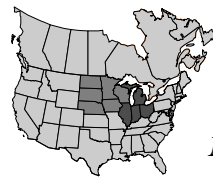


NEWS & VIEWS

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Negligence of Potassium in Corn/Soybean Systems: Are You Guilty?

SOYBEANS have gained in prominence in the Midwest over the past several decades. Since 1980 there has been a growing trend toward a 50/50 corn/soybean rotation. This system makes a lot of sense in the central U.S. for a number of reasons. The area is especially well-suited to growing corn and soybeans from the standpoint of soils and climate. The two crops fit well into the growing season, require generally complimentary production inputs and equipment, and provide many mutual benefits when grown in rotation. The transportation infrastructure in the Midwest is well-suited to moving corn and soybeans rapidly to domestic and international markets. Domestic processing and feeding centers are concentrated in the area as well.

When corn was the dominant crop in the rotation, fertilizer applied to the corn was generally sufficient to maintain the soybean crop every third or fourth year. It was not a problem for soybeans to be a “secondary feeder”, but the situation today is different. Soybean acreage in Illinois, Indiana and Ohio increased 53 percent and yield increased 40 percent between 1970 and 1996. Soybeans now enter the rotation more frequently, often at least 50 percent of the acreage on a given farm. So, their potassium (K) needs can no longer be met with carryover from the corn fertilizer. Over the past 15 years, corn yields have increased more than K applications, so less K was left over for the soybeans. Soybean yields also have increased, so their removal of K, which is proportionally higher than the removal by corn, has had a more significant impact on the K balance sheet. Not only do they require more K than corn, but they also have a greater uptake demand during the drier part of the growing season when K supply to the

root surface is reduced. The increasing use of soybeans in the rotation, combined with increased yields of both crops, has put a strain on the nutrient management system commonly used in the Midwest.



Soybeans have a less extensive root system than corn. Research at Purdue University by Dr. Stan Barber and others showed that soybeans have a maximum uptake rate (per unit of root) that is only one-tenth that of corn. This work also showed that corn at 68 to 79 days has roughly twice the root length in the plow layer when compared to soybeans. Numerous studies have shown that conservation tillage practices lead to stratification of nutrients. Corn has a fibrous root system that concentrates roots in the nutrient-rich surface soil. Soybeans have a less dense system that just doesn't explore the surface soil as well to extract the K. The soybean roots can draw nutrients from lower in the profile, but many eastern Midwest subsoils are naturally low in K. If the K applied is stratified near the surface, it will be positionally unavailable to the soybean roots that are actively taking up nutrients and water from lower in the soil profile. In reduced tillage systems, this is further complicated by the fact that K taken up by plants is deposited on the surface as the plant dies. The stratification between surface and subsurface zones in the soil thus becomes greater.

Another factor to consider is root pruning by diseases and pests. Soybean cyst nematode infestations often appear as K deficiency. The infected root system is compromised and not able to access the soil K as well. So,

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will K availability in the soil overcome the effects of an infestation? Certainly not a heavy infestation, but yield reductions from a light infestation can be reduced or avoided by ensuring balanced nutrient availability, including sufficient K. Maintaining a high soil K test is often one of the best treatments to help the soybean crop withstand infestations of cyst nematodes.

Low K status, similar to effects of excessive nitrogen (N), may make a plant more desirable for pests to attack. With low K, protein synthesis from the amino acid building blocks is reduced. The accumulation of amino acids in plant tissues helps lure pests to feed on that tissue. With high N, amino acids may accumulate in tissue, because they are produced in excess of what is used for protein synthesis.

Potassium plays many different roles in plant growth and development. High K helps increase crop tolerance to drought stress. Under normal conditions, soybeans can survive as well as corn, but when stress conditions occur, soybean roots are less able to maintain adequate uptake of nutrients. Potassium is critical to maintaining favorable plant water status. If K becomes deficient, stomates do not function properly, inhibiting photosynthesis and interfering with plant water relations. In simple terms, K in the cell water allows the cells to maintain high internal water pressure. More K permits the maintenance of this pressure as the plant's environment gets drier and drier. With sufficient K, plants can continue to photosynthesize (produce sugars) and to grow (cell extension caused by internal water pressure) through periods of dry conditions. Marginal K plants or K stressed plants cannot maintain as high an internal pressure in cells. Not only do they cease to grow, but the plants may also wilt during the heat of the day.

When adequate K applications are not made, K is "mined" out of clay minerals of "fixing" soils. Later, fertilizer K additions must first go to satisfy the depleted fixation sites instead of the cation exchange sites where they are more plant-available. It then takes substantially more fertilizer K to raise the soil test level to provide adequate plant-available K.

The bottom line is that K is still a relatively inexpensive input (cheap for a fertilizer and certainly cheap and not "environmentally sensitive" relative to most pest/pathogen control substances) which can help overcome or moderate a number of common production agriculture problems. **Isn't it a mistake...agronomically and economically... not to pay more attention to K management and applications, especially as soybeans become a more prominent and valuable crop in a system?**

When you consider all the wonders K performs for a plant, you might call it "negligence" to not maintain an adequate supply. In recent years, fertility management has been so dominated by concerns about managing N that some growers relegated K management to the second tier

in terms of management strategies. However, it must be remembered that K is important for getting the most out of an investment in N fertilizer. Data from Ohio State University have shown that soils testing higher in K increase the efficiency with which corn utilizes N. **Figure 1** shows that at higher soil test K levels, lower N rates can be applied to reach optimum yields. Maintaining higher levels of K in the soil also has the potential to increase the return to an investment in N fertilizer. Thus, proper K nutrition is an important part of an agronomically sound and profitable operation.

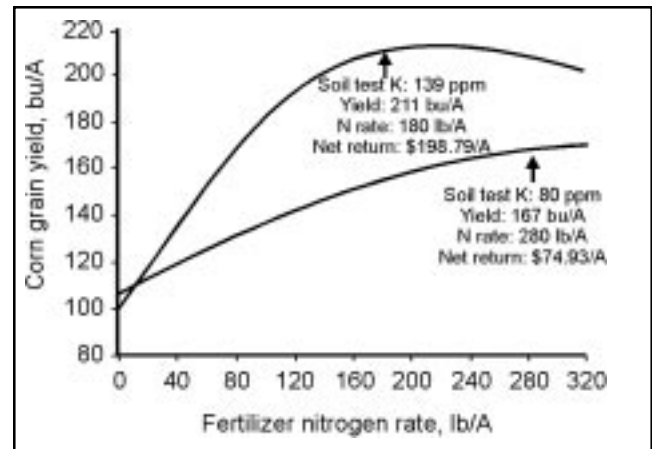


Figure 1. Potassium increases N use efficiency, corn yields, and profits. (Based on corn price @ \$2.50/bu, N cost @ 22¢/lb.) ppm=parts per million

Proper N management has received much attention because of its potential impact on groundwater quality. Environmental concerns have resulted in an even greater interest in N, generating more research and publicity. However, focusing upon N alone ignores other factors that contribute to crop utilization of N. Data from the same study illustrated in **Figure 1** show that higher levels of soil test K decrease the amount of N remaining in the soil profile in the fall, after the crop is harvested (**Figure 2**). Lower levels of profile nitrate (NO₃) mean reduced chances of groundwater contamination. This makes K an

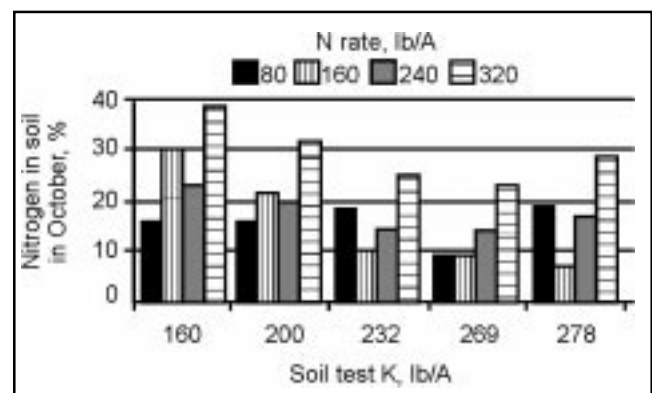


Figure 2. Percent of applied N remaining in soil in October related to soil test K level.

average recommendations, the low K areas of these 472 fields would not receive adequate K fertilizer, and thus would have reduced yield potential.

These samples from *high* testing fields, but needing additional K, represent a major unmet need for K fertilizer in these so-called “mature market” states and significant potential profit losses for the farmers managing these fields. The best hope for meeting this need is the adoption of variable-rate within-field application of K fertilizer. **This problem cannot be corrected with recommendations based on field-average soil tests.** In fact, in every year that management on the field-average basis continues, the farmers risk suffering yield losses due to insufficient K.

We now have the tools with site-specific management to address the problem. Putting them to work, **even on high testing fields**, appears to offer benefits not only for the fertilizer supplier, but also for the farmers whose potential production is being restricted with field-average management.

Research consistently shows that K is an important nutrient in crop production. The low relative price of K combined with its tremendous benefits makes it an extremely critical component of a profitable environmentally and agronomically sound management system. With so many benefits, one simply cannot afford to be negligent in the use of K. Soil test summaries indicate that we have been severely negligent in K management. ■

InfoAg99

FAR, PPI/PPIC, and Purdue University are organizing InfoAg99, the fourth in the series of Information Agriculture Conferences, set for August 9-11, 1999, at Purdue campus, West Lafayette, Indiana. The 1999 program will focus on using site-specific technology and electronic communications systems in the development and implementation of nutrient management plans. Hands-on training with special software tools will be included. Watch for details on the internet at: <http://www.ppi-far.org/infoag99>.

Note: News & Views are available online through the “What’s New” section at the PPI web site: www.ppi-far.org.

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