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Corn and soybean responses to deep-band phosphorus and potassium

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Abstract
Broadcast fertilization of phosphorus (P) and potassium (K) is a popular and low-cost fertilizer application method. A band application theoretically could further increase yield of row crops or reduce the optimum fertilization rate under some conditions. Concentrating these nutrients in bands could increase nutrient uptake in soils with unusually high capacity to fix P and K and when root growth is restricted by unfavorable soil conditions. Particularly with no-till or ridge-till management, deep banding also could increase nutrient uptake and yield compared with broadcast or banding with the planter when the soil surface layer becomes drier.

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INTEGRATED CROP MANAGEMENT

Corn and soybean responses to deep-band phosphorus and potassium

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Previous research conducted in Iowa showed little advantage of banding P with the planter. Thus, Iowa fertilizer recommendations have focused on broadcast fertilization. Currently, starter (N-P-K) fertilization is recommended only under special conditions such as in cold and wet soils and with heavy residue cover (see Iowa State University Extension Publication PM 1688, General Guide for Crop Nutrient Recommendations in Iowa [1]). However, research in Minnesota during the early 1990s and farmers' observations suggested possible problems with broadcasting K for ridge-till corn that were not alleviated with starter fertilization. Also, K deficiency symptoms have been observed over the years in corn managed with various tillage systems, mainly when spring rainfall is below normal. The latter problem was especially evident in the 2000 growing season. See the June 26, 2000, ICM newsletter article Potassium Deficiency Symptoms in Corn [2].

Current research

Because of these observations, since 1994 more than 100 experiments were conducted at research farms and on producers' fields to study corn and soybean responses to the placement of granulated P and K fertilizers in no-till, ridge-till, and chisel-plow tillage systems. Broadcast and deep-banded fertilizers were applied in the fall. Deep bands, 30 inches apart, were coulter-knife injected 5 to 7 inches below the soil surface. The crops were planted directly above the tilled knife track, except when soybean was drilled. The planter bands were placed 2 inches to the side and 2 inches below the seeds (this placement was not evaluated for drilled soybean).

Phosphorus

The P placement method seldom influenced grain yield for any crop or tillage. Figure 1 summarizes results for trials at the research farms that compared the three placements for no-till and chisel-plow tillage, and Fig. 2 shows data for producers' ridge-till fields. Data for trials in producers' no-till fields are not shown because only the broadcast and deep-banding methods were compared and results were similar. The banded P almost always increased corn early growth in no-till and ridge-till fields. The lack of yield difference between the placement methods was observed with application rates ranging from 28 to 120 lb P_2O_5/acre. Although a few fields tested very low in P, no field tested less than 7 ppm (Bray-1 test). Results of another study in a north central Iowa field testing very low in P (2 ppm) showed that at low P application rates (25 lb P_2O_5/acre) banding with the planter produces higher yields than broadcasting. At that site, however, only currently recommended broadcast rates or a combination of both placements achieved maximum yield and maintained soil-tests values in the optimum range.

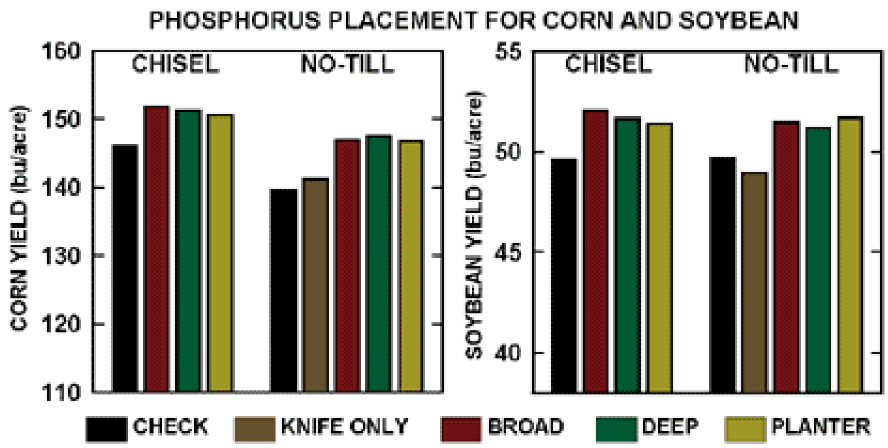

Figure 1. Phosphorus placement and tillage effects on corn and soybean yields.

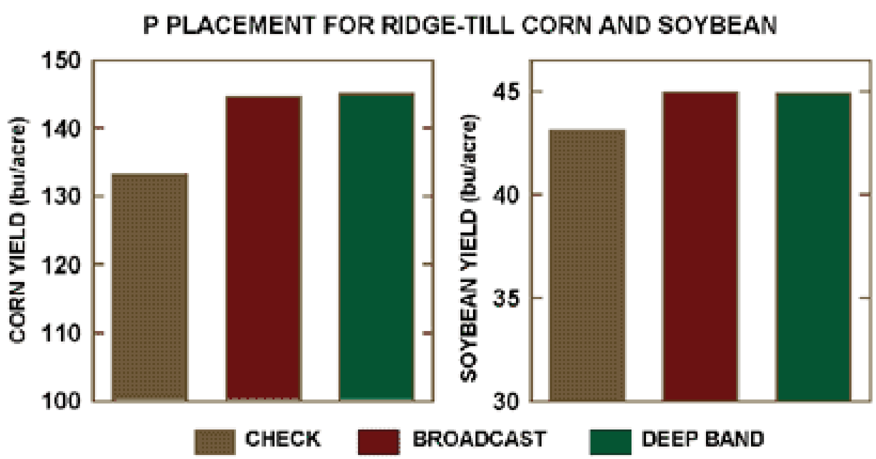

Figure 2. Effect of the phosphorus placement on yield of ridge-till corn and soybean.

Planting on top of a fall-applied coulter-knife pass without applying fertilizer never influenced the yield of soybean under any tillage and of corn under ridge-till or chisel-plow tillage. No-till corn yield was increased by approximately 2 to 3 bu/acre on average over the strict no-till check (Fig. 1). This coulter-knife effect was not observed when either low or high P rates were applied. This result, and the fact that the coulter-knife pass increased early plant P uptake markedly (data not shown), suggest a direct or indirect effect of the coulter-knife pass on soil P availability in no-till.

Potassium

In contrast to results for P, deep K banding increased corn yield over the broadcast or planter-band placement. Figure 3 summarizes data for trials at the research farms and Fig. 4 data for ridge-till fields. The differences were smaller for soybean, and the two band placements often did not differ. The differences between the placements were similar for K rates ranging from 35 to 140 lb K_2O/acre. Across all fields and years, the corn yield advantage of the deep banding over the other two placement methods was approximately 8 bu/acre for ridge-till; 4 to 5 bu/acre for no-till, including data from producers' fields not shown in Fig. 3; and approximately 2 bu/acre for the chisel-disk tillage. The corn response to deep band K usually was larger and more consistent for ridge-till fields than for the other tillage systems, and in many trials even high rates of broadcast K did not increase yield at all over the control. In no-till fields, the response to deep band K was consistent across fields but its magnitude varied markedly. The results clearly show that deep banding K reduces the yield gap between the chisel-plow and no-till systems (Fig. 3).

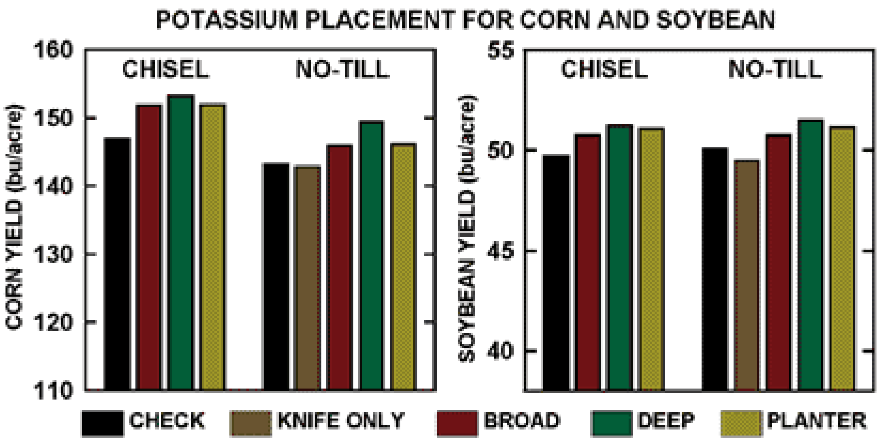

Figure 3. Potassium placement and tillage effects on corn and soybean yields.

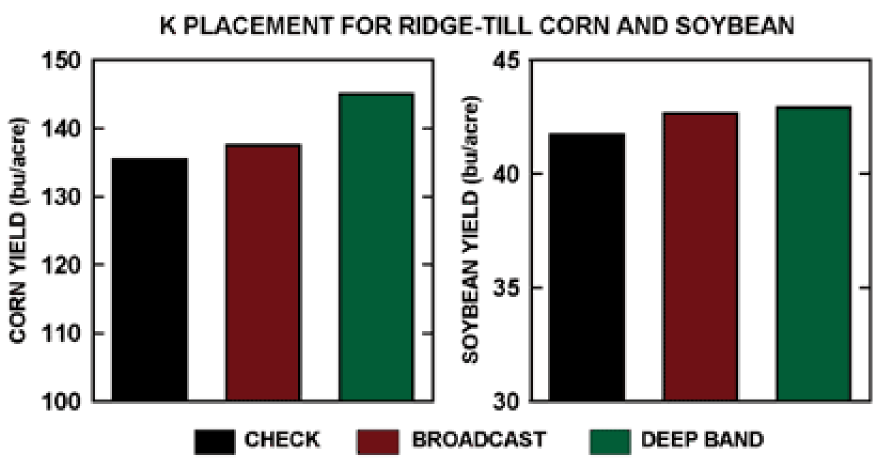

Figure 4. Effect of the potassium placement on yield of ridge-till corn and soybean.

The response to deep-band K was explained by the deep-placed K because planting on top of the coulter-knife without K fertilization seldom increased yield over the check in the K trials (where P was uniformly applied at high rates). Comparisons of separate P and K applications with a P-K mixture in trials conducted on the producers' fields (data not shown) confirmed that the responses due to deep banding were due to the deep-banded K. Responses frequently were observed in high-testing soils and could not be solely explained by K stratification. It is likely that the responses were related to weather conditions, particularly soil moisture. Under normal conditions, corn grown with no-till or ridge-till draws a higher percentage of nutrients from the soil nearer the surface, because of the higher nutrient levels present. However, when surface soil layers become drier, root development in deeper portions of the soil profile increases. When this happens, the portion of the root system actively taking up nutrients can be below the zone of highest nutrient concentration.

Summary

Deep banding of K may provide distinct yield advantages by making K more available in ridge-till and no-till fields, even on soils that test optimum to high in K. Producers can deep-band P at the same time to increase early corn growth, which could be important in some conditions. A thorough economic analysis of these results was not completed at this time. Deep banding increases fertilizer application costs, but the magnitudes of the yield responses suggest that deep banding will be cost-effective in most ridge-till fields and in many no-till fields, but not in a chisel-plow system.

The likelihood of large responses to deep banding of K increases when late-spring or early summer rainfall is below normal. Although the results showed that only planting on top of a knife track after deep banding K markedly reduces the yield gap between the chisel-plow and no-till systems, responses indicated in Fig. 1 suggest that tillage itself may increase yield under some conditions. A previous article in this newsletter discusses some aspects of fall strip tillage for no-till (Tillage in 2001: Fall Strip-Tillage [3], August 21, 2000).

The economic benefit of deep banding can be increased in two ways. An ongoing on-farm project in no-till fields shows that a combination of fall strip tillage, anhydrous ammonia application, and deep banding of P and K produces higher yields and does not increase costs significantly compared with a separate broadcast P and K application. Also, deep banding the needed P and K once for the 2-year corn-soybean rotation will produce yield increases in both crops equivalent to application before each crop.

This article originally appeared on pages 166-168 of the IC-484(22) -- September 18, 2000 issue.

Links:
[1] http://www.extension.iastate.edu/Publications/PM1688.pdf
[2] http://www.ipm.iastate.edu/ipm/icm/2000/6-26-2000/kdef.html
[3] http://www.ipm.iastate.edu/ipm/icm/2000/8-21-2000/striptillage.html

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