Long-Term Corn Response to Nitrogen and Potassium in Northern Iowa

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Introduction

Results of a long-term study with continuous corn conducted at this farm from 1963 to 2001with several nitrogen (N), phosphorus (P), and potassium (K) fertilization rates showed a positive interaction between N and K, but not between N and P or between P and K. A deficiency of either N or K not only reduced the maximum corn grain yield level, but also limited the yield response to increasing rates of the other nutrient. A new study with continuous corn was established in 2013 and was evaluated until 2017 to further assess possible N by K interactions. A previous report summarized early years of this new study. These reports summarize data across the five years.

Materials and Methods

An experiment with continuous corn receiving several N and K fertilization treatments was established in 2013 in an area with Webster soil. The plots were managed with chisel-plow/disk tillage, a target corn population of 34,000 plants/acre, and a 30-in. row spacing. Annual treatments replicated three times and applied until 2017 were the combinations of five N rates (0, 75, 150, 225, and 300 lb N/acre) and four K rates (0, 24, 48, and 72 lb K_2O/acre). Both nutrients were applied in the spring before the last light disking using granulated urea and potassium chloride (potash) fertilizers. Grain yield was adjusted to 15.5 percent moisture. The blades of corn leaves opposite and below the primary ear were sampled at the silking growth stage (R1), and grain was sampled at harvest time for analyses of N and K concentrations.

Results and Discussion

The corn grain yield varied across the evaluation years, mainly in response to weather conditions. The average yield for the two highest N rates and plots receiving K fertilizer was 177, 145, 200, 215, and 265 bushels/acre in 2013, 2014, 2015, 2016, and 2017, respectively.

There were large grain yield increases from N fertilization, but smaller yield increases from K fertilization each year that did not differ statistically for the annual rates of 24, 48, or 72 lb K_2O/acre. In fall 2016, soil-test K by the dried sample procedure for the zero N rate was 113, 154, 187, and 217 ppm for K rates of 0, 24, 48, or 72 lb K_2O/acre, respectively (soil samples were not taken after the last corn harvest in 2017). Yield and K removal increased with increasing N rates. For the highest N rate, soil-test K for those K rates was 93, 129, 134, and 175 ppm. The soil-test K values range from the Very Low to High interpretation categories (see ISU Extension publication PM 1688).

Results are summarized by showing averages of grain yield and both N and K removed with grain harvest across the five years of the study. Data is shown for all N application rates, but for K we show data for plots where no K was applied and averages across all plots where K fertilizer was applied, because there were no statistically significant differences between the K application rates.

Figure 1 shows results for grain yield and N or K removed with grain harvest. The graph for yield shows a very large response to N, with or without K applied. With K applied, however, corn responded up to the highest N rate or 300 lb N/acre, whereas without K application yield was maximized by 225 lb N/acre. Furthermore, K application increased yield only with the highest N rate applied. Therefore, there was a positive N by K interaction, which means the response (and yield level) increased as the level of the other nutrient increased.

Results for ear-leaf and grain N and K concentrations are not shown. The N and K concentrations increased significantly with increasing N and K rates, but there was no clear interaction with N by K. However, Figure 1 shows the N and K removed with grain harvest showing a similar type of interaction to the one observed for grain yield, which is explained mainly by the effects on yield. This interaction is noteworthy because a corn response to a higher N rate with applied K was observed even for the lowest K rate applied. Therefore, the results do not imply that excess K is needed to allow corn to express its capacity to respond to N fertilization.

Conclusions

Adequate fertilization with both N and K were needed to optimize corn grain yield and allow corn to express its response potential. A K deficiency not only reduced yield for all N rates, but also reduced the corn capacity to respond to N fertilization.

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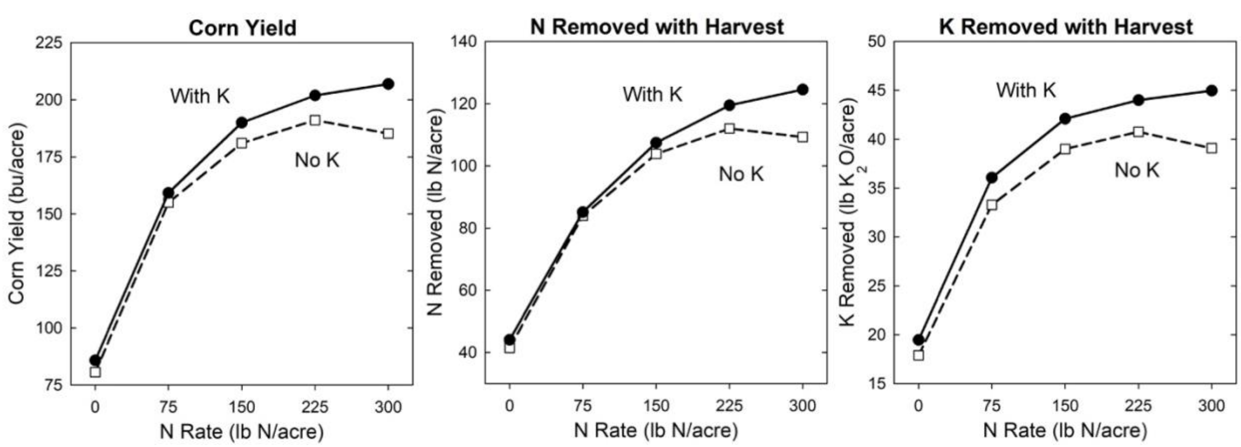

Figure 1. Corn grain yield and N and K removed with harvest as effected by N fertilization without K fertilization or for the average of three K fertilization rates (averages from 2013 to 2017).