Potassium Placement: What's New for Soybeans and Corn in Conservation Tillage Systems?

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Many producers need to pay closer attention to potassium (K) availability in order to realize improved stress tolerance, higher yields, and higher grain quality of both corn and soybean crops. Devoting more attention to exchangeable K status in different soils (and at multiple depths) is even more important now that conservation tillage systems are routinely employed relative to 30 years ago when moldboard plowing was common.

Recent research results in Indiana, surrounding states, and in Ontario have resulted in some tentative conclusions that are important for farmers and crop consultants to consider as they reflect on current K management systems.

1. Frequency of Low K Soils in Indiana?

One overriding concern is the sheer volume of soil test samples from Indiana that test low or medium in exchangeable K. A recent analysis by the Potash and Phosphate Institute concluded that 71% of soil samples tested at commercial labs were in these categories. That suggests that K fertilizer rates are often insufficient (and perhaps frequently below crop removal rates). High within field variability in exchangeable K is another reason not to be complacent even with a medium soil-test K level.

2. Soil K Stratification in Continuous No-Till?

Nutrient stratification may further limit K availability to corn and soybeans. Soil exchangeable K concentrations in the top 4" are often double those at the 4-8" depth when fields are not moldboard plowed. The degree of K stratification varies with soil characteristics, K fertilizer rates, K application method, and stover management. Still, highly K stratified soils are likely to result additional yield reductions in corn and soybean when droughty conditions persist during growth periods involving high K uptake.

3. Soil K Stratification in Rotational No-till?

The majority of Indiana's corn and soybean fields rotate from no-till soybean to some form of full-width tillage prior to corn in sequence. Results after 20 years (1975-94) of continuous chisel plowing suggest that soil exchangeable K is equally stratified as after continuous no-till in the top 4" versus the lower 4-8" layer. There is thus little to be gained by shallow tillage systems like single-pass cultivation, disking or even chisel plowing in terms of somehow achieving a more uniform distribution of exchangeable K in the top 8". A uniform K availability is best achieved with a moldboard plow, but the

"fix" is very temporary and occurs at considerable cost (in erosion and dollars). Vertical K stratification can be almost as pronounced 1-2 years after a single moldboard plow pass as it is in continuous no-till.

The whole notion that it is somehow advantageous to incorporate broadcast-applied K fertilizer through tillage implements other than a moldboard plow is faulty. Indeed, the very shallow fertilizer incorporation actually achieved (generally to less than half the depth of tillage tines), and the consequent loss of surface residue cover after soybean in rotation may compromise K availability to tilled corn even more than to no-till corn in dry years. Without residue cover, and with drier surface soils, corn roots in tilled plots will proliferate more at deeper soil depths where exchangeable K availability is lower.

4. Annual or Biennial K Application?

A major K study by Dr. Sylvie Brouder (Purdue Agronomy Dep't.) at five research stations across Indiana suggests that annual K fertilizer application maintains higher soil-test K in the 0-4" depth than biennial application (even when the same average annual K rate is applied). Her measurements were for the 5-year period of 1997-2002, and were based on soils in corn-soybean rotations sampled at multiple depths at the R1 state of soybean development, and when soil-test K was determined by the ammonium acetate extraction method. Three of the sites were continuous no-till, and two sites were continuous chisel.

Another benefit of annual broadcast application in a corn-soybean rotation is the horizontal K stratification that can be apparent after corn harvest. In low soil-test K situations, soybean rows between former rows of corn may have even lower plant K status than those close to the former rows.

5. Fertilizer Enrichment to What Depth?

The same studies by Dr. Sylvie Brouder show conclusively that the gain in soil-test K associated with broadcast K fertilizer application is all in the surface 4". Even K_20 fertilizer rates as high as 180 pound/acre/year did almost nothing to improve soil-test K in the 4-8" layer from their original values in 1997. Ideally, initial soil-test K levels would be in excess of 100 ppm at the 4-8" depth before continuous no-till systems are adopted involving only broadcast-application of K fertilizers.

6. Banded K in Corn?

The two primary means of banding K fertilizer are via deep banding (deeper than 5", usually in conjunction with strip tillage) and a traditional 2" by 2" starter placement.

Recent research results suggest that deep-banded K can be superior to broadcast K if dry conditions persist before silk emergence. Deep banding should not be the sole strategy employed if soil-test K levels are low; multiple approaches should then be employed (e.g. any 2 of deep band, surface broadcast, and starter band). On soils with soil-test K below 125 ppm (in 0-6" depths or 2-6" depths), corn yields have increased by 5 or more bushels per acre in response to a starter band even when 150 pounds of 0-0-60 was deep banded below the intended corn rows.

Starter-banded K should especially be considered for corn in continuous no-till fields with low to medium soil-test K and extensive K stratification. For cost reasons, dry starter fertilizer capability

on no-till corn planters can be a real asset. Liquid starter systems offer more of a challenge to successful and affordable starter K placement.

Another related aspect of current investigation is the response of corn in very high yield situations (e.g. above 200 bushels per acre) to even deeper K banding. Although continued research funding is very uncertain, we are determined to investigate the response of corn to K placement at both 6" and 12" below the soil surface. All the above studies are affected by interactions with hybrid, growing season precipitation, and soil characteristics.

7. Banded K in Soybean?

No-till soybean is usually less responsive to banded K fertilizer applications than no-till corn. Thus, for the most part, broadcast K fertilizer application is suitable for narrow-row soybean production systems.

If K fertilizer is banded, soybeans benefit only if rows are directly over the K bands. However, intentional deep banding soybean in 30" row widths would likely result in soybean yield reductions relative to broadcast K application for narrow-row soybean simply because of the yield reductions typically associated with row widths <15" versus those above 28".

Regardless of how K fertilizer is applied, it is even more important to have sufficient K available for soybean than for corn. Soybean harvest typically removes more K from the field than K removed by grain corn harvest. Soybean plants also continue to accumulate proportionately more K during pod fill than corn does in the grain filling period. Any soil-borne disease stress can further compromise the ability of soybean roots to capture sufficient K.

8. Does K Status Affect Grain Quality?

Recent quality research confirms just how important it is to maintain high plant K and seed K concentrations. For instance, higher seed K in soybean seed is positively associated with high concentrations of isoflavones (a nutraceutical with purported human health benefits). Furthermore, grain oil concentrations in high oil corn have been observed to increase with higher soil-test K in recent site-specific management research in eastern Indiana.

One essential aspect of K fertility management, therefore, is to reduce the incidence of low yield or low grain quality attributes resulting from areas of fields with below optimum soil-test K. Improved K fertilizer management may be an essential ingredient to achieving more uniform crop performance in terms of both yield and quality.

Conclusions:

Recent research suggests that our traditional recommendations on depth of soil sampling, on how and when to apply fertilizer K, and on interpretation of optimum soil-test K concentrations or critical plant tissue levels need to be re-examined in light of the extensive adoption of conservation tillage. Much has changed in tillage, row widths, cultivars, and plant populations since the time our current K recommendations were made. If sufficient funding becomes available, we should be in a better position to provide more specific and soil-appropriate K recommendations for improving yields and quality of conservation-till corn and soybean.

In the short-term, farmers are advised to keep soil-test K concentrations well above the currently accepted critical levels, and to do some

sampling in 4” increments to understand the extent of vertical K stratification after successive years of conservation tillage. The stratification concern is not limited to continuous no-till; it can be of equal concern in shallow tillage systems like that used when no-till soybean is followed by a disk or field cultivator before corn is planted.