WHY MORE MIDWEST K PROBLEMS IN 2003?

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Throughout the Midwest, potassium (K) nutrition is receiving more and more attention. Many crop advisers and scientists have noted K deficiency symptoms in areas where none previously existed. Also, unexpectedly large variance in soil test K levels has been observed from year to year. Concern over K nutrition has led to a re-examination of factors important to K soil fertility evaluation and control. This paper focuses on three primary areas important to Wisconsin agriculture: 1) historical trends in crop nutrient removal, 2) factors that influence soil test K, and 3) variability in crop response to applied K.

Historical Trends in Crop Nutrient Removal

Like many states, fertilizer K consumption in Wisconsin has been declining over time. Consumption peaked in 1985 at about 391 short tons K_2O and declined fairly steadily until 1993, where it reached a low of about 247 short tons K_2O. From 1994 to 2000, fertilizer use has begun to rebound, with about 300 short tons K_2O used in 2000.

Although fertilizer K usage has declined over time, the amount of K removed by crops has increased steadily. About 31% of Wisconsin crop acreage is in a corn/soybean rotation (Padgitt et al., 2000). Figure 1 shows historical trends in K removal by a corn/soybean rotation.

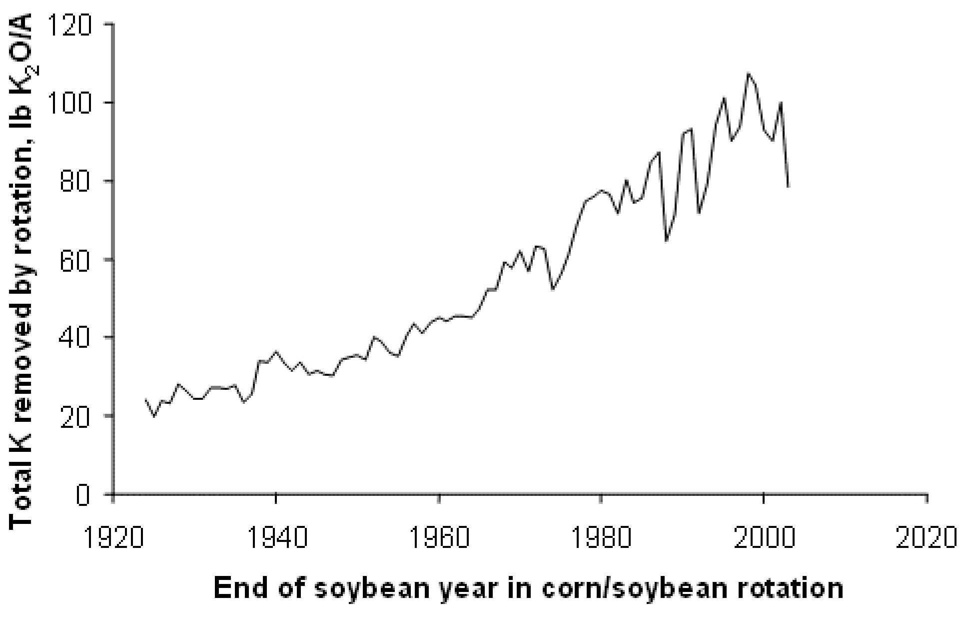

Figure 1. Historical trends in Wisconsin state average K removal by a corn/soybean rotation (NASS 2003; PPI 2003).

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In 1924, total K removal by a corn/soybean rotation was about 24 lb K_2O/A. In 1998, this same rotation removed a high of about 107 lb K_2O/A.

Another important factor in Wisconsin is the inclusion of forages in rotations. Wisconsin uses forages in rotations to a much greater extent than any surrounding state (Padgitt et al., 2000). Alfalfa and corn silage yields have been increasing over time, resulting in steadily greater K removal per acre (Figure 2).

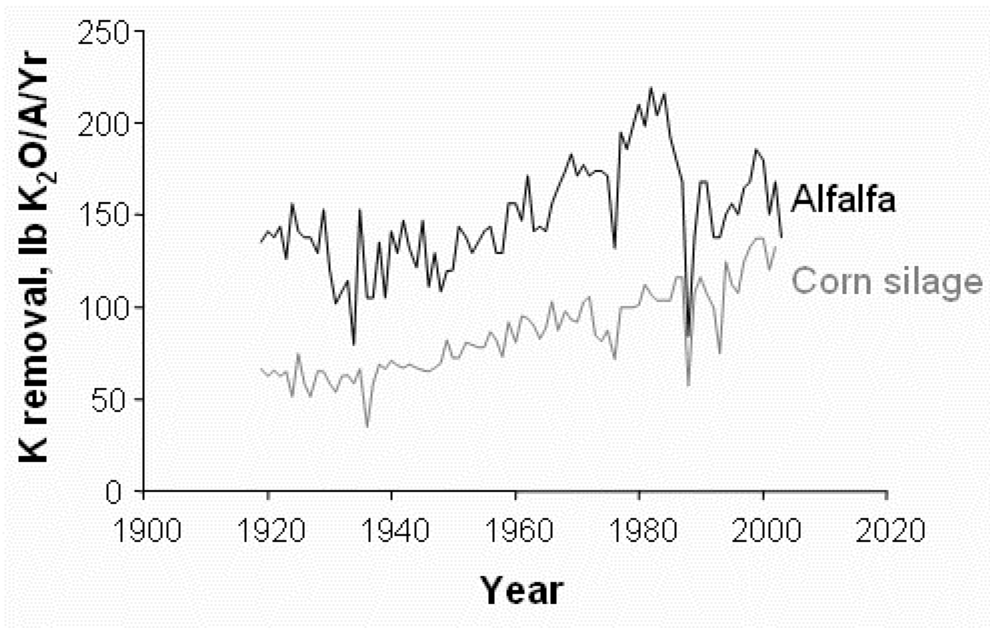

Figure 2. Historical trends in Wisconsin state average K removal by alfalfa and corn silage (NASS 2003; PPI 2003).

Allegorical evidence from Wisconsin crop advisers suggests that K deficiency symptoms are often visible in corn following alfalfa. This suggests that alfalfa may be removing more K than is applied, leaving a deficit for the subsequent corn crop. Historical nutrient budgets (comparing total K applied as commercial fertilizer and manure to total K removed by crops) should be conducted on suspect fields. Resources and guidance for estimating nutrient budgets are available from PPI at http://www.farmresearch.com/pkalc/default.asp.

Despite steadily greater K removal by crops and reduced fertilizer K use, soil test K levels in Wisconsin have generally been increasing (Combs and Peters). This is likely a reflection of manure applications in the state. Another contributing factor may be declining alfalfa acreage and increasing soybean acreage. At current yield levels, soybeans remove less K per acre than alfalfa.

Factors that Influence Soil Test K

For decades, scientists have known that soil test K results can be greatly influenced by many factors. A hallmark study conducted in Wisconsin (Attoe, 1946) demonstrated how soil test K can change with soil type, drying, and fertilization. Table 1 demonstrates how drying soils can increase exchangeable K levels, measured with a neutral ammonium acetate extractant. Increases of 3 to 89% were observed for cropped soils without fresh additions of K fertilizer. However, when fresh applications of K were made, these same soils fixed K when dried. Soil mineralogy, particularly iron content and form, are important factors in explaining such behavior (Stucki, 1996).

Table 1. Changes in soil test K as a result of drying and K fertilization (Attoe, 1946).

	Not fertilized			Fertilized with 1080 lb K_2O/A		
	Exchangeable K present			Exchangeable K present		
Soil type	Moist	Dry	Change	Moist	Dry	Change
	(ppm)	(ppm)	(%)	(ppm)	(ppm)	(%)
Antigo sil	46	61	33	421	376	-11
Carrington sil	69	109	58	471	349	-26
Miami sil	75	142	89	523	309	-41
Plainfield sil	61	63	3	470	444	-6
Spencer sil	38	51	34	442	388	-12
Superior cl	64	72	13	505	281	-44

Another important factor influencing variability in soil test K levels over time is soil sampling methodology. Reduced tillage systems, commonplace in much of the Midwest, have led to steep concentration gradients in soil test K over short depth increments (Robbins and Voss, 1991). Consequently, variability in sampling depth from year to year and from location to location can result in trends that do not reflect reality. Also, too few probes taken per composite sample can increase the chance of misrepresenting K fertility status. Proper sampling is a controllable factor that can reduce sampling noise and lead to improved assessments.

Variability in Crop Response to K

Recently, Iowa State University scientists rewrote their soil test K recommendations (Mallarino et al., 2003). The basis for their revisions was the variability in crop response to soil test K levels. Recent soil test calibration research indicated that some soils were K deficient when managed at levels conventionally thought adequate. The switch from soil analytical procedures using wet samples to those using dried samples may have resulted in over-estimation of K supply in some soils (Mallarino et al., 2003), leading to the new adjustments. This reinforces the importance of soil moisture conditions on evaluating plant-available K in the soil.

What Advisers Can Do to Address K Issues

Crop advisers can take an active role in helping to solve some of current K issues. First, ensuring soils are sampled properly and as consistently as possible will improve assessments of K fertility. Second, advisers can collect supporting data when sampling. Recording soil moisture conditions, soil series, landscape position, and past fertilization practices can aid in interpreting results. In-season tissue testing can also be performed to confirm visual K deficiencies or find K deficiencies not exhibiting classic symptoms (Kelling et al., 2000). By recording such information, advisers may be able, over time, to identify factors important for explaining soil test K behavior under local conditions.

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