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Effect of Phosphorus Fertilizer Broadcast in Fall or Spring on Yields of No-Till Corn and Soybean

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Abstract
A three-year study was conducted to evaluate the efficiency of fall or spring broadcast phosphorus (P) fertilization for no-till corn and soybean. Some believe broadcast fertilization is a less efficient placement method than banding for no-till because P tends to accumulate at or near the soil surface. However, long-term research has shown no difference between band and broadcast P fertilizer placement methods for 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. Such application date in advance to planting the crops could provide sufficient time for fertilizer granules or dissolved P movement below the residue cover as a result of rain, freezing and thawing, and/or macrofauna activity. Therefore, this study was planned to test this hypothesis by comparing broadcast fertilization in fall and spring for no-till corn and soybean.

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Introduction

A three-year study was conducted to evaluate the efficiency of fall or spring broadcast phosphorus (P) fertilization for no-till corn and soybean. Some believe broadcast fertilization is a less efficient placement method than banding for no-till because P tends to accumulate at or near the soil surface. However, long-term research has shown no difference between band and broadcast P fertilizer placement methods for 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. Such application date in advance to planting the crops could provide sufficient time for fertilizer granules or dissolved P movement below the residue cover as a result of rain, freezing and thawing, and/or macrofauna activity. Therefore, this study was planned to test this hypothesis by comparing broadcast fertilization in fall and spring for no-till corn and soybean.

Materials and Methods

Five single-year trials were conducted from 2005 through 2007 on five different sections of the farm. The soil series were Marshall (sites 1, 2, and 3) or Exira (sites 4 and 5). Soil pH and organic matter (0–6 in. depth) ranged from 5.6 to 7.2 and 2.7 to 4.0, respectively. The no-till management histories ranged from four to six years. Treatments were 0, 20, 40, 60, 80, or 100 lb P_2O_5/acre applied using granulated triple superphosphate in fall (late October or November) or in spring within a week prior to planting the crops. Corn was planted in rows spaced 30 in., and soybean was drilled in rows spaced 10 in. Nitrogen and potassium were applied across all plots as needed following recommendations.

Table 1 shows that the soils tested low to high according to Iowa State University soil-test P interpretations for a 6-in. sampling depth for Marshall (high subsoil P) and Exira (low subsoil P) soils (Extension publication PM 1688). As expected, and as is commonly seen in Iowa, there was significant soil P stratification at all sites. Research at this farm and others have shown, however, that a shallow sampling depth for no-till results in higher soil-test values but seldom improves the prediction of crop response to P.

Results and Discussion

Timely and adequate rainfall determined that crop yields were highest in 2006. Average corn yields were 170 and 203 bushels/acre in 2005 and 2006, respectively. Average soybean yields were 58, 63, and 53 bushels/acre in 2005, 2006, and 2007, respectively. Yield data and analysis of variance for each trial (not shown) indicated that P fertilization increased yield only at the soybean sites 2 and 4. Analysis of variance also indicated that the timing of the broadcast P application did not affect the corn or soybean yield response at any site. No yield response was expected at the site testing High (site 3) but a response was expected at the other sites. Previous Iowa research in fields managed with various tillage systems and using broadcast or band placement methods has shown that the probability of corn and soybean response to P is about 80%, 65%, 25%, 5%, and less than 1% for soils testing very low, low, optimum, high, and very high, respectively.

Figure 1 shows average yields across the two soybean responsive trials. The yield data points

for the timing of P application are shown in the graph although apparent differences were not statistically significant. Therefore, we fitted one average response equation. The yield data points and the average response curve show a response up to about 60 lb P_2O_5/acre. This rate is in agreement with recommendations because these two responsive sites tested borderline between low and optimum.

The crop responses to P applied in fall or spring did not confirm our theory, which was that a lack of difference between broadcast and band P placement methods shown at this farm and many other fields during the last decade could have been explained by broadcast fertilization in the fall. The results of these trials showed no significant difference between the timing of P application for corn or soybean.

We also measured early crop growth and plant P uptake responses at V5 to V6 growth stages, although data are not shown in this summary report. Results showed that P fertilization increased early growth and early P uptake only for soybean at site 5 (where there was no grain yield response), and that there was no clear difference between fall and spring broadcast P application.

The lack of difference between fall or spring broadcast P fertilization observed in trials at this farm coincides with the results from 15 other similar trials conducted during the last three years in other regions of Iowa.

Conclusions

The results of this study showed no difference in yield response of no-till corn or soybean to broadcast P fertilization in fall or spring. The results must be interpreted together with previous results from many fields (including an ongoing long-term study at this farm and four others) showing no consistent or large yield response to P placement methods for corn or soybean managed with no-till or chisel-plow tillage. We believe that Iowa conditions (such as soil properties, rainfall patterns, and root growth patterns among others) allow for efficient use of broadcast P fertilizer applied in the fall or spring.

Acknowledgements

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Table 1. Sites and initial soil-test P.†

			Bray-1 soil-test P (ppm)			
Site	Year	Crop	0–3 in.	3–6 in.	0–6 in.	Class‡
1	2005	C	15	5	10	Low
2	2005	S	14	7	11	Opt.
3	2006	C	22	11	16	High
4	2006	S	20	11	15	Low
5	2007	S	13	7	10	Low

†C, corn; S, soybean.
‡Interpretation classes for the Marshall soil (high subsoil P, sites 1, 2, and 3) and Exira soil (low subsoil P, sites 4 and 5).

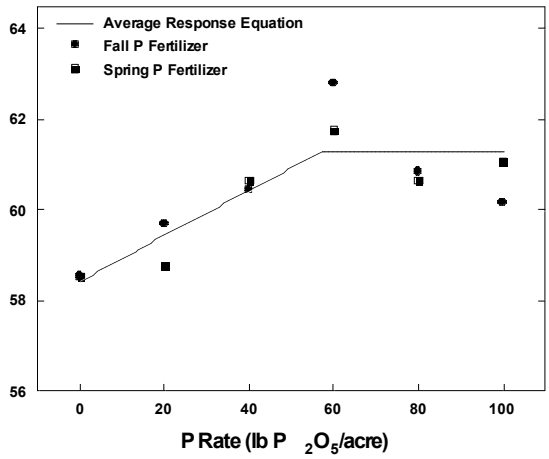

Figure 1. Average yield response to P and time of application across two soybean responsive trials.