	178 b	61 ab	232 a
Crystal Green	182 b	60 ab	218 bc
Rock phosphate	166 b	60 ab	231 a
Unamended control	178 b	57 ab	213 c

While phosphorus was the primary focus of the field study, from an economic perspective, nitrogen content of the fertilizers may also play a role in determining overall profitability. Variability in P and N content across P-fertilizer products resulted in differences in application amounts of P-fertilizer and urea across treatments. Figure 2 highlights variation in the application of fertilizer to meet total fertilization rates of 26.2 lbs P ac^{-1} and 236 lbs N ac^{-1} for corn production.

FIGURE 2: Fertilizer-P and N application (lbs ac^{-1}) for corn study



ECONOMIC ANALYSIS

Since there is no current market price for ECST, the price was set at the price of Crystal Green, which was roughly double the price of all other fertilizer-P sources. Table 2 compares the total estimated net returns for corn, soybean, and rice across treatments. Using TSP as the point of reference, applying ECST resulted in a 10.6% greater net return over TSP in corn and 2.4% greater in soybeans (Table 2).

TABLE 2: Estimated change in net returns by fertilizer-P source

Fertilizer Treatment	Corn	Soybean	Rice
	% change from TSP		
TSP	-	-	-
ECST	10.6%	2.4%	-4.7%
DAP	-9.2%	1.7%	-1.7%
MAP	-4.9%	3.2%	0.4%
Crystal Green	-13.0%	-20.3%	-12.2%
Rock Phosphate	-19.6%	-12.9%	-3.6%

CONCLUSIONS

Results of these field experiments indicated that struvite was at least comparable, and at times superior, to other commercially available fertilizer-P sources when used for rice and corn production. While the market price of struvite is currently higher than other commercially available fertilizers, overall net returns per acre were found to be greater for electrochemically precipitated struvite than most other fertilizers. This suggests that from both an agronomic and economic perspective, struvite may show promise as an alternative fertilizer-P source in the production of two important commodities (corn and rice) for Arkansas row crop producers.

RELEVANT LITERATURE

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