

Phosphorus and Potassium Management for Corn and Soybeans Managed with No-Till and Chisel Plow Tillage

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Introduction

A study was initiated in 1994 to evaluate phosphorus (P) and potassium (K) fertilizer rates and placement methods for corn and soybeans managed with no-till and chisel plow tillage. No-till management resulted in little or no incorporation of residue and fertilizer into the soil. Broadcast fertilization has generally been inefficient with no-till because both nutrients accumulate near the soil surface. Subsurface banding of P and K fertilizers, however, can be more effective.

Procedures

The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown in rotation on adjacent areas of Mahaska and Nira soils by alternating crops each year. Tillage and fertilization treatments are applied for both crops, which are planted with a 30-in. row spacing. Plots managed with chisel plow tillage are chisel plowed in the fall and field cultivated or disked in the spring as needed. The fertilizer placement methods were broadcast, deep-band, and band with the planter until 2001, when deep-band treatments were discontinued. Broadcast fertilizers are applied in the fall. Planter attachments apply bands 2 in. below and 2 in. beside the seed. Fertilizer rates until 2001 included a check, rates to supply about one-half the estimated maintenance needs (28 lb P_2O_5 /acre or 35 lb K_2O /acre), and full maintenance (56 lb P_2O_5 /acre or 70 lb K_2O /acre). Beginning in 2002, higher annual broadcast P and

K rates (112 lb P_2O_5 /acre or 140 lb K_2O /acre) were applied to plots that had received one-half those rates, both deep-banded and banded with the planter; however, they have not increased yield over the maintenance P and K application rates and data are not shown.

Summary Results

Tillage Effects. Soybean yield has been 1 to 2 bushels/acre less with no-tillage. However, corn managed with tillage averaged 8 bushels/acre more until 2003 and has been 22 bushels/acre more during the last two years. Perhaps increased residue accumulation explains this result. A very large difference (30 bu/acre) in 2005 is probably explained by much slower early corn growth with no-till in May and June for all fertilizer placement methods. Early growth differences for soybean were small; it is less sensitive to early growth restrictions.

Phosphorus Fertilization Effects. Results have shown little or no response to P until 2003 (Table 1). Soil-test P (high in 1994) decreased to a value between low and optimum by 2002, and has been low since then. During the last two years, there was a small response to P in soybeans and a larger response in corn. The response was larger for no-till than for chisel plow tillage, although the difference was more pronounced with corn. The larger response with no-till is explained by a large impact of drought on the yield of the no-till checks. For example, the tillage effect was 28 bushels/acre for the corn checks but only 8 to 13 bushels/acre for the highest P rate.

The P application method has not affected crop yield in the past, although occasionally no-till corn yield was slightly more for the planter-

band method. However, the last two years have shown a clear advantage for this method. On average, banded P produced 7 bushels/acre more than broadcast P. This difference was larger in 2005, probably because of the drought.

Potassium Fertilization Effects. Both crops have shown a yield response to K fertilizer since 1994 (Table 1), although corn responses have been more consistent. The responses in the early years of this study together with data from other locations were used to update Iowa State University K recommendations in 2003, because it showed that higher soil-test K levels were needed to produce optimum crop yield. According to new interpretations, soil-test K was borderline between low and optimum in 1994, and values for the checks decreased to low by 2001.

Yield responses to K fertilizer until 2001 were slightly more for band placements than for the broadcast placements, mainly for the deep-band method (not shown) that was discontinued. In the last two years, the planter-band method has

maintained this small advantage only for no-till corn, about 3 bushels/acre on average.

Conclusions

Tillage has not had large and consistent effects on soybean yield over the years, but corn yield has been higher with tillage. This difference has increased over time.

Crop responses to P fertilization developed only recently, when soil-test P of plots receiving no P for years decreased to low. Crop responses to K fertilization since 1994 have been reasonable because soil-test K levels in check plots were between the low and optimum, but have decreased to low over time.

Differences between fertilizer placement methods have been small in the past, but P and K banding for no-till corn was better than broadcast for the last two years, probably because of the increasing residue accumulation for this tillage system. Continuing this study should indicate if tillage and placement trends continue into the future.

Table 1. Average effects of tillage, fertilizer placement method, and annual phosphorus and potassium rates on corn and soybean grain yields from 1994 to 2003 and for the last two years (2004 and 2005).

| Period | Crop | Tillage | Phosphorus (lb P ₂ O ₅ /acre) | | | | Potassium (lb K ₂ O/acre) | | | | | |
|--------|---------|---------|---|-----------|-----|---------|--------------------------------------|-------|-----------|-----|---------|-----|
| | | | Check | Broadcast | | Planter | | Check | Broadcast | | Planter | |
| | | | Grain Yield (bu/acre) | | | | | | | | | |
| 94-03 | Soybean | Chisel | 54 | 54 | 55 | 54 | 55 | 52 | 55 | 54 | 53 | 54 |
| | | No-till | 51 | 52 | 53 | 53 | 53 | 52 | 53 | 52 | 53 | 52 |
| | Corn | Chisel | 156 | 157 | 157 | 157 | 156 | 154 | 161 | 163 | 162 | 165 |
| | | No-till | 145 | 148 | 147 | 151 | 151 | 147 | 154 | 156 | 154 | 158 |
| 04-05 | Soybean | Chisel | 55 | 56 | 56 | 54 | 57 | 58 | 60 | 60 | 59 | 60 |
| | | No-Till | 51 | 56 | 57 | 54 | 55 | 53 | 58 | 57 | 56 | 56 |
| | Corn | Chisel | 182 | 181 | 186 | 195 | 188 | 193 | 195 | 191 | 196 | 204 |
| | | No-till | 154 | 167 | 173 | 174 | 180 | 165 | 167 | 170 | 176 | 166 |