Enhanced Efficiency Phosphorus Application for a Corn-Soybean Rotation

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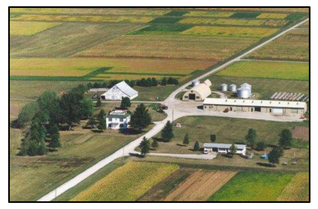
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INTRODUCTION

Phosphorus (P) is an essential mineral plant nutrient that is taken up by plants as inorganic ions ($H_2PO_4^-$ and HPO_4^{-2}) found in soil solution. With rising fertilizer costs, farmers are evaluating application rates and considering enhanced efficiency P treatments. When applied to single crops, Blevins (2009) reported a 1.2 to 1.4 Mg ha^{-1} increase in corn grain yields when AVAIL® was added to MAP at 22 kg P_2O_5 ha^{-1} and applied as a broadcast or banded treatment. Similarly, rice yields increased 502 kg ha^{-1} when reduced rates of triple super phosphate were applied (28 kg P_2O_5 ha^{-1}) with AVAIL (Dunn and Stevens, 2008).

Increasing yields and fertilizer efficiency can also be achieved with other management practices. For instance, banded P fertilizer applications using strip-till systems may increase P efficiency (Minor et al., 1993). Lime applications can improve yields and P fertilizer efficiency, but little is known of the interactive effects of adding P enhancers and liming.

OBJECTIVES

<u>Objective 1</u> - *Placement experiment*
- Evaluate the effects of P placement, application rate, and enhanced efficiency P products on soybean grain yield and P uptake in a corn-soybean rotation.

<u>Objective 2</u> - *Lime experiment*
- Determine the effects of P fertilizer source, P enhancer, and agricultural lime on soybean grain yield, and P uptake in a corn-soybean rotation.

Table 1. MAP rate and P enhancer effect on soybean plant population in objective 1. Data were combined over site-year, location, and placement.

P enhancer	MAP rate (kg P_2O_5 ha^{-1}) 0	56	112
	Plants ha^{-1}		
Non-treated	378,000	371,000	359,000
AVAIL	367,000	371,000	378,000
P-Max	370,000	351,000	382,000
$LSD_{(0.10)}$	19,000		

Table 2. ANOVA table for the soybean portion of the P placement experiment (Objective 1).

Source	Plant Population	Dry Weights	Grain Moisture	Grain Yield
	P-value	P-value	P-value	P-value
Placement	0.21	0.60	0.82	0.08
Year*placement	0.86	0.44	0.15	0.95
MAP rate	0.38	0.45	0.61	0.48
Year*MAP rate	0.24	0.74	0.78	0.95
P enhancer	0.81	0.75	0.39	0.49
Year*P enhancer	0.30	0.51	0.92	0.94
Placement*MAP rate	0.78	0.14	0.50	0.78
Year*placement*MAP rate	0.56	0.37	0.98	0.40
Placement* P enhancer	0.69	0.92	0.95	0.66
Year*placement* P enhancer	0.35	0.60	0.33	0.83
MAP rate* P enhancer	0.06	0.43	0.88	0.43
Year*MAP rate* P enhancer	0.33	0.64	0.68	0.90
Placement*MAP rate* P enhancer	0.86	0.55	0.19	0.56
Year*placement*MAP rate* P enhancer	0.14	0.40	0.68	0.92

MATERIALS AND METHODS

The corn production portion of this study was conducted in 2010 and 2011 (Dudenhoeffer et al., 2012) at three University of Missouri research centers (Fig. 1). Soybean were seeded in the same fields as the corn the following growing season with no additional fertilizer or tillage operation. This poster contains the results of the soybean portion of the growing seasons.

Data were subjected to ANOVA (P=0.1) and main effects presented in the absence of significant interactions.

Two P enhancers were evaluated:
- AVAIL® (Specialty Fertilizer Products, Leawood, KS) at 2.1 L Mg^{-1} P_2O_5
- P_2O_5-Max® (P-Max, Rosen's Inc., Fairmont, MN) at 4.2 L Mg^{-1} P_2O_5

<u>Objective 1</u>
- The study was conducted at the Greenley Research Center near Novelty and the Hundley-Whaley Research Center near Albany.
- The tillage/placement treatment was either no-till/broadcast or strip-till/deep banded.
- The P application rate was either none (0 kg P_2O_5 ha^{-1}), half the recommended rate (56 kg P_2O_5 ha^{-1}), and recommended rate (112 kg P_2O_5 ha^{-1}) of monoammonium phosphate (MAP).

<u>Objective 2</u>
- The study was conducted at the Greenley Research Center in 2010 and 2011, and the Delta Research Center near Portageville in 2010.
- P fertilizer and lime was broadcast surface applied.
- The P fertilizer source treatment was either diammonium phosphate (DAP) or triple superphosphate (TSP). DAP and TSP were applied at 117 kg P_2O_5 ha^{-1} at Novelty in 2010, 112 kg P_2O_5 ha^{-1} at Novelty in 2011, and 56 kg P_2O_5 ha^{-1} at Portageville in 2010.
- The aglime treatment was either none or the recommended rate. The recommended liming rate was 4.0 Mg ha^{-1} at Novelty in 2010, 1.7 Mg ha^{-1} at Novelty in 2011, and 2.2 Mg ha^{-1} at Portageville in 2010.

Table 3. Soybean yields main effects in objective 1 analyzed by placement. Data were combined over site-year, location, MAP rate, and P enhancer.

Placement	Grain Yield
	Mg ha^{-1}
No-till/ broadcast	3.06
Strip-till/ deep banded	3.00
$LSD_{(0.10)}$	0.05

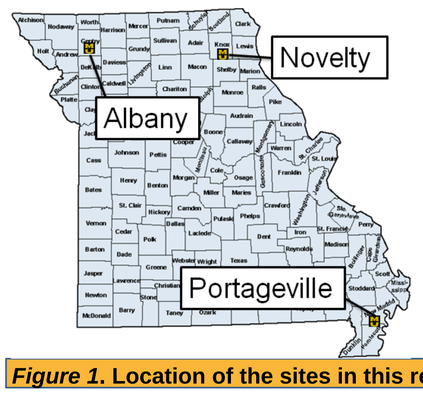

Figure 1. Location of the sites in this research.

RESULTS

<u>Objective 1</u>
- P-Max applied with 56 kg P_2O_5 ha^{-1} MAP had slightly lower plant populations compared to P-Max applied the other fertilizer rates and non-treated P, but P-Max applied with the 112 kg P_2O_5 ha^{-1} MAP increased plant populations 26,000 plants ha^{-1} over the same MAP rate with no enhancer (Table 1).
- None of the factors conducted in this study affected dry weights or grain moisture (Table 2).
- Placement was the only factor that had an effect on soybean yields. No-till/broadcast yielded 0.06 Mg ha^{-1} higher than strip-till/deep banded (Table 3).

<u>Objective 2</u>
- When no P enhancer was applied at Novelty, the non-limed treatment increased soybean dry weights 0.51 Mg ha^{-1} more compared to the lime treatment (Table 4). Soybean dry weights of AVAIL and P-Max were 0.31 to 0.4 Mg ha^{-1} lower than the non-treated when no lime was applied. AVAIL increased dry weights 0.48 Mg ha^{-1} when lime was not applied compared to when lime was added. At Portageville, AVAIL applied with no lime increased dry weights 1 Mg ha^{-1} over the non-treated control with no lime application and 1.4 Mg ha^{-1} compared to AVAIL in conjunction with a lime application.
- Soybean dry weights were not affected by P source (Table 5).
- In 2011 at Novelty, TSP in conjunction with lime, DAP with no application of lime, and the non-P fertilized lime treatment had higher yields compared to DAP in combination with a lime application (Table 5). DAP yielded 0.12 Mg ha^{-1} lower than the non-treated control at Novelty in 2012. At Portageville, applying no fertilizer resulted in lower yields compared to when either DAP or TSP was applied. P-Max paired with TSP had soybean yields 0.26 Mg ha^{-1} lower than P-Max paired with DAP and 0.19 Mg ha^{-1} lower than AVAIL paired with TSP.

Table 4. The effect of P enhancers on soybean dry weights in objective 2. Data were combined over site-year and P source.

	Soybean dry weights			
	Novelty		Portageville	
	Liming Application		Liming Application	
P enhancers	None	Recommended	None	Recommended
	Mg ha^{-1}		Mg ha^{-1}	
Non-treated	5.79	5.28	9.13	9.99
AVAIL	5.39	4.91	10.13	8.73
P-Max	5.30	5.45	9.76	8.91
$LSD_{(0.10)}$	0.39		1.00	

Table 5. Soybean dry weights and yield results based on P source in objective 2. Data were combined over site-year, location, P source, and P enhancer except for yield (NS = not significant).

		Grain Yield					
		Novelty 2011		Novelty	Portageville		
		Liming Application			P enhancers		
P source	Dry weights	None	Recommended	2012	Non-treated	AVAIL	P-Max
	Mg ha^{-1}	Mg ha^{-1}		Mg ha^{-1}	Mg ha^{-1}		
Non-treated	6.54	3.19	3.17	1.38	3.78	3.82	3.74
DAP	6.80	3.22	3.07	1.26	4.07	4.16	4.26
TSP	6.81	3.21	3.23	1.32	4.17	4.19	4.00
$LSD_{(0.10)}$	NS	0.09		0.07	0.12		

CONCLUSIONS

- Strip-till/deep banding placement did not increase soybean production following corn.
- The application of lime the growing season before soybeans did not result in an increase in dry weights or yields.
- P enhancers showed limited improvements to soybean production when they were applied for the prior corn crop under the conditions observed in these experiments.

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