2013

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

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Abstract

Considerable research has been conducted in central Iowa to study potassium (K) fertilization rates and placement methods on corn and soybean grain yield, K uptake, and soil-test K values. However, no research has investigated K recycling to the soil by maturing plants and crop residue until the next crop is planted. The amount and the timing of the K recycled to the soil should have a significant impact on soil-test K values, and should explain a great deal of usually very high soil-test K temporal variability. Therefore, plots of several field K trials in central Iowa were used to investigate these issues.

Keywords

RFR A12129, Agronomy

Disciplines

Agricultural Science | Agriculture | Agronomy and Crop Sciences

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

RFR-A12129

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Introduction

Considerable research has been conducted in central Iowa to study potassium (K) fertilization rates and placement methods on corn and soybean grain yield, K uptake, and soil-test K values. However, no research has investigated K recycling to the soil by maturing plants and crop residue until the next crop is planted. The amount and the timing of the K recycled to the soil should have a significant impact on soil-test K values, and should explain a great deal of usually very high soil-test K temporal variability. Therefore, plots of several field K trials in central Iowa were used to investigate these issues.

Materials and Methods

The study involved one field trial with corn and soybean grown in rotation and the crop years 2008, 2009, 2010, and 2011; although the last crop residue and soil samples were collected in spring 2012. The study included several K rates, but we summarized results for two K rates used for the recycling study. These were a control that received no K fertilizer and an annual rate of 180 lb K_2O/acre (0-0-62 fertilizer). In 2008 and 2009 the trial included two different hybrids, which were considered separately for this study. Therefore, there was a total of five site-years for corn and one for soybean.

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 two 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 soil, and one bag was removed approximately every 45 days from early December until early April. The plant, grain, and residue samples were dried, weighed, and analyzed for K concentration to calculate dry matter yields and K accumulation.

Results and Discussion

Yield and potassium uptake and removal.
As expected, corn and soybean yields, tissue K concentrations, K accumulation in tissues, and the crop response to the 180-lb K rate varied greatly across trials and years. For this report, however, we show and discuss only averages across all years.

Table 1 shows that K fertilizer on average caused a small yield increase (6 and 3 bu/acre for corn and soybean, respectively). Larger responses were expected since control plots tested 86 to 111 ppm over the years. Potassium also increased grain K concentration, grain K accumulation, and residue dry matter yield in variable proportions (4 to 13% increase for corn and -5 to 15% for soybean). However, for both crops K fertilization caused very large increases for K accumulation in vegetative parts at PM, residue K concentration, and K accumulation in residue (63 to 75% increase for corn and 108 to 121% for soybean).

The results in Table 1 confirmed 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 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 important 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 corn and soybean vegetative parts reached a maximum at the PM growth stage and then decreased over time. Figure 1 shows this trend by plotting the amount of K remaining in plant tissue expressed as a percentage of the maximum observed at PM. 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. The sharpest K loss to the soil occurred between PM and early December, but soybean lost about 80 percent of the K, whereas corn lost only about 60 percent. The additional residue K loss during winter and early spring were very small for soybean but still large for corn. By early April, 11 and 24 percent of the K remained in soybean and corn residue, 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 14 ppm higher than about a week after the previous fall crop harvest.

Conclusions

Potassium fertilization increased corn and soybean yield 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 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 slightly lower soil-test K early in the fall than in spring.

Acknowledgements

We recognize support by the Iowa Soybean Association Checkoff and the International Plant Nutrition Institute.

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

			Corn			Soybean		
Stage	**Plant part**	**Measurement**	**K0**	**K180**	**% Incr.**	**K0**	**K180**	**% Incr.**
Physical Maturity	Vegetative	K accum,. lb K_2O/acre	52	86	66	33.2	69.1	108
Harvest	Grain	Yield DM‡, bu/acre	154	160	4	51.9	55.2	6
		K conc., %	0.29	0.31	8	1.84	1.98	8
		K accum., lb K_2O/acre	29.6	33.3	13	68.6	78.6	15
	Residue	Yield, ton DM/acre	2.7	2.8	4	1.2	1.1	-5
		K conc., %	0.44	0.72	63	0.44	0.97	121
		K accum., lb K_2O/acre	27.4	47.9	75	12.4	26.0	109

†Data for corn (5 site-years) and soybean (1 site-year) sometimes were for different years so care should be taken with direct comparisons.
‡DM, dry matter.

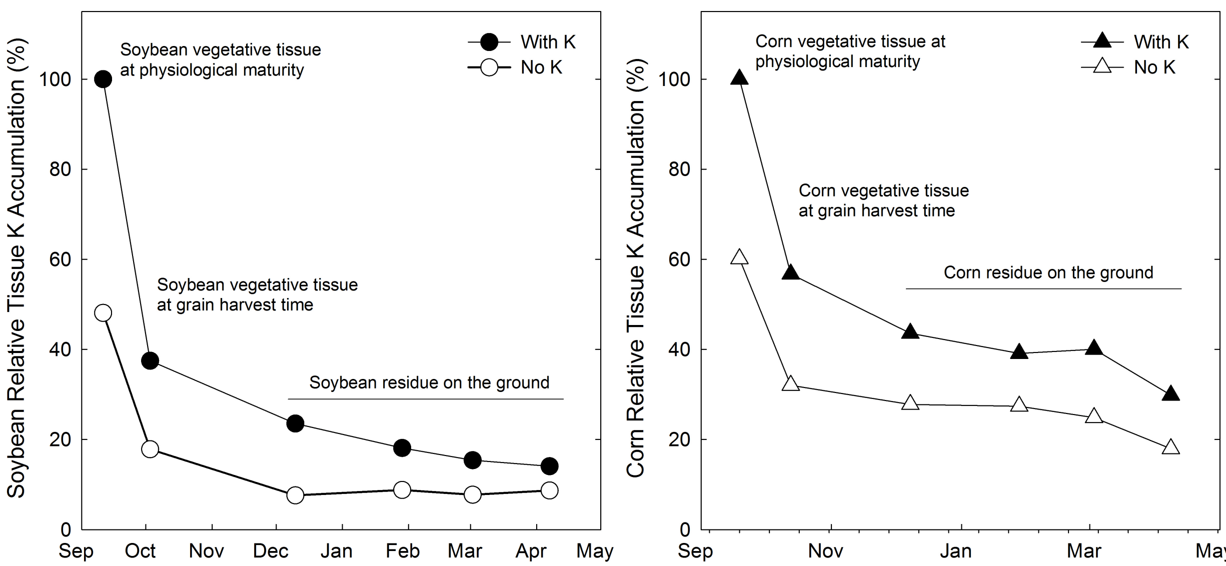

Figure 1. Amount of K remaining in corn and soybean residue over time expressed relative to the maximum amount in vegetative tissue at the physiological maturity growth stage for two K treatments (means across all site-years).