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Is K the Cinderella Nutrient for Reduced-Till Systems?

All methods of providing additional K increased whole plant and corn ear-leaf K concentrations as well as grain yield.

Summary: *A preliminary evaluation in 2003 and additional soil-testing in 2004 showed K stratification in the soil profile for the till- and slot-plant treatments. Whole-plant samples at the V6 growth stage in 2003 showed low K concentrations, but low rainfall during reproductive growth stages (grain-fill) mitigated or masked any yield response to postemergence (V10) rescue applications of potassium thiosulfate (KTS). In 2004, 30-lb/A broadcast, dry band, or liquid band applications were compared with a control (0 lb/A K_2O) for both corn and soybeans. Use of sodium-saturated cation exchange membranes successfully quantified K movement and positional availability. All methods of providing additional K increased whole-plant (V6) and corn ear-leaf K concentrations as well as grain yield compared to the control. We conclude that K is being neglected and limiting yield when reduced-till is used on these soils.*

Table 1. Soil test stratification measured in 2003 within slot- and till-plant plots near Ames, Iowa.

Depth Inches	Bluk Density g/cm³	Organic Matter %	pH	Bray P (ppm)	Exchangable K (ppm)
0 to 2	1.19	4.16	6.53	52	176
2 to 4	1.24	3.81	6.61	29	96
4 to 8	1.58	3.68	6.28	19	65

Table 2. Soil test stratification measured in 2004 within slot- and till-plant plots near Ames, Iowa.

Depth Inches	Bluk Density g/cm³	Organic Matter %	pH	Bray P (ppm)	Exchangable K (ppm)
Continuous Corn					
0 to 2	1.15	43.8	6.24	50	199
2 to 4	1.35	38.6	6.32	38	119
4 to 8	1.42	36.1	6.16	14	83
Corn/soybean rotation					
0 to 2	1.16	46.2	6.56	43	192
2 to 4	1.26	41.9	6.49	34	119
4 to 8	1.42	39.5	6.32	17	107

The potential for K deficiencies with reduced-till, especially for corn, is a well-documented soil fertility problem. However, with increased emphasis on N and P management because of their potential off-site effects, researchers, consultants, and farmers may have begun to overlook the importance of K as compared to N and P.

We raise this issue because in the spring of 2000, technicians managing the ARS-National Soil Tilth Laboratory (NSTL) field research program noted that following emergence of soybeans planted in a long-term (>30 yr) tillage study at the Iowa State University-Agronomy and Agricultural Engineering Research Center (ISU-AERC), plants in no-till (slot-plant) and till-plant treatments were showing much greater stress than those planted into moldboard, chisel, or springdisked treatments. The problem was initially attributed to herbicide carryover since Balance WDG had been applied to corn in 1999. In 2001, similar problems occurred in the same tillage treatments after corn emergence. Weed science specialists were consulted, but after observing the plots they concluded the problem was not herbicide related.

2002 to 2003

In an effort to determine what was causing the slot- and till-plant treatments to have slower early season growth and generally lower yields, a fertilizer blend (16-40-40) was deep-banded (6 inches) below the surface or broadcast with and without the tillage associated with banding to subplots within both tillage treatments in autumn of 2002. The 2003 early-season plant growth response to banded fertilizer was so striking that additional soil test and plant analyses were made. Incremental soil analyses in 2003 (Table 1) confirmed that K was very stratified in both tillage treatments. A postemergence “rescue” treatment

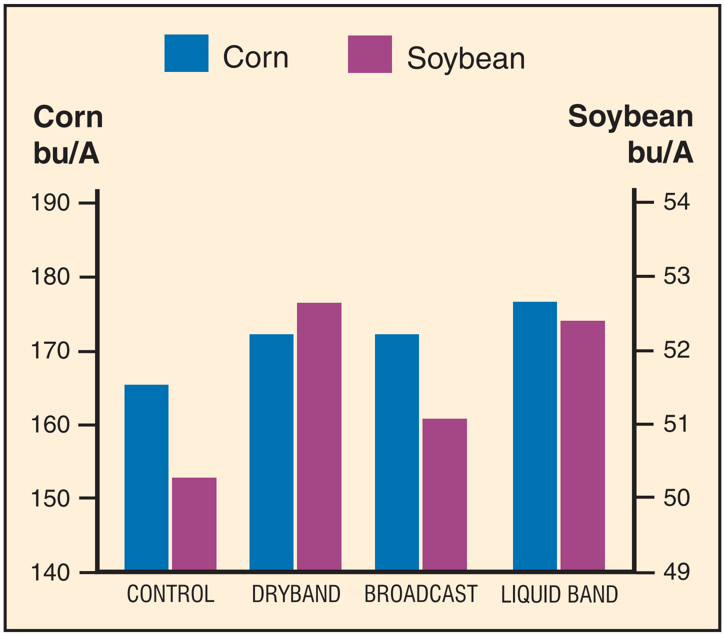

Figure 1. Grain yield response in 2004 to K treatments on slot- and till-plant plots near Ames, Iowa.

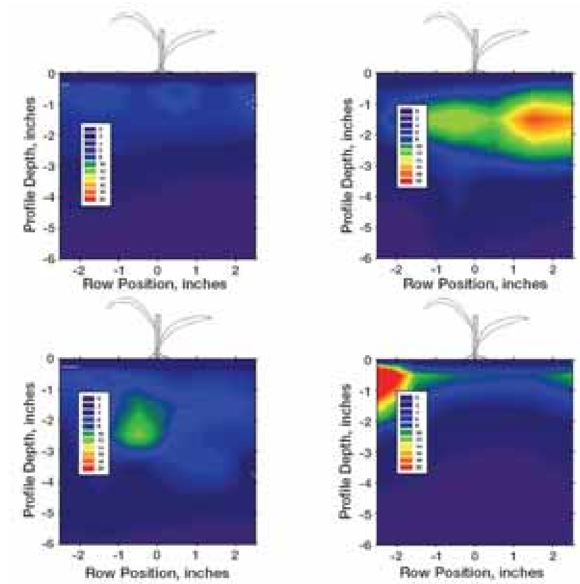

Figure 2. Profile distribution of bio-available K three weeks after broadcasting dry material (top right), subsurface banding dry material (bottom left), or surface dribble application (bottom right) approximately two inches to side of corn row in 2004. Control is shown top left.

using KTS was imposed on subplots that had the broadcast with tillage treatment in 2002 to determine if early-season K stress observed in many reduced-till fields might be mitigated with this material.

Soil test analyses, averaged for the depth increments (0 to 2-, 2 to 4- and 4 to 8-inch depths) showed a statistically significant (but not functionally significant) difference in pH for the long-term till (ridge-till) and slot-plant (no-till) treatments (6.4 vs. 6.6), but bulk density, organic matter, Bray P, and exchangeable K, Ca, and Mg showed no significant differences.

The fall-applied 14-40-40 lbs N-P_2O_5-K_2O/A deep-band strips had significantly higher Bray P and exchangeable K than the broadcast or broadcast with tillage strips, probably because the soil samples were collected from within the corn rows and therefore there was a high probability that one or more of the concentrated fertilizer bands was hit during the sampling process.

The most notable soil test differences, however, were the stratification for bulk density, organic matter, pH, Bray P, and exchangeable K as shown in Table 1. This stratification was not unexpected since it had been evident within the first few years at this site and documented for the Clarion-Nicollet-Webster soil association in an on-farm study just a few miles away.

The “rescue” KTS treatment applied to the broadcast with tillage strips in 2003 provided an additional 35 lbs/A K_2O and 24 lbs/A S at the V10 to V12 growth stages. Analysis of leaf tissue from opposite and below the primary ear at anthesis showed no significant differences for K, Ca, Mg concentrations due to tillage or supplemental fertilizer treatments.

Corn yields showed a small difference, averaging 176, 179, and 180 bu/A for the broadcast 14-40-40, broadcast + KTS, and deep-band 14-40-40 treatments, respectively. Grain moisture averaged 16.2, 16.1 and 16.0 percent, respectively.

2004

Subsequently, a more detailed study comparing a high-volume (20- to 30-gal/A) surface dribble application of K fertilizer at planting with broadcast and deep-band treatments was proposed, funded, and implemented starting in 2004.

Soil samples collected from both tillage treatments in Block 70 (continuous corn) and 71 (corn/soybean rotation) prior to applying fertilizer treatments in 2004 again showed stratification of P and K (Table 2), but perhaps most revealing were the soil test results expressed as a percentage of base saturation. At this research site and in a nearby on-farm study on the same soil association, K saturation was below 2 percent for both long-term tillage treatments.

Whole plant analyses showed slightly higher K concentrations for all three placement methods but the differences were not statistically different. Leaf samples at anthesis were significantly different with the control being lower than all of the K treatments. Soybean leaf samples at full bloom (R4) also had numerically but not significantly different K concentrations. The Ca and Mg concentrations in whole plant and leaf samples were very high for both control and treated plots. Concentrations of Ca and Mg in soybeans were decreased by additional K applications.

Grain yield for both crops also showed a significant positive response to additional K (Figure 1), confirming that K is an important factor contributing to the slow early season growth and lower grain yield from the reduced-till plots at the Ames, Iowa, research site.

Bio-available K

Measurements of bio-available K with resin sheets were successful. Higher concentrations of K were measured near the soil surface for all three of the K placements three weeks after application (Figure 2).

Similar results were recorded six weeks after application (data not shown).

The highest concentration of bioavailable K was found at a depth of one to two inches below the surface for the 0-0-30 dribble treatments; however, higher concentrations of K also were measured throughout the one- to two-inch soil layer after broadcast application of 0-0-30 (Figure 2).

In contrast, only small increases in bio-available K concentrations were measured in plots in which 0-0-30 was applied in a subsurface band. The reason for this is unclear. Perhaps there was significant variation in measurable soil K in the direction of the application band, so that even with three replications, additional measurements may be necessary to identify areas with more bio-available K.

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