Potassium Availability and Uptake

Plants differ in their ability to take up K depending on several factors. The factors that affect availability of K in the soil and resulting plant uptake are soil factors, plant factors, and fertilizer and management practices.

Availability and uptake of potassium (K) is often complicated by many interacting components. Two factors that have a predominating effect are the soil and plant characteristics involved. A third factor, improved fertilizer and management practices, can be used to modify the inherent characteristics of soils and plants involving K uptake.

Soil Factors

The soil itself. This includes the material from which the soil was formed, the amounts and types of clay minerals in it, the vegetation and climate under which it was formed, topography and drainage, and the length of time it has been forming.

The cation exchange capacity (CEC) of the soil. This reflects the soil's ability to hold K and other cations and store them in the soil for crop uptake. Clay minerals and soil organic matter are the two parts of soil that contribute to CEC. In general, the higher the CEC of the soil, the greater the storage capacity and supplying power for K.

The quantity of available K in the soil. This is the value the K soil test reflects. It is the sum of exchangeable K and water soluble K. As the level of soil test K decreases, the crop response to applied K increases.

The nonexchangeable or slowly available K. This is the K that is in equilibrium with available K and renews the soil's supply of exchangeable K. For most soils, the more crops depend on nonexchangeable K, the lower the yields.

The K fixation capacity of the soil. Some soils have clay types that can fix large amounts of K from fertilizers or other sources. This reduces the availability of K to the crop.

The amount of K in the subsoil and the density or consistency of subsoil layers. Some subsoils are high in K available to roots. Others, such as those formed under grass in the central Corn Belt, have low K availability.

If dense layers (fragipans, etc.) develop in the subsoil, root penetration and rooting volumes are decreased, reducing the availability of K and other nutrients that are there. Root systems are frequently shallow, with roots concentrated in the upper layers where K supply may be adequate, but where shortage of water can make it unavailable to plants.

Soil temperature. Low soil temperatures reduce K availability and uptake rate by crops. The optimum soil temperature for K uptake for a crop such as corn is about 85ºF.

Effects of low temperature can be somewhat offset by increasing soil K levels. Row K can be important with lower soil temperatures, especially for early planted and minimum till crops.

Soil moisture. Moisture is needed for K to move to plant roots for uptake.

Moisture is needed for root growth through the soil to "new" supplies of K. It is needed for mass-flow movement of K to the plant roots with water and for the diffusion of K to the roots to resupply that taken up by the roots. Drought stress or excess moisture reduces K availability and uptake by crops. Increasing soil K levels can help overcome the adverse effects.

Soil tilth. Tilth is related to the friability and ability to get air into the soil. Air is needed for root respiration for K uptake. Tillage when soils are too wet leads to compaction.

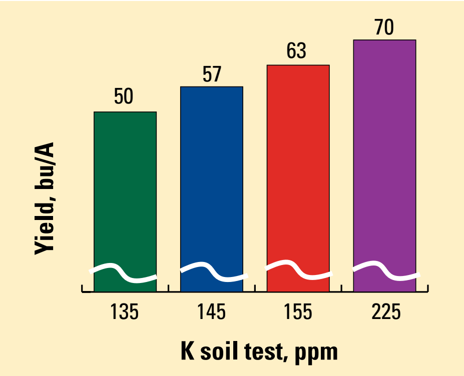

Figure 1. Higher K soil tests can increase soybean yields.

Plant Factors

The crop. Crops differ in their ability to take up K from a given soil.

This is associated with the type of root system and surface area of the roots. Grasses, for example, have a much greater capacity to take up K from the plow layer than alfalfa does. Grasses have many more fibrous, branching roots, increasing the K absorbing surface.

The variety or hybrid. Crop genetics come into play with the differences among varieties or hybrids of a given crop. Differences are developed through plant breeding. They usually relate back to the type of root system, root density, and metabolic activity that affect K uptake and, hence, availability of K for a given K test. Plant K content, in turn, has major influence on plant water relations and metabolic processes, often serving as a regulator of physiological processes. Potassium as a nutrient has a very positive effect on root branching and density.

Another factor is that new varieties often have higher yield potentials which increase the demands placed on soil to supply enough K. Additional K will be needed under higher yields.

Plant populations. As plant populations increase, yields of some crops are greater, and demands on soil K are increased. Yields often will not increase with higher populations unless adequate levels of K are in the soil, from native or fertilizer sources.

Crop yield. As crop yields increase, total K uptake increases. The uptake per unit of crop yield, such as pounds of K per bushel or ton, may be nearly constant at optimum yield levels.

Fertilizer and Management Practices

Increased use of nitrogen (N) and other limiting nutrients. When adequate K is available, addition of N and/or phosphorus (P) greatly increases K uptake, as yields are increased. Usually the uptake of K by crops closely parallels N uptake and may be greater. So, as limiting nutrients are added, the demands on soil K increase.

Applications of K in fertilizers, manures or crop residues. The major way to increase K availability is to apply adequate amounts. Potassium is readily available from all these sources, provided they are located where roots can absorb the K. **Figure 1** illustrates how higher soil test levels can increase yields.

Placement of K. Broadcast plow-down applications of K are more available than surface applied disked-in K. Row K at moderate rates and soil test levels is usually twice as available to corn as similar amounts broadcast. Deep placement or drip irrigation helps move K down. Gypsum applied with K also helps move K down in very fine textured soils.

Conservation tillage limits availability of surface applied K. Soil K levels should be built to high levels before shifting to minimum or conservation tillage. This improves K distribution within the plow layer. In many fine textured soils, surface applied K moves very little in the soil and has low availability, particularly under dryland conditions.

Drainage increases K availability. Draining soils of excess moisture helps many soils warm up earlier and improves the aeration of the soil. This improves the availability of soil K.

Weed and insect control. Controlling weeds and insects reduces competition for moisture and nutrients, so that the crop being produced has relatively more K available. BC