Potassium Fertilization Rate Effects on Soil-Test Potassium and Yields of Corn and Soybeans

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Abstract
A 3-yr study was conducted to assess the effects of several potassium (K) fertilization rates on grain yield, K removal by corn and soybean, and soil-test potassium. This study complements long-term experiments at the farm that include fewer K application rates. The Iowa State University (ISU) soil-test K interpretations and fertilization guidelines were updated in 2003 based on research in many Iowa fields. One major change was to increase the soil-test potassium (STK) level suggested for optimum crop production. The category previously deemed Optimum, which ranged from 91 to 130 ppm (ammonium-acetate or Mehlich-3 K tests, 6-in. samples), was changed to Low, and the High category (131 to 170 ppm) was reclassified as Optimum. Fertilization with K is recommended to maintain this level.

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Introduction

A 3-yr study was conducted to assess the effects of several potassium (K) fertilization rates on grain yield, K removal by corn and soybean, and soil-test potassium. This study complements long-term experiments at the farm that include fewer K application rates. The Iowa State University (ISU) soil-test K interpretations and fertilization guidelines were updated in 2003 based on research in many Iowa fields. One major change was to increase the soil-test potassium (STK) level suggested for optimum crop production. The category previously deemed Optimum, which ranged from 91 to 130 ppm (ammonium-acetate or Mehlich-3 K tests, 6-in. samples), was changed to Low, and the High category (131 to 170 ppm) was reclassified as Optimum. Fertilization with K is recommended to maintain this level.

Materials and Methods

Two trials were established in 2004 and were evaluated until 2006. One trial (North) was established on an area with Webster soil and the crop sequence was corn-soybean-corn. The other soils (South) were Webster and Canisteo and the crop sequence was soybean-corn-corn. Treatments replicated four times were similar for both trials. Rates applied for the first crop were 0, 30, 60, 120, and 180 kg K_2O/acre (0-0-60 fertilizer). Before the second and third crop, all initial plots were divided into two subplots, and no K was applied to one subplot while 120 lb K_2O/acre was applied to the other. Crops were planted using a 30-in. row spacing. Cornstalks were chisel-plowed in the fall and field-cultivated in the spring. Soybean residue was field-cultivated in spring.

Results and Discussion

Initial STK was in the Optimum interpretation category for both trials. However, the average STK was 162 ppm for the North trial and 138 ppm for the South trial. Current ISU guidelines in Extension publication (PM-1688) indicate a 25% probability of moderate to small crop responses to K in this soil-test category, for which maintenance K rates are recommended.

Table 1 shows yields for the first year and for subplots of the second year and third year of each trial that did not receive 120 lb K_2O/acre. The first-year crops did not respond to K (an average response of 2 bushels/acre in both trials was not statistically significant). The response of second-year crops to K applied the previous year differed between trials. Soybeans of the North trial did not respond to K, however fertilized corn of the South trial yielded an average of four bushels/acre more. The data seemed to show that corn responded up to a rate of 180 lb K_2O/acre. This is unreasonable, however, because yields were similar for rates of 30, 60, and 120 lb K_2O/acre, and the higher yield for the high rate probably resulted from random variation.

Responses of third-year crops were larger. On average, fertilized corn of the North trial responded by nine bushels/acre and fertilized corn of the South trial responded by 11 bushels/acre. Trends across all K rates for both trials indicated no difference among the K fertilizer rates.

Crop yield for subplots for the second and third years that received 120 K_2O/acre were similar to yields of subplots not receiving this rate (data not shown). Therefore, the results indicate that the lowest rate used (30 lb K_2O/acre) applied once before the first crop resulted in as much yield response as higher rates for the three crops.

Table 2 shows K removal with grain harvest for the first and second years (grain was not sampled the last year). There was no fertilizer K effect on grain K concentration or K removal. A small yield response of corn grown the second year in the South trial did not result in increased K removal because grain K concentrations were highly variable (within and across years or fields) and was smaller for the high K rates.

Table 3 shows STK for samples taken in fall 2004 (between the first and second years) and in fall 2005 (between the second and third years). Analyses of soil samples taken after the 2006 harvest are not available yet. Data from the North trial showed expected results and, although they were affected by the degree of variability common to field plots, showed that STK decreased in non-fertilized plots, remained near initial values for the lower K rates, and increased in plots receiving the higher K rates. These results and the K removal results indicate that K application rate had a clear effect on STK after harvest in this trial.

Data from the South trial results are difficult to explain. Unexpectedly, data for samples taken after the first and second crops did not reflect the K rates applied the first year and STK increased for all treatments. Moreover, results for samples taken after the second year do not show a clear decrease in non-fertilized plots and a small or no decrease in fertilized plots. We cannot explain the differences between the two trials. Other research at this farm and other Iowa fields has shown high variability of STK from year to year that could not always be accounted by K removal. Research using additional soil-test methods is being investigated to better explain the observed results.

Conclusions

The results of this study confirmed a low probability of yield response to K fertilization when STK is in the Optimum category. A rate much lower than needed to maintain STK maintained high yield for three years. However, in one trial this rate did not maintain the initial STK. Results of the other trial demonstrated high temporal variability of STK due to poorly understood reasons. Although soil testing for K is a useful tool, the high degree of uncertainty indicates a need for continued research to improve soil K testing.

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Table 1. Grain yield as affected by 0 to 180 lb K_2O/acre applied once in 2004.

		K_2O/acre				
		0	30	60	120	180
		bushels/acre				
Year	Crop	North Trial				
2004	Corn	197	202	196	197	203
2005	Soybean	60	60	59	61	61
2006	Corn	195	205	207	208	197
		South Trial				
2004	Soybean	48	50	48	52	50
2005	Corn	185	188	188	186	195
2006	Corn	167	181	178	180	174

Table 2. Grain K removal for plots fertilized once with 0 to 180 lb K_2O/acre.

		K_2O/acre				
		0	30	60	120	180
		K_2O lb/acre				
Year	Crop	North Trial				
2004	Corn	30	30	29	28	27
2005	Soybean	95	95	93	96	93
		South Trial				
2004	Soybean	66	68	65	71	66
2005	Corn	52	54	50	51	55

Table 3. Soil-test K for plots fertilized once with 0 to 180 lb K_2O/acre.

		K_2O/acre				
		0	30	60	120	180
		Soil-test K (ppm)				
Season	Previous crop	North Trial				
Fall 04	Corn	158	161	165	179	200
Fall 05	Soybean	143	153	154	167	181
		South Trial				
Fall 04	Soybean	155	154	189	176	181
Fall 05	Corn	162	156	159	169	185