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Efficacy of Broadcast Phosphorus Fertilizer Applied in Fall or Spring for No-Till Corn and Soybean

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Abstract
Broadcast fertilization could be an inefficient placement method with no-till because phosphorus (P) tends to accumulate at or near the soil surface. However, long-term research at this farm has shown no difference between banded and broadcast P fertilizer placement methods for corn and soybean managed with no-till or chisel-plow tillage, even with significant stratification of soil-test P. One possible explanation for this result is that broadcast P was always applied in the fall because this is what most Iowa farmers do. We theorize that such an advance application could provide sufficient time for fertilizer granules or dissolved P to move below the residue cover as a result of rain, freezing and thawing, and/or macrofauna activity. To test this hypothesis, a study was conducted to compare fall and spring broadcast P fertilizer application for no-till corn and soybean.

Keywords
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Introduction

Broadcast fertilization could be an inefficient placement method with no-till because phosphorus (P) tends to accumulate at or near the soil surface. However, long-term research at this farm has shown no difference between banded and broadcast P fertilizer placement methods for corn and soybean managed with no-till or chisel-plow tillage, even with significant stratification of soil-test P. One possible explanation for this result is that broadcast P was always applied in the fall because this is what most Iowa farmers do. We theorize that such an advance application could provide sufficient time for fertilizer granules or dissolved P to move below the residue cover as a result of rain, freezing and thawing, and/or macrofauna activity. To test this hypothesis, a study was conducted to compare fall and spring broadcast P fertilizer application for no-till corn and soybean.

Materials and Methods

Four single-year trials were conducted in 2005 and 2006; one with corn and one with soybean each year. Soils were Marshall in three trials and Exira in the fourth. For each crop, the no-till management histories were one year for one site and ten years for the other. Treatments were 0, 20, 40, 60, 80, or 100 lb P_2O_5/acre as granulated triple superphosphate fertilizer applied in fall (in the last week of October or November) or in spring one to three days before planting the crops. Corn was planted with a 30-in. row spacing on April 28, 2005 and on April 23, 2006. Nitrogen was uniformly applied across all corn plots in spring at a rate of 120 to 150 lb N/acre. Potassium fertilizer was uniformly applied across all corn and soybean plots at 120 lb K_2O/acre.

Results and Discussion

Initial soil-test values (Table 1) showed significant stratification of soil P, organic matter, and pH at all sites. In 2005, soil-test P at both sites tested in the Low interpretation class (9–15 ppm) when measured either in the top 3 in. of soil or as the average of 0–3 and 3–6-in. sampling depths. In 2006, soil-test P at both sites tested borderline between the Optimum (16–20 ppm) and High classes (21–30 ppm) when measured in the top 3-in. layer of soil but borderline between the Low and Optimum classes as the average of the 0–3 and 3–6-in. sampling depths.

Timely and adequate rainfall produced corn yields that were higher in 2006 than in 2005. The average corn yield in 2005 for P rates of 40 to 100 lb P_2O_5/acre was 172 bushels/acre and in 2006 it was 207 bushels/acre. Soybean yields were similar in both years. As expected, due to the initial soil-test P values, both crops responded to P application in 2005 but only soybeans responded in 2006. Responses in 2005 were smaller than expected, however, and yield differences between the control and the higher P treatments were 4 to 7 bushels/acre of corn and 2 to 4 bushels/acre of soybeans. Figure 1 shows yields for the responsive corn trial and yield averages across the two responsive soybean trials.

Both crops clearly responded up to 40 lb P_2O_5/acre, but there was high variability for the higher rates (60 to 100 lb P_2O_5/acre). The apparent yield differences among the data points for the higher rates and the two times of P application were small and not statistically significant. The yield variability for the higher P

rates seems very large due to the scale used in the graphs but yield differences were small. Therefore, we fitted one response equation to all data for each crop (Figure 1). The response curves for each crop indicated an average response up to rates of 60 to 70 lb P_2O_5/acre.

The crop responses to P applied in fall or spring did not clearly confirm our theory for a lower efficacy of P broadcast in spring. There was no difference for soybean. Although data points in the corn graph suggest that the fall application was better for some P rates, that was not the case for all rates and differences were not statistically significant.

Results of early corn and soybean growth responses (plant weights measured at the V5 to V6 growth stages) (data not shown) also indicated no difference between fall and spring P application. This result is important because P fertilizer for the spring treatment was broadcast only one to three days before planting the crops.

Table 1. Selected initial soil-test values at the sites.

Site	Year	Crop	Depth	Soil P	OM	pH
			(in.)	ppm	(%)	
1	2005	Corn	0–3	15	4.2	7.6
			3–6	5	2.9	6.9
2	2005	Soybean	0–3	14	4.4	6.6
			3–6	7	3.6	5.4
3	2006	Corn	0–3	22	4.4	5.8
			3–6	11	3.1	5.4
4	2006	Soybean	0–3	20	4.0	6.4
			3–6	11	3.2	5.6

Soil P, Bray-1 test; OM, organic matter.

Results and Discussion

The results of these four trials showed no clear difference in yield response to broadcast P fertilizer applied in fall or spring for no-till corn and soybean. These results must be interpreted together with results from a long-term study at this farm that indicated no difference between broadcast and banded P application for these crops. Therefore, perhaps the conditions in this region of Iowa (soil properties, rainfall patterns, root growth, etc.) allow for efficient use of broadcast P fertilizer in no-till management. New trials are being conducted in 2007 at this farm and at other farms to evaluate crop responses under different conditions.

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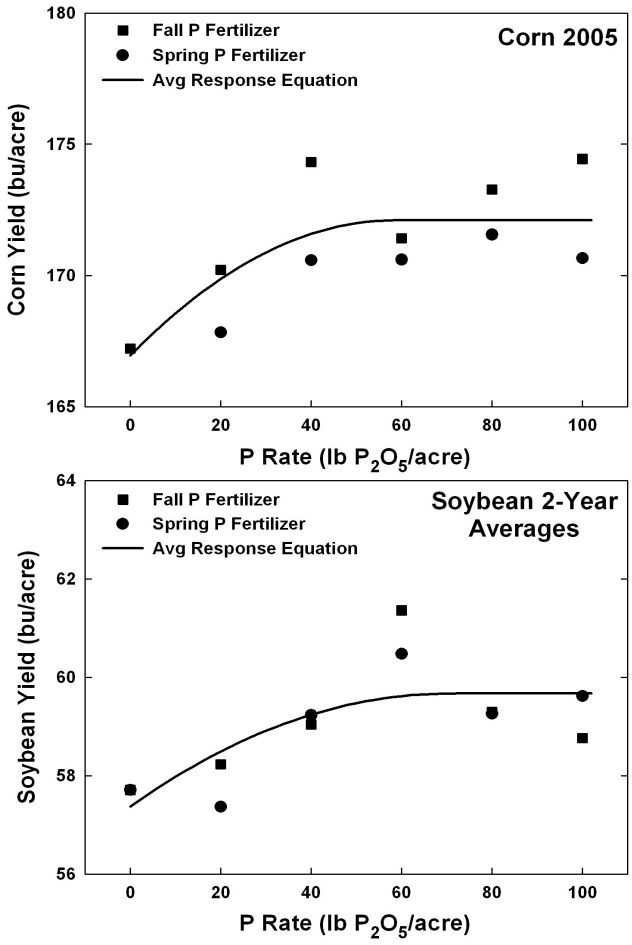

Figure 1. Yield response to P and time of application for one responsive corn trial and for averages across two responsive soybean trials.