POTASSIUM in Mississippi Soils

Potassium (K) is the element second only to nitrogen in the amount plants absorb. Although plants need large amounts of K, its exact function is not clearly known. It apparently helps stimulate early growth, increase plant protein production, and improve plant water use efficiency. Potassium also enhances plant resistance to diseases and insects.

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 time. Most K is in the structural component of the soil. Sandy textured soils have much less than fine-textured clay soils.

Potassium in Soils

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

Unavailable K is in soil minerals such as feldspars and micas. Over a long time, 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 ("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 can replenish the measurable K pool. However, it is possible for K in the soil tested pool to be "fixed" in the slowly unavailable pool to plants during the growing season.

How much K is "fixed" varies with the particular type of clay dominant in a soil. Many soils in Mississippi are dominated by clays with large shrink-swell capacities (such as forming cracks in dry seasons). These soils can fix large amounts of K in drying but release substantial amounts when rewetted.

Sandy, low organic matter soils can not hold much potassium. You should manage these soils to minimize K movement away from the rooting zone.

Soil testing procedures measure the readily available K pool. This K is in the soil solution and easily removed from soil clay edges. Potassium in the soil readily and regularly interchanges between the solution and the clays. Note that this K is not the same pool within the clay structure.

When plants use the K in 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 is 1 to 4 percent of plant dry matter weight. How much plants remove 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.

Plant root systems cannot intercept enough K in the soil or soil water to maintain plants. About 90 percent of the K plants need must move to the root surfaces by diffusion, or move from an area of high concentration to one of low concentration within the moisture films around soil particles. Soil moisture conditions, soil aeration, and soil temperature can affect this diffusion.

Higher soil moisture usually increases K movement in the soil. However, when soils are soaked with water, the resulting decrease in root function will decrease K uptake. Soil temperature affects all plant functions. Potassium uptake is best at temperatures of 60 to 80 ºF.

Soil Testing for Potassium

You should base soil fertility management of K on a sound soil testing program. Instructions on properly sampling soils is available from your county Extension office.

The common K soil test proceduress use a chemical procedure that assesses the K in soil solution and the K on soil solids that exchange with it. The Mississippi State University Extension Service Soil Testing Laboratory uses an extraction solution and procedure developed for the different 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 should reflect the probability of 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 usually should respond.

The K indices used by the Mississippi State University Extension Service Soil Testing Laboratory are listed in Tables 1 - 3. These indices are categorized by crop requirements and by Cation Exchange Capacity (CEC). The CEC of a soil is a measure of its ability to store nutrients that are determined during the soil testing procedure. Recommendations are available for crops other than those listed in the tables.

Potassium Fertilization

If soil test recommendations call for K fertilizer to optimize crop production or plant growth, several materials listed in Table 4 are available.

Most commercial K fertilizer used in the state is potassium chloride, or muriate of potash. Potassium chloride may be pink, red, or white. While the color difference is caused by iron impurities, there is no difference in the amount or plant-availability of K in the material. Potassium-magnesium sulfate is a good K source if the crop also needs magnesium.

In most crop production systems, it is usually 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, K is prone to overwinter loss on sandy, low CEC soils.

Potassium Deficiency Symptoms

Plants lacking K will have shortened internodes, weak stalks, excessive lodging, more leaf and stalk disease, and 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 leaf may also 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_20 per acre) and indices for rice, peanuts, fescue, and fall grasses using the Mississippi Soil Test Extractant.

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_20 per acre) and indices for soybeans, corn for grain, forage legumes, and small grains using the Mississippi Soil Test Extractant.

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_20 per acre) and indices for cotton, corn silage, and home horticulture crops using the Mississippi Soil Test Extractant.

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

Table 4. Common fertilizer sources of potassium.

Fertilizer	Nitrogen %	Phosphate	%Potash %
Muriate of potash (potassium chloride)	0	0	60-62
Potassium-magnesium sulfate	0	0	20
Potassium nitrate	13	0	44
Potassium sulfate	0	0	50

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