NEWS & VIEWS

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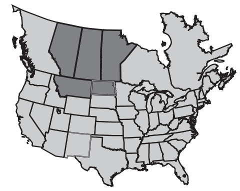

Dr. Adrian Johnston, Northern Great Plains Region Director
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Potassium Nutrition in the Northern Great Plains

POTASSIUM (K) is the only nutrient taken up in amounts similar to nitrogen (N) by most crops. It plays a critical role in crop production, especially plant water movement and enzyme activation. A deficiency of K restricts plant growth and grain filling. While many of the northern Great Plains soils have an abundance of soil K to meet crop needs, some of North America's lowest testing soils can also be found in this region.

An abundance of plant-available K comes from a soil with a large supply of K. Originating in soil minerals such as feldspar and mica, positively charged K is released and ends up bound to negatively-charged soil colloids. As soil K is taken up from soil solution by growing crops, the bound K moves mainly by diffusion into the zone adjacent to plant roots (**Figure 1**). Where an abundant supply of K exists, this process of nutrient release into the zone of plant root uptake generally meets crop requirements. Where soil K is low, the ability to maintain adequate solution K adjacent to plant roots can be reduced.

Soil testing for K has generally followed three approaches. The first is to evaluate the soil for K sufficiency through extraction of the soil sample with ammonium acetate, or another chemical related to the ammonium acetate extraction. This provides an estimate of soil supply of plant-available K and fertilizer recommendations based on provincial or state field trials. The second method of K assessment is referred to as base saturation, or Basic Cation Saturation Ratio (BCSR). This approach was developed in the mid- to late-1940s in New Jersey. The researchers proposed an "ideal ratio" of cations: 65% calcium (Ca), 10% magnesium (Mg), 5% K, and 20% hydrogen (H). It was modified in the late 1950s for Missouri soils to 65 to 85% Ca, 6 to 12% Mg, and 2 to 5% K. The problem in using base saturation is that it focuses on the ratio of bases, completely ignoring the soil concentration of a nutrient. As a result, BCSR often results in recommendations that are far from cost effective in soils where K is high. Finally, a number of anion exchange resins have been developed to evaluate soil K supply. The resins imitate a plant root by decreasing soil K and promoting K release into solution and diffusion to the membrane.

Attention Crop Advisers:

Are you looking for a current resource on K nutrition in the northern Great Plains? If so, we encourage you to review and download the PowerPoint presentation "Potassium Nutrition in the Northern Great Plains", available on the PPI/PPIC website. This comprehensive presentation reviews the role of K in building crop yields, K uptake, soil testing, and fertilizer management approaches. Notes and references included will help you build knowledge and support working with clients.

Go to: >**www.ppi-ppic.org/ngpk**<

Potassium uptake by plants follows a pattern similar to N, with rapid early uptake followed by very limited uptake once the crop has flowered. Under irrigated conditions, the uptake of nutrients like K can occur longer

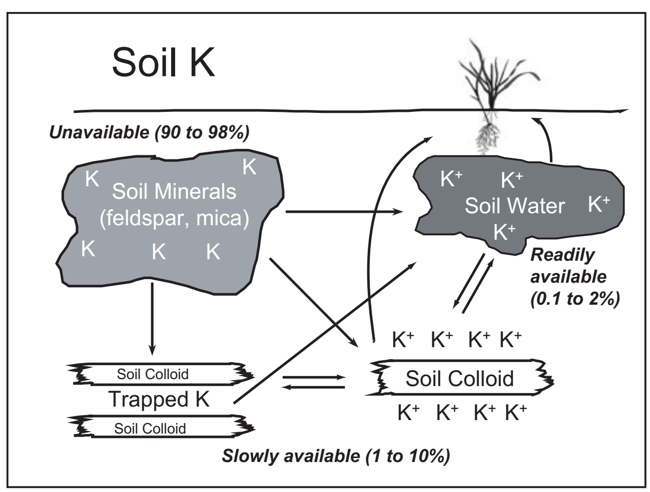

Figure 1. Soil K cycle shows soil solution supply for plants and the soil sources that resupply it.

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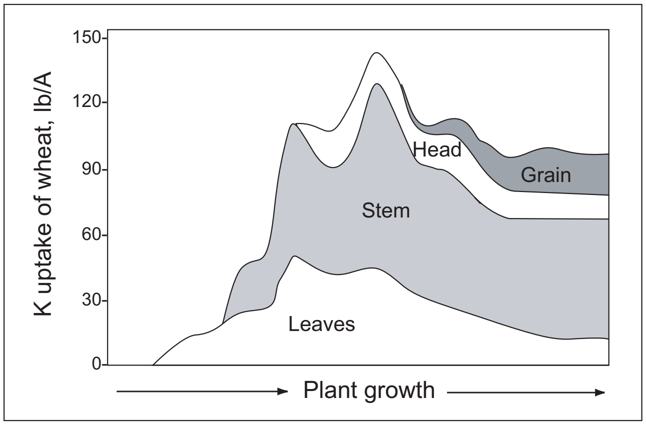

Figure 2. Growing season pattern and distribution of K in a 90 bu/A spring wheat crop in Montana. Source: Jacobsen, et al., 1992; graphic from Korb, et al., 2002.

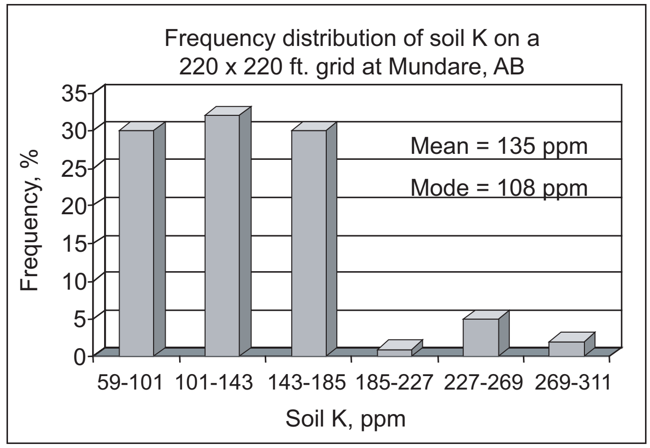

Figure 3. Frequency distribution of soil K from a grid-sampled Alberta field. Note that 30% of the field tested in the low range, less than 101 parts per million (ppm); the field mean was moderate to sufficient (135 ppm). Source: Penny, D., T. Goddard, and T. Roberts. 1996. High soil variability leads to under-fertilization. Better Crops, 80 (3): 37-39.

in the growing season, meeting the needs of the high yielding crop. However, unlike N, most of the K taken up by plants remains in the leaves, stems, and head, with only a small proportion in the harvested grain (< 20%). The K uptake and distribution pattern shown in **Figure 2** illustrates the total above-ground K in a 90 bu/A irrigated spring wheat crop in Montana. The decline in total above-ground K indicates the loss of K in leaves dropped as the plant matures. Where the entire above-ground biomass is harvested, very high rates of K are removed. An example is alfalfa, where K removal is approximately 60 lb K_2O/A for each ton of dry matter harvested. Alternatively, a wheat crop removes about 0.35 lb K_2O/bu harvested (17.5 lb K_2O in 50 bu).

A K budget for the northern Great Plains indicates a significant deficit balance between inputs and removal. This is a result of the abundant soil supply of K available for plant uptake in the absence of fertilizer or manure additions (**Table 1**). While the majority of soils testing greater than 250 to 300 lb K/A are considered sufficient to grow most grain crops, there are isolated areas that are very deficient in K and require soil amendment.

On soils where responses to K fertilizer addition have been observed, large differences have been recorded in crop and fertilizer placement response. Of the crops evaluated, barley is the most responsive to K, followed by wheat, and then canola. As the soil test K level decreases, the response of crops to added fertilizer K increases. Seed row placement of fertilizer K has been shown to provide the best crop response at low application rates, followed by band and broadcast application. Where low soil test K occurs, the best crop responses have been obtained with a large broadcast application along with low rates (15 lb K_2O/A) applied with the seed.

Potassium responses have also been recorded on soils testing high in K. This K response is attributed to cold soils in the spring limiting soil K availability, field variability where portions of a field will have high soil test K while other portions are low (**Figure 3**), and the chloride (Cl) ion found in most potash (KCl) fertilizers. Chloride is a micronutrient required for plant growth and development. It can also have an impact on seedling root and leaf diseases, grain filling and final seed weight, and physiological leaf spot on certain cultivars.

Potassium nutrition is critical to crop production. Where deficiencies exist, nutrient addition has a major impact on crop response. Key points are:

- Most northern Great Plains soils are high in K, allowing for a net removal of soil K each year.
- Crops take up as much K as N during growth, with only a small proportion removed in the harvested grain. Where the entire crop is harvested, K removal is very high.
- Where deficient, crop response to K is greatest for barley, followed by wheat and canola.
- Crop responses on high K soils to potash (KCl) can be a Cl response, which influences seedling and leaf disease, grain filling, and physiological leaf spot. ■

Table 1. Northern Great Plains Region K budget, 2000-2001.

State or Province	Crop removal (R)	Fertilizer applied (F)	Recoverable manure (M)	Balance	
				F-R	F+M-R
	- - - - - - - - - - - - - K_2O, million lb - - - - - - - - - - - - -				
Alberta	607	128	136	-479	-343
Saskatchewan	640	59	43	-581	-538
Manitoba	332	92	45	-240	-195
Montana	352	42	9	-310	-301
North Dakota	609	52	13	-557	-544