Potassium in Mississippi Soils

Potassium (K) is absorbed in large amounts by plants. Potassium uptake by crops under good growing conditions is high, often equal to nitrogen (N) uptake and several times the quantity of phosphorus (P) uptake.

Potassium is used in photosynthesis, sugar transport, water and nutrient movement, protein synthesis, and starch formation by plants. Adequate K plant nutrition influences disease resistance, water stress tolerance, winter hardiness, tolerance to plant pests, and uptake efficiency of other nutrients.

Potassium mobility is often related to soil texture: movement is greatest in soils with more sand content. The buildup of K in soils is related to soil texture with the greatest accumulation generally in clay soils, followed by loam and coarse-textured sands.

Although soils provide a great deal of K through natural processes, fertilization with K may be necessary to maximize plant growth. The total amount of K in soil ranges from 5 to 25 tons per acre. While this amount seems like a lot of K, only a small amount is plant-available at any particular point in time. Most K is in the structural component of the soil. Sandy-textured soils have much less than fine-textured, clay soils. Where levels of soluble K in the soil are high, plants may take up more K than needed in a "luxury consumption" that does not increase yields.

Potassium in Soils

There are three forms of K "pools" in the soil: unavailable, slowly available or "fixed," and readily available.

Unavailable K is within soil minerals such as feldspars and micas. Over extremely long periods, these minerals will break down and K will be released. However, this process is much too slow to provide full K needs of growing plants.

Slowly available or "fixed" K is trapped between layers of clay minerals. This type of soil K is not measured by soil testing procedures, but, over time, it will become plant-available. However, it is possible for K measured in the soil-testing process to become "fixed" in the slowly unavailable pool to plants during the growing season.

How much K is "fixed" varies with the particular types of clay present in a soil. Many Mississippi soils are dominated by clays with large shrink-swell capacities (i.e., cracks form in dry seasons). These soils can fix large amounts of K upon drying but release substantial amounts when rewetted.

Sandy, low-organic-matter soils have little capacity to hold or retain K. These soils should be managed to minimize K movement away from the rooting zone.

Readily available K is the pool measured by soil testing procedures. This is K present in the soil solution and K easily removed from soil clay edges. Potassium in the soil readily and regularly interchanges between the water in the soil and the clay solids. Note that this K is not the same pool within the clay structure.

When plants use the K present in the soil solution, more K is released from the clay particles to the solution in response to the decrease in concentration. This interchange of K in the soil is extremely important to plant nutrition.

Plant Uptake of Potassium

Potassium used by growing crops must be absorbed from the soil. Potassium constitutes 1 to 4 percent of plant dry matter weight. The quantity removed by plants varies among crops. Cotton contains about 20 pounds of K_2O equivalent K per bale harvested, and hybrid bermudagrass hay contains about 50 pounds per ton. Extension Publication 2647 *Nutrient Management Guidelines for Agronomic Crops Grown in Mississippi* contains detailed information about K uptake by various crops.

Plant root systems cannot intercept sufficient K in the soil or soil water to maintain plant function. About 90 percent of the K needed by plants must move to the root surfaces by diffusion, which is movement from an area of high concentration to one of low concentration within moisture films surrounding soil particles.

Factors affecting K diffusion include soil moisture conditions, soil aeration, and soil temperature.

Higher soil moisture usually increases K movement in the soil. However, when soils are saturated with water, the resulting decrease in root function will decrease K uptake. Soil temperature affects all plant functions. Potassium uptake is optimum at temperatures of 60 to 80°F, but uptake is reduced at lower temperatures.

Soil Testing for Potassium

Soil fertility management of K should be based on a sound soil-testing program. Information on soil testing in Mississippi is available for farmers and homeowners. The common K soil test procedures use a chemical procedure that results in assessing the K in soil solution and the K on soil solids that exchanges with it. The Mississippi State University Extension Service Soil Testing Laboratory uses an extraction solution and procedure developed for the diverse soils of the state.

The relationship between K soil test levels and K fertilizer requirements is developed through research. Plant K uptake and yield are related to measured quantities of K in the soil. These results are used to develop "soil test K indices."

Indices commonly used to report soil test K are very high, high, medium, low, or very low. Each category reflects the probability of plant response to K application. Crops grown on soils with a very high K index normally should not respond to potash fertilizer application, but crops on very low K soils should usually respond.

The K indices used by the MSU Extension Soil Testing Laboratory are listed in **Tables 1, 2, and 3**. These indices are categorized by crop and by cation exchange capacity (CEC). The CEC of a soil is a measure of its ability to store the positively charged nutrients that are determined during the soil testing procedure.

Potassium Fertilization

If soil test recommendations call for K fertilizer to optimize crop production or plant growth, several materials are available. MSU Extension does not recommend potassium fertilization for soils that have high or very high indices, except for cotton in the high index.

Detailed information on commercial fertilizer recommendations, options, and management is available for field crops. See Extension Publication 2647 *Nutrient Management Guidelines for Agronomic Crops Grown in Mississippi* and Publication 2500 *Inorganic Fertilizers for Crop Production*.

Most commercial K fertilizer used in the state is potassium chloride, or muriate of potash. Potassium chloride may be pink, red, or white. The color difference is due to iron content of the materials; there is no difference in the amount of plant-available K in the material. Potassium-magnesium sulfate is a good K source if magnesium is also needed for the crop.

In most crop production systems, it is preferable to apply K at or before planting. While K may be fall-applied for row crop production in Mississippi on soils with low loss potential (CEC > 8), K is vulnerable to overwinter loss on sandy, low CEC soils.

Potassium Deficiency Symptoms

Plants lacking K will have shortened internodes, weak stalks, excessive lodging, and more leaf and stalk disease; they also will be a lighter green when viewed from a distance. Severe deficiency will cause leaf drying and drying along the outer margins. Because K is mobile in plants, symptoms begin at the tips of lower leaves and move up the plant as the deficiency persists.

Inner portions of the leaves may have a striped appearance. This often can be confused with deficiency symptoms for sulfur, magnesium, and zinc.

Table 1. Soil test potassium levels (pounds K per acre) and indices using the Mississippi soil test extractant for perennial winter grass pasture (fescue or orchard grass); small grains for pasture; peanuts; perennial summer grass pasture (bahia, dallis, or Bermuda); rice; or annual legumes with ryegrass.

Index	CEC < 7	CEC 7–14	CEC 14–25	CEC > 25
Very Low	0–40	0–50	0–60	0–70
Low	41–80	51–110	61–130	71–150
Medium	81–120	111–160	131–180	151–200
High	121–210	161–280	181–315	201–350
Very High	> 210	> 280	> 315	> 350

Table 2. Soil test potassium levels (pounds K per acre) and indices using the Mississippi soil test extractant for dryland corn for grain, soybeans, oats, wheat, barley, summer pastures (bahia, dallis, or Bermuda) with annual legumes (white clover, red clover, lespedeza, arrowleaf clover, ball clover, or subterrean clover); temporary summer grass pastures (millet, sorghum, sudangrass, sorghum-sudangrass hybrids, or johnsongrass); forage legumes; perennial winter grass pasture with clover (white clover, red clover, subterranean clover with fescue or orchardgrass); pasture grass with annual legumes (crimson clover, annual lespedeza, arrowleaf clover, ball clover, or subterrean clover with bermuda, dallis, or bahiagrass); Johnsongrass hay; mixed grass hay; annual or sericea Lespedeza hay; or sunflowers.

Index	CEC < 7	CEC 7–14	CEC 14–25	CEC > 25
Very Low	0–50	0–60	0–70	0–80
Low	51–110	61–140	71–160	81–180
Medium	111–160	141–190	161–210	181–240
High	161–280	191–335	211–370	241–420
Very High	> 280	> 335	> 370	> 420

Table 3. Soil test potassium levels (pounds K per acre) and indices using the Mississippi soil test extractant for alfalfa; cotton; corn or sorghum for silage; sweet potatoes; irrigated corn; or hybrid Bermudagrass hay.

Index	CEC < 7	CEC 7–14	CEC 14–25	CEC > 25
Very Low	0–70	0–80	0–120	0–150
Low	7–150	91–190	121–240	151–260
Medium	151–200	191–240	241–290	261–320
High	201–350	241–420	291–510	321–560
Very High	> 350	> 420	> 510	> 560

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