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Potassium is Essential for Crop

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INTRODUCTION

Potassium (K) is an essential nutrient for plant growth. It's classified as a macronutrient because plants take up large quantities of K during their life cycle.Minnesota soils can supply some K for crop production, but when the supply from the soil isn't adequate, a fertilizer program must supply the K.

Role in plant growth

Potassium is associated with the movement of water, nutrients and carbohydrates in plant tissue. It's involved with enzyme activation within the plant, which affects protein, starch and adenosine triphosphate (ATP) production. The production of ATP can regulate the rate of photosynthesis.

Potassium also helps regulate the opening and closing of the stomata, which regulates the exchange of water vapor, oxygen and carbon dioxide. If K is deficient or not supplied in adequate amounts, it stunts plant growth and reduces yield.

For perennial crops such as alfalfa, potassium plays a role in stand persistence through the winter. Other roles of K include:

- Increases root growth and improves drought resistance.
- Maintains turgor; reduces water loss and wilting.
- Aids in photosynthesis and food formation.
- Reduces respiration, preventing energy losses.
- Enhances translocation of sugars and starch.
- Produces grain rich in starch.
- Increases plants' protein content.
- Builds cellulose and reduces lodging.
- Helps retard crop diseases.

Potassium in soils

The total K content of soils frequently exceeds 20,000 ppm (parts per million). While the supply of total K in soils is quite large, relatively small amounts are available for plant growth at any one time. That's because nearly all of this K is in the structural component of soil minerals and isn't available for plant growth.

The amount of K supplied by soils varies due to large differences in soil parent materials and the effect weathering has on these materials. Therefore, the need for K in a fertilizer program varies across the United States.

Three forms of K – unavailable, slowly available or fixed and readily available or exchangeable – exist in an equilibrium in the soil system. Below, we describe these forms and their relationship to one another. Figure 1 also illustrates the general relationship among these forms.

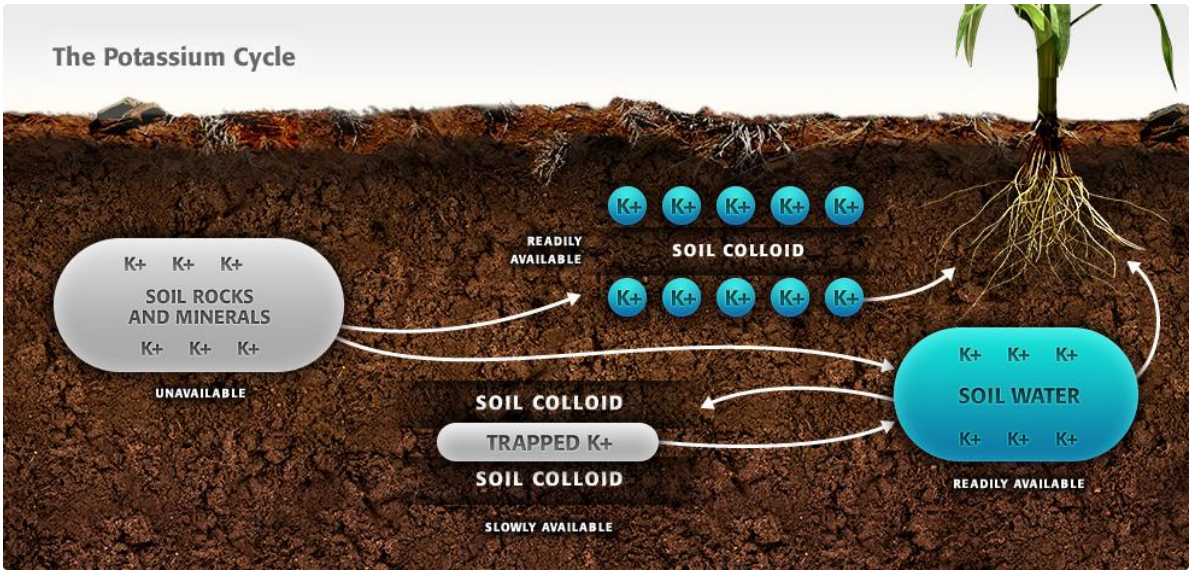

Figure 1: Generalized soil cycle of K in the soil and where K may be annually applied or removed.

Forms of potassium

Primary minerals (unavailable potassium)

Secondary minerals and compounds (slowly available potassium)

Solution potassium (readily available K)

Plant uptake: Key factors

Several factors affect potassium uptake by plants, including soil moisture, soil aeration and oxygen level, soil temperature and tillage system.

Soil moisture-Higher soil moisture usually means greater K availability. Increasing soil moisture increases K's movement to plant roots and enhances availability. Research has generally shown more responses to K fertilization in dry years.

Soil aeration and oxygen level- Air is necessary for root respiration and K uptake. Root activity and subsequent K uptake decrease as soil moisture content increases to saturation. Oxygen levels are very low in saturated soils.

Soil temperature-Root activity, plant functions and physiological processes all increase as soil temperature increases. And increased physiological activity leads to increased K uptake. The optimum soil temperature for uptake is 60 to 80 degrees Fahrenheit. Potassium uptake reduces at low soil temperatures.

Tillage system-Availability of soil K reduces in no-till and ridge-till planting systems. The exact cause of this reduction isn't known, although research results point to restricted root growth combined with a restricted distribution of roots in the soil.

Symptoms of potassium deficiency

Some crops exhibit characteristic deficiency symptoms when adequate amounts of K aren't available for growth and development. Potassium is mobile in plants, and will move from lower to upper leaves.

Alfalfa-Yellow or white spots on the margins of the leaflets (Figure 4) characterize potassium deficiency in alfalfa. Symptoms first appear on the older plant tissue. Potassium deficiency in alfalfa can be easily confused with damage caused by the potato leafhopper.

Figure 4: Potassium deficiency symptoms in alfalfa. Note the white spots in the margins of the leave

Potato-Potassium deficiency in potato occurs as scorching of the leaflet margins, which first occurs on the older leaves (Figure 5 and 6).

You can usually first notice symptoms during tuber bulking (mid-July), as the tuber is a strong sink for potassium. Potassium-deficient potato vines will die back prematurely, which can often be confused with diseases causing vine death.

Figure 5: Early potassium deficiency symptoms in potato.

Figure 6: Late potassium deficiency symptoms in potato.

Predicting potash needs

- You can monitor K status of soils with plant analysis and routine soil testing.
- Soil testing is the most reliable predictor of a fertilizer program's need for potash. Plant analysis can confirm a suspected deficiency indicated by visual symptoms or routinely monitor the effects of a chosen fertilizer program.
- Potassium sufficiency levels by crop

Plant analysis tools

Soil tests: Soil sample drying's effect on results

Soil testing labs commonly air dry soil samples prior to analysis. Drying soils high in clay can affect the amount of K extracted.

Sources of potassium

There are a limited number of fertilizer materials that can supply K when needed. Table 3 lists these materials.

Table 3: Common potassium fertilizer sources

Material	Chemical formula	Approximate K_2O
Potassium chloride	KCl	60 to 62%
Potassium sulfate	K_2SO_4	50%
Potassium-magnesium sulfate (K-mag or Sul-Po-Mag)	K_2SO_4, $2MgSO_4$	20%
Potassium thiosulfate	K_2S2O_3	17%
Potassium nitrate	KNO_3	44%

Applying and managing potassium

Suggested management practices for K vary with each crop.

You can apply potassium fertilizer either in the fall or spring for most soils in Minnesota. Sandy soils with a low cation exchange capacity have a low ability to hold K. Consider potassium to be partially mobile on sandy soils and apply it closer to the time of planting.

Liquid forms of potassium

Liquid forms of potassium are available for in-furrow application as a starter fertilizer. These forms of fertilizer are manufactured with either potassium chloride (KCl) or potassium hydroxide (KOH).