



Extension
UNIVERSITY OF WISCONSIN-MADISON

The Potassium (K) Cycle

for general cropping systems in Wisconsin



Potassium deficiency symptoms first manifest in older leaves, because potassium is highly mobile in plants and moves from older to younger tissue.

Potassium is one of the 17 essential nutrients necessary for optimal plant growth and health. After nitrogen, it is the nutrient needed in the largest amount by crops.

losses —

+ additions

CROP REMOVAL

Potassium is removed by crop uptake and harvest. Alfalfa, grass mixes, pastures, corn silage and small grains with straw remove large amounts and can cause potassium levels to drop quickly.

CROP RESIDUES

Potassium is lost quickly from residue and returns to the solution K.

EROSION & RUNOFF

Potassium losses from erosion and runoff do not threaten water quality like nitrogen and phosphorus can.

MANURES & BIOSOLIDS

Potassium and other nutrients are provided by these applications and should be credited.

FERTILIZERS

Potassium fertilizers are highly soluble and immediately supply the solution K.

LEACHING

Potassium leaching occurs when soils lack enough negatively charged clay particles to retain strong bonds with positively charged K^+ ions. This is of particular concern in sandy soils.

Potassium enters (is "retained") and exits the interlayers of clay particles when changes in soil moisture and temperature occur.

Root uptake

Solution K
is always in the positive ion form K^+

available



Potassium in solution K is always in the positive ion form (K^+), which is taken-up by plant roots through adsorption.

Soil tests measure
Solution K and
Exchangeable K

Exchangeable K

available



Potassium diffuses from organic matter and clay particle surfaces when the solution K becomes depleted.

Retained K

slowly available



Mineral K 90–98%

of soil K is in the mineral form

not available



Potassium is confined within the structure of soil minerals and clay. Although a very small amount is released over time as weathering occurs, the majority is unavailable.

KEY POTASSIUM (K) CONCEPTS

- ☑ **K fertilizer recommendations** vary by soil type because soils vary in the amount of K they can supply and retain.
- ☑ **K uptake** by plants is dependent on available soil moisture: lack of precipitation can affect this.
- ☑ **K availability** is improved by incorporating organic amendments.
- ☑ **Crops recycle K** which can lead to stratification especially on no-till fields and pastures.
- ☑ **To increase soil test K by 1-ppm**, it takes 8 lb of K₂O/acre (to convert K to K₂O multiply by 1.2).

GENERAL CONSIDERATIONS

Monitor soil K levels with routine soil testing:

- Use results to identify fields that need and do not need additional K.
- For soils testing Very Low to Low, fertilize to replace crop removal and build soil-test K levels.
- For soils are testing Optimum, High, or Very High, fertilize at crop removal, 1/2 crop removal, and 1/4 crop removal.
- Prioritize fields testing low for K for manure applications; to ensure the most accurate credits, test manure for nutrient content.
- Phosphorus (P) and K affect N use efficiency. Correct both K and P deficiencies before investing in additional N.
- For fields where the majority of the plant is removed (corn silage, alfalfa, other forage crops), test soil every two years since these crops remove large amounts of K, and levels can drop quickly.

Identify the highest demanding crop in the rotation to meet K requirements:

- Consult Table 7.2 of UW Extension A2809 *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin* for recommendations based on the crop demand level. From highest to lowest:
 - Level 4** — Potatoes
 - Level 3** — Tomatoes, peppers, brassicas, leafy greens, root, vine, and truck crops
 - Level 2** — Alfalfa, corn silage, wheat, beans, sweet corn, peas, fruits
 - Level 1** — Corn grain, soybean, clover, small grains (except wheat), grasses, oilseeds, pasture

SPECIFIC SITUATIONS

- 1— In poorly drained clay soils:** K is trapped between the clay layers during wetting and drying cycles.
 - As the layers expand (wet) and contract (dry), K is released into the soil solution for plant uptake or bound tightly (fixed K).
- 2— In coarse & organic or irrigated soils:**
 - It is difficult to build up K levels in these soils as they do not retain K. They may require annual K applications; spring split applications are preferred to fall.
 - In soils with low K buffering, K should be monitored by soil testing every two years.
 - For irrigated sandy soils growing high-dollar vegetable crops, annual soil testing is recommended.
 - On sandy soils, plant tissue test compliments K management.
 - In sandy to silt loam soils, K movement can be underestimated.
 - Organic soils hold very little K and are not suited for high K removal crops.
- 3— For corn on soils that are slow to warm in the spring:**

A minimal amount of starter fertilizer (10 lb N - 20 lb P₂O₅ - 20 lb of K₂O per acre) can be beneficial.

 - On medium to fine textured soils, salt injury may occur if more than the recommended amount of starter is applied.
 - For soils that test in the excessively high K range, no K should be applied.
 - Any nutrients (N, P, and K) applied as starter fertilizer need to be credited against the overall nutrient recommendation from the soil test report.
- 4— Manure on hay or forages prior to seeding** is an effective way to both supply K and distribute manure.
- 5— Manure on forages or hay as a topdress fertilizer** is also an effective way to both supply K and distribute manure. Be certain to:
 - Target older hay stands (do not damage young stands with increased traffic, weed seed introduction, and stimulation of grass growth).
 - To avoid smothering and salt injury, limit application rates to 10–12 tons/acre or 3,000–5,000 gallons/acre.
 - To avoid compaction, spread on firm dry soils.
 - To avoid burning alfalfa regrowth, spread as soon as possible after cutting.
- 6— Forage from fields with excessively high K level:** Test forage for excessive K levels (> 3%) to prevent increased incidence of milk fever and other related illnesses in cattle.