Potassium in Turf Grass

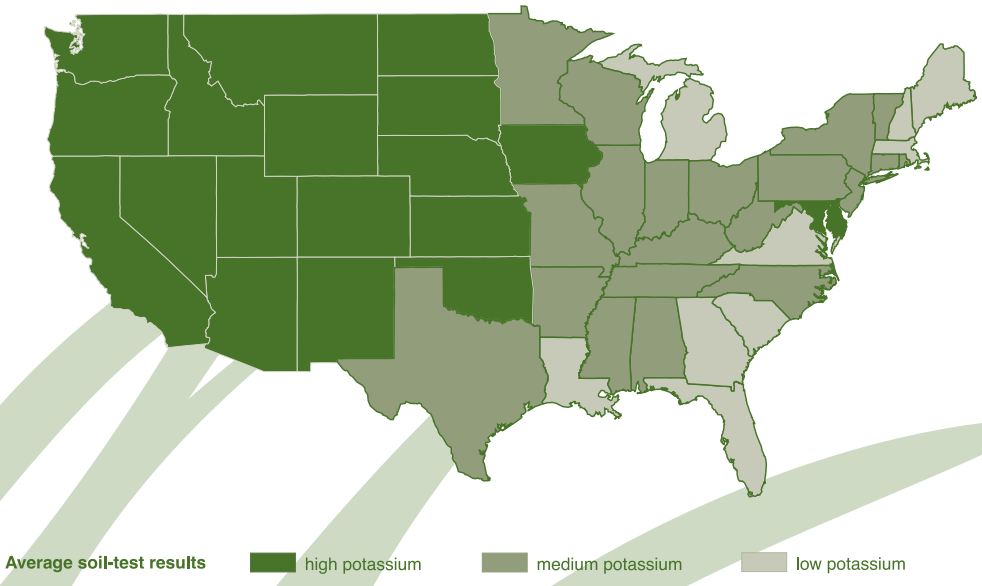
Potassium is essential for plant growth and is used by more than 60 plant enzymes that are involved in various biochemical reactions including the production of sugars and starches. In addition, potassium helps plants by increasing disease resistance, strengthening cell walls, increasing winter hardiness and drought resistance.

Potassium is the most abundant cation utilized in plant growth. Potassium is taken up by the plant roots from the soil and circulates throughout the plant in the form of K+. Unlike nitrogen and phosphorus, which take a number of different forms, potassium is only present in the soil in a single form and does not change. However, the amount of potassium present is complicated by the different soil textures and climatic conditions.

Native Potassium Reserves

Different soil types have developed from different geological material, each has varying levels of potassium. As a result, native potassium levels are widely varied throughout the United States. The following map is based on native undisturbed soils. Where conditions extensive dirt work (cutting and filling) exist it is difficult to know if the completed grading consists of mainly native top soil or a type of sub soil. The only way of knowing what the native potassium (or for all fertility levels and soil characteristics) a soil analysis is essential. It establishes a bench mark for all future comparisons. Constructed soils (golf greens and athletic fields) are all together different. By construction technique potassium as well as all nutrients will be low.

Potassium Soil-Test Levels in the Continental United States



Feldspars and micas are geological minerals that are rich is potassium with concentrations as high as 80 – 100,000 parts per million (ppm). The potassium contained in feldspars and micas is held very tightly within these minerals and is generally unavailable for plant uptake. However, the potassium that is imprisoned within these minerals can be released through climatic conditions. These conditions contribute to what is called weathering. Weathering is the decomposition of rocks into smaller and smaller minerals—a process that takes thousands of years. Precipitation is the key climatic condition that results in potassium being released during the weathering of potassium containing minerals.

In addition to the weathering of soil minerals, precipitation caused released potassium to leach through the soil over time. (The process of leaching is greatly magnified on constructed sand soils.) Normally, we do not consider potassium as a nutrient that can leach in medium and fine textured soils. In fact, at the most, movement would be measured in millimeters per year. However, after thousands and thousands of years of precipitation, the amount of potassium present in the soil has been leached downward throughout the soil profile. The result is, today's native (on undisturbed soils) potassium levels.

As you can see by the map, soils in the southeast portion of the U.S. are more deficient in potassium than other regions, particularly in the west. As stated this is directly related to precipitation.

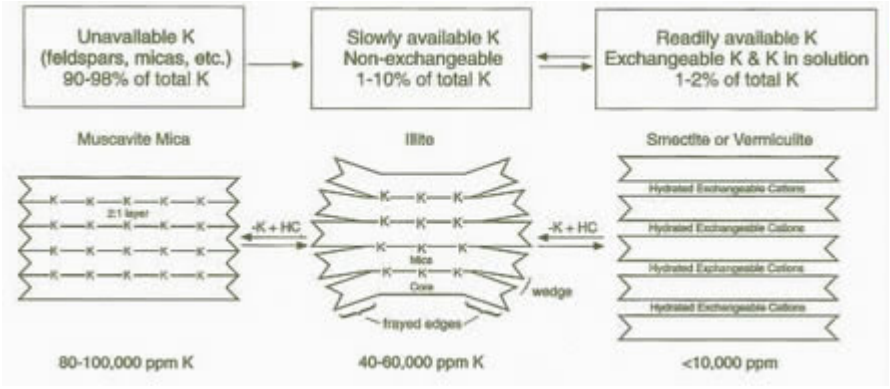
Factors Affecting Potassium Availability

If native potassium levels are dependent upon precipitation, high rainfall should result in low potassium levels. However, even in areas that have higher potassium reserves, the amount of potassium that is available for plant growth may be low due to the soil clay tube and the soils cation exchange capacity (CEC). Both soil clay type and CEC are physical properties of the soil that cannot be changed.

Soil Clay Types

Potassium only takes one form (K+), but there are three basic soil clay types that hold or trap potassium and control its availability. The major soil clay types are shown below:

Forms of Potassium in the Soil



Muscavite and mica-clay minerals are rich in potassium with concentrations of 80 - 100,000 ppm. However, the potassium contained in this clay is imprisoned between the clay layers, making it virtually unavailable to plant roots.

Illitic clay types are the product of weathered muscovite and mica clay. As shown in the figure, the edges of the illitic clay are frayed and wedged open, exposing the interior potassium that is deeper within the clay layers. The frayed edges of the clay can be repaired when potassium is applied and captured within the clay walls. Soil-test potassium levels are difficult to increase when illitic clay are present because of this entrapment process.

The third clay type is montmorillinite or vermiculite. These clay types are lacking all of the interior potassium that normally binds the clay layers together. This allows clay types to expand and contract during wetting and drying cycles. These clay types hold onto the potassium in a manner that makes the potassium readily available for plant roots.

Keep in mind, that all three clay types can be present in the soil at the same time. The amount of available potassium will be dependent on the dominate clay type present in the soil. For example, soils dominated by elliptic clays, it would be difficult to increase soil-test potassium levels by applying potash. Most soils have a mixture of clay types.

Cation Exchange Capacity (CEC)

Clay and organic matter are negatively charged and therefore have the ability to hold positively charged cations such as potassium (K+), calcium (Ca++), Magnesium (Mg++), sodium (Na+) and hydrogen (H+). In contrast to the imprisoning caused by soil clay types, holding onto potassium is a good think. The ability to hold these positively charged cations is called the soils' cation exchange capacity and is an important measure for the soils fertility. CEC measures the number of available exchange sites.

The availability of potassium increases as the percentage of exchange sites occupied with potassium increases. Therefore, the interpretation of a soil test report requires knowing the soil-test potassium levels and the CEC. Ideally, the potassium should occupy about 3 to 5% of the exchange sites.

Constructed sand soils are the exception to the above rule. These soils virtually have no clay and extremely low levels of organic matter, resulting in very few exchange sites. Potassium, as well as the rest of the cations, is subject to leaching very rapidly. In these soils it is better to maintain lower K values and apply K fertilizers with multiple applications annually. On these soils potassium should be treated similar to how nitrogen is applied.

Optimum range
Soil Cation Exchange Capacity (CEC)

	5	10	15	20
	Parts per million			
Potassium	91 – 120	121 – 160	151 – 200	181 – 240
Magnesium	60 – 119	120 – 239	180 – 359	240 – 479
Calcium	600 – 1199	1200 – 2399	1800 – 3599	2400 – 4799

Potassium Fertilization

The table above provides the starting point for a sound potassium fertilization program. Based on your CEC and soil test K values, you can determine whether your K fertility is; less than standard, greater than standard or optimum. The second step involves the management of grass clippings. When clippings are removed and exported for the site, usable potassium is also removed. On average 3 to 4 pounds of K/1000 sf are removed annually when clippings are exported. This amount is then retained and quickly recycled as plant available K.

If the value off of a soil test is less than standard, then 4 to 5 pounds of K/1000 sf needs to be applied annually. (If a quick buildup is desired then 5 to 6 pounds can be applied.) If the value is greater than standard, then lower amounts of K would be needed. When soil K values get greater than 400 ppm little response from potassium would be expected. Note; do not apply more than 1 lb of K/1000 sf in any ONE application.

As stated above, soil potassium values can be built up and maintained on medium and fine textured soils. However, on constructed sand soils building K soil test values should not be your objective. Small frequent applications are much more desirable.