Potassium Fertilizer Effects on Yield of Corn and Soybean and on Potassium Uptake and Recycling to the Soil

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Introduction

Research has been conducted in Iowa to investigate potassium (K) fertilization of corn and soybean, but not at this farm. Insufficient K amounts in the soil or applied with fertilizer or manure significantly decreases crop yield end economic benefits to growers. Also, research in other locations has shown large soil-test K temporal variability within a season or from the fall to spring. Therefore, a study was initiated in 2009 to investigate these issues.

Materials and Methods

The study involved two identical field trials in adjacent field areas in order to evaluate both crops of the corn-soybean rotation each of the three years. One trial began with corn and the other with soybean. The study included several treatments, but we summarize results for two K treatments used for the recycling study. These treatments were a control that received no K and plots that received a high annual rate of 180 lb K_2O/acre (0-0-62 fertilizer). The high K rate was among rates that produced statistically maximum crop grain yield. The 2010 corn crop was lost due to poor and uneven stand resulting from excessive rainfall and soil nitrogen loss.

Plant samples were taken from all plots at the physiological maturity (PM) and at grain harvest. At PM, six corn plants and soybean plants from 15 sq ft of each plot were cut 2 in. above ground level, and were separated into grain and all other plant parts (stalks, leaves, and cobs for corn; and stems, leaves, and pod shells for soybean). At grain harvest, similar sampling procedures were followed for 10 corn plants and soybean plants in 50 sq ft. The residue sampled from each plot was divided into five equal portions, and one was removed at harvest time. The other four residue portions were placed in a mesh plastic bag flat on top of non-tilled ground, and one bag was removed approximately every 45 days from early December until early April. The plant samples were dried, weighed, and analyzed for K concentration to calculate dry matter yield and K accumulation. This report summarizes results for 2009, 2010, and 2011 crop years, although the last residue and soil samples were collected in spring 2012.

Results and Discussion

Yield and Potassium Uptake and Removal. As expected, corn and soybean yields, tissue K concentrations, K accumulation in tissues, and the response to K fertilizer varied greatly across trials and years. For this report, however, we show averages across all trials and years.

Table 1 shows that K fertilization caused a large grain yield increase for both crops, which is reasonable because the initial soil-test K was Low (100 ppm). Fertilization also increased grain K concentration, grain K accumulation, and residue dry matter yield in variable proportions (3 to 14% increase for corn and 0 to 22% for soybean). However, for both crops, K fertilization caused very large increases for residue K concentration and K accumulation in residue (increases of 34 to 38% for corn and 91 to 92% for soybean). Typically fertilization increases K accumulation in vegetative parts at PM, which was evident in corn but not soybean (46% increase in corn and 6% in soybean).

The results in Table 1 confirm a much lower grain K concentration in corn than soybean; and showed a much lower grain K concentration in corn grain than in corn residue, but a higher concentration in soybean grain than in soybean residue. An important result for crop production and K management was that K fertilization may increase corn or soybean yield or not, but always has a much smaller effect on K removal with grain harvest than in K accumulation in residue, which recycles to the soil.

The differences between corn and soybean in the distribution of K between grain and residue and in the dry matter production are very important criteria for K management. These differences determine that harvest of corn residue in addition to grain has a much greater impact on K removed from fields compared with grain harvest alone and soybean harvest. Corn residue often is being harvested for feed, bedding, or bioenergy.

Potassium Recycling to the Soil. The K accumulation in crop vegetative parts reached a maximum at the physiological maturity growth stage and then decreased over time. Figure 1 plots the amount of K remaining in plant tissue expressed as a percentage of the maximum at physiological maturity. The K recycling trend over time was similar for both K rates, except for higher K levels with the 180-lb rate, and was more gradual for corn than for soybean. The sharpest K loss to the ground occurred by early December, but soybean lost about 80 percent of the K whereas corn lost only about 50 percent. The additional residue K loss during winter and early spring was very small for soybean but still large for corn. By early April, the soybean and corn residue had 17 and 33 percent of the K remaining, respectively.

Study of effects of precipitation on K loss from plant tissue to the soil is not completed at this time. Preliminary results show that in order to reach a certain K loss, more rain is needed for corn residue than for soybean residue. This was explained by slower leaching of K from within the cornstalks.

The trends of K recycling to the soil partly explained temporal soil-test K variation. On average across all sampled plots, soil-test K in early April was 31 ppm higher than about a week after the previous fall crop harvest.

Conclusions

Potassium fertilization increased corn and soybean yield significantly in this low-testing soil. It also increased the K accumulation in crop vegetative tissue more than in grain. Therefore, residue harvest in addition to grain would greatly reduce the K recycled to the soil and increase future K fertilizer needs. There was a large K loss from mature plant tissue and residue to the soil in the fall, which occurred earlier for soybean than for corn. The significant K recycling explained lower soil-test K values early in the fall than in spring.

Acknowledgements

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Table 1. Dry matter yield and K content of corn and soybean plant parts. †

			Corn			Soybean		
Stage	**Plant part**	**Measurement**	**K0**	**K180**	**% Inc**	**K0**	**K180**	**% Inc**
Phys. Mat.	Vegetative	K accum. lb K_2O/acre	91	132	46	64.2	67.9	6
Harvest	Grain	Yield DM‡ bu/acre	146	162	11	52.4	57.5	10
		K conc. %	0.34	0.35	3	1.71	1.89	11
		K accum. lb K_2O/acre	33.6	38.2	14	64.3	78.4	22
	Residue	Yield ton DM/acre	4.0	4.1	3	1.7	1.7	0
		K conc. %	0.82	1.09	34	0.68	1.31	92
		K accum. lb K_2O/acre	78.6	108.2	38	27.3	52.3	91

†Data for corn (2 site-years) and soybean (3 site-years) sometimes were for different years so care should be taken with direct comparisons.
‡DM, dry matter.

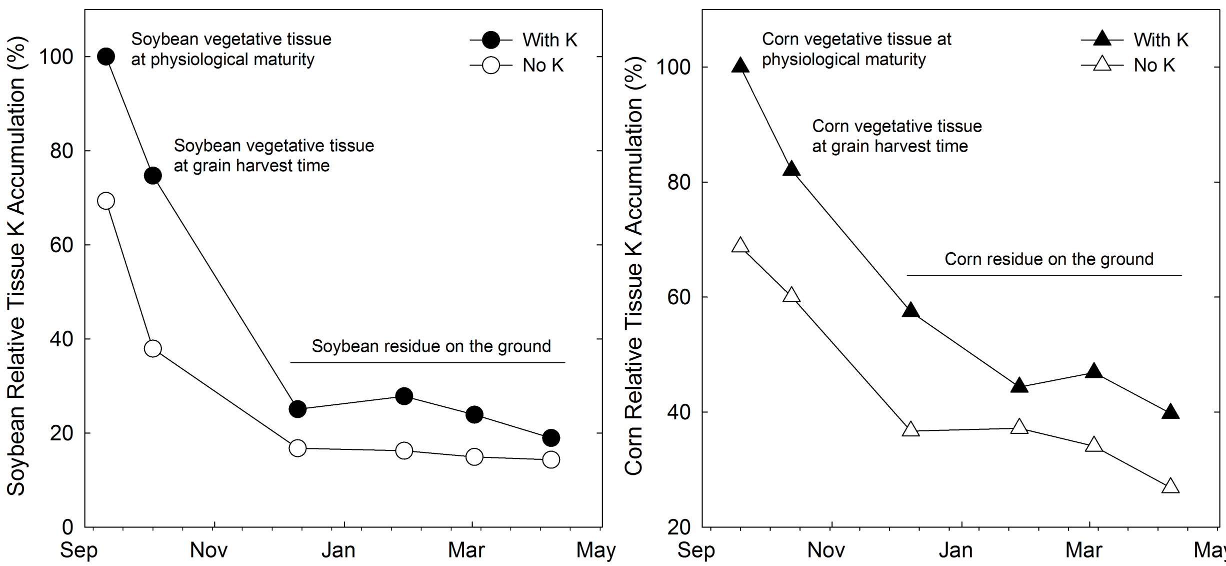

Figure 1. Amount of K remaining in corn and soybean residue over time expressed relative to the maximum amount in vegetative tissue at the physiological maturity growth stage for two K treatments (means across all site-years).