Use of Potassium in Starters for Corn in Reduced Tillage Production Systems

By W.B. Gordon

Application of starter phosphorus (P) and potassium (K) at corn planting often results in improved crop performance and yield. This starter effect is commonly attributed to improved early season nutrient availability and increased tolerance of early season stresses associated with cool, moist soil conditions. The results of two north central Kansas experiments exploring the effect of starter K in irrigated ridge-till corn production are reported in this article. Starter K improved corn yield in both studies, despite high soil test K levels.

The use of conservation tillage has increased in recent years because of its effectiveness in conserving soil and water. Potassium deficiency can be a problem on soils that have been managed with reduced tillage practices. The large amount of residue left on the soil surface can depress soil temperature early in the growing season. Low soil temperature can interfere with plant root growth, nutrient availability in soil, and crop nutrient uptake.

Soil temperature influences both K uptake by roots and K diffusion through the soil. Low soil water content or zones of soil compaction also can reduce K availability. Potassium uptake in corn is greatest early in the growing season and accumulates in plant parts at a relatively faster rate than either dry matter, nitrogen (N), or P. Cool spring temperatures can limit early-season root growth and K uptake by corn.

In plant physiology, K is the most important cation not only in regard to concentration, but also with respect to physiological functions. A deficiency in K affects such important physiological processes as respiration, photosynthesis, chlorophyll development, and regulation of stomatal activity. Plants suffering from K deficiency show a decrease in turgor resulting in reduced resistance to drought. The main function of K in biochemistry is its function in activating many different enzyme systems involved in plant growth and development. Potassium also influences crop maturity and plays a role in reducing disease and stalk lodging in corn. The appearance of K deficiency in fields managed with conservation tillage systems has been reported with greater frequency in recent years and has become a legitimate concern for producers.

Starter fertilizer applications have proven effective in enhancing nutrient uptake and yield of corn, even on soils

Potassium in starter fertilizer can boost early season corn growth and yield in some conditions.

Table 1. Starter fertilizer effects on V6 dry weight, K uptake, days from emergence to mid-silk, and yield of corn. Three-year average from Experiment 1, 2000-2002.

Treatments $N\text{-}P_2O_5\text{-}K_2O$, lb/A	V6 dry weight	V6 K uptake	Days to mid-silk	Grain yield, bu/A
	lb/A	lb/A		
0-0-0 check	210	6.2	79	162
30-15-0	382	10.9	71	175
15-30-5	355	15.2	71	173
30-30-0	395	11.2	71	184
30-30-5	460	15.2	68	195
LSD (0.05)	28	1.5	2	10

that are not low in available nutrients. The objective of these two studies was to determine if K applied as a starter at planting could improve K uptake and yield of corn on soils that had been managed in a ridge-tillage production system.

Two separate studies were conducted at the North Central Kansas Experiment Field. Both experiments were conducted on a Crete silt loam soil in areas that had been ridge-tilled since 1984. Both sites also were furrow irrigated. Potassium deficiencies had been observed in these two areas prior to the initiation of the studies. Ear leaf K concentrations had proven to be below published sufficiency ranges.

Experiment 1. This field experiment was conducted for three crop years, 2000-2002. Soil test results showed that initial pH was 6.2 and organic matter was 2.4%. Bray-1 P in the top 6 in. of soil tested high…40 parts per million (ppm), while exchangeable K tested very high…420 ppm. Soil test results in this experiment and in Experiment 2 are from composite samples (0 to 6 in. depth) that came from equal amounts of soil taken from the center, the shoulder, and middle of the row. Treatments consisted of the liquid starter fertilizer combinations 30-15-5, 15-30-5, 30-30-0, and 30-30-5 (total lb $N\text{-}P_2O_5\text{-}K_2O$/A). A no starter check was also included. Starters were made using 28% urea ammonium nitrate (UAN), ammonium polyphosphate (10-34-0), and potassium thiosulfate (KTS, 0-0-25-17). Nitrogen was balanced so that all plots received 220 lb N/A regardless of starter treatment. On plots receiving no K as KTS, ammonium sulfate was included in order to eliminate sulfur (S) as a variable. Starter fertilizer was applied 2 in. to the side and 2 in. below the seed at planting (2x2 starter).

The 30-30-5 starter treatment increased corn 6-leaf stage dry matter and tissue K content, decreased the number of days from emergence to mid-silk, and increased grain yield as compared to the 30-30-0 treatment (**Table 1**). A small amount of K applied as a starter on this soil testing high in K resulted in better growth, more nutrient uptake, and 11 bu/A greater yield than starter that did not include K. In all cases, the 30-30-5 starter also was superior to the 15-30-5 treatment, indicating that N is an important element of starter fertilizer composition in this system. All starter treatments improved growth and yield over the no-starter check.

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Table 2. Starter fertilizer effects on V6 dry weight, K uptake, days from emergence to mid-silk, and yield of corn. Two-year average from Experiment 2, 2002-2003.

Treatments $N\text{-}P_2O_5\text{-}K_2O\text{-}S$, lb/A	V6 dry weight	V6 K uptake	Days to mid-silk	Grain yield, bu/A
	lb/A	lb/A		
0-0-0-0 Check	208	6.9	82	161
30-15-0-0	290	8.8	76	185
30-15- 5-5	312	12.8	76	189
30-15-15-5	395	16.2	72	198
30-15-25-5	398	16.9	72	197
30-15-15-0	398	16.1	72	198
LSD(0.05)	31	1.9	2	11

of total Cl was 6, 12, 78, and 4 for grain, heads, stems, and leaves (**Figure 1**). Uptake and removal rates at maturity were 1.22 and 0.24 lb K_2O/bu and 0.29 and 0.02 lb Cl/bu (**Table 2**). Maximum uptake rates earlier in the season were 1.84 lb K_2O/bu and 0.30 lb Cl/bu.

Table 2. Average uptake and removal rates observed in this study.

	N[1]	P_2O_5	K_2O	Cl
	lb/bu			
Uptake				
At maturity	1.15	0.66	1.22	0.29
At maximum uptake	1.15	0.66	1.84	0.30
Removal				
At maturity	0.92	0.53	0.24	0.02

[1]Note: N deficiencies were observed in this study.

Summary

Uptake patterns vary considerably from nutrient to nutrient. At the end of the season in this irrigated spring wheat study, most of the N and P were located in the grain. Most of the K and Cl were found in the stems. Total uptake of N and P peaked near physiological maturity, whereas maximum uptake of K and Cl occurred earlier in the season during head emergence and stem elongation, and ended with flowering.

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Experiment 2. This 2-year experiment was conducted during the 2002-2003 growing seasons on a site that was lower in soil test K than the previous experiment. Analysis showed that initial soil pH was 6.9; organic matter was 2.5%; Bray-1 P was high...35 ppm, and exchangeable K was 150 ppm (very high). Treatments consisted of liquid starter fertilizer rates of 0, 5, 15, or 25 lb K_2O/A applied in combination with 30 lb N, 15 lb P_2O_5, and 5 lb S/A. A 30-15-15-0 treatment was included to separate the effects of K and S. The K source used in this treatment was KCl (muriate of potash). The source of K used in all other treatments was KTS. Starter fertilizer was again applied 2 in. to the side and 2 in. below the seed at planting. Nitrogen was balanced on all plots to give a total of 220 lb/A.

Grain yield was maximized with application of 15 lb of K_2O/A in the starter (**Table 2**). Addition of 15 lb K_2O/A to the starter increased grain yield by 13 bu/A over the starter containing only N and P. No response to S was seen at this site. All combinations improved yields over the no-starter check.

Even though soil test K was in the high range, addition of K in the starter fertilizer increased early season growth and yield of corn. At this site, 15 lb K_2O/A was required to reach maximum yield. In the previous experiment on a soil much higher in available K, only 5 lb K_2O/A was needed to maximize yields.

Conclusion

Nutrient management in conservation tillage systems can be challenging. The increased amounts of crop residue present in these systems can cause early season nutrient deficiency problems that the plant may not be able to overcome later in the growing season. Early season P and K nutrition is essential for maximizing corn yield. In these experiments, addition of K to starters containing N and P has been shown to improve early season growth, nutrient uptake, earliness of maturity, and yield of corn grown in a long-term ridge-tillage production system.

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