AGRONOMY

Factors Affecting Potassium Availability

We know that the potassium content of the soil is dependent on thousands of years of geological and climatic conditions that have resulted in the weathering of potassium-containing minerals. As a result, in areas that receive higher levels of precipitation, total soil potassium reserves will become lower and lower over time.

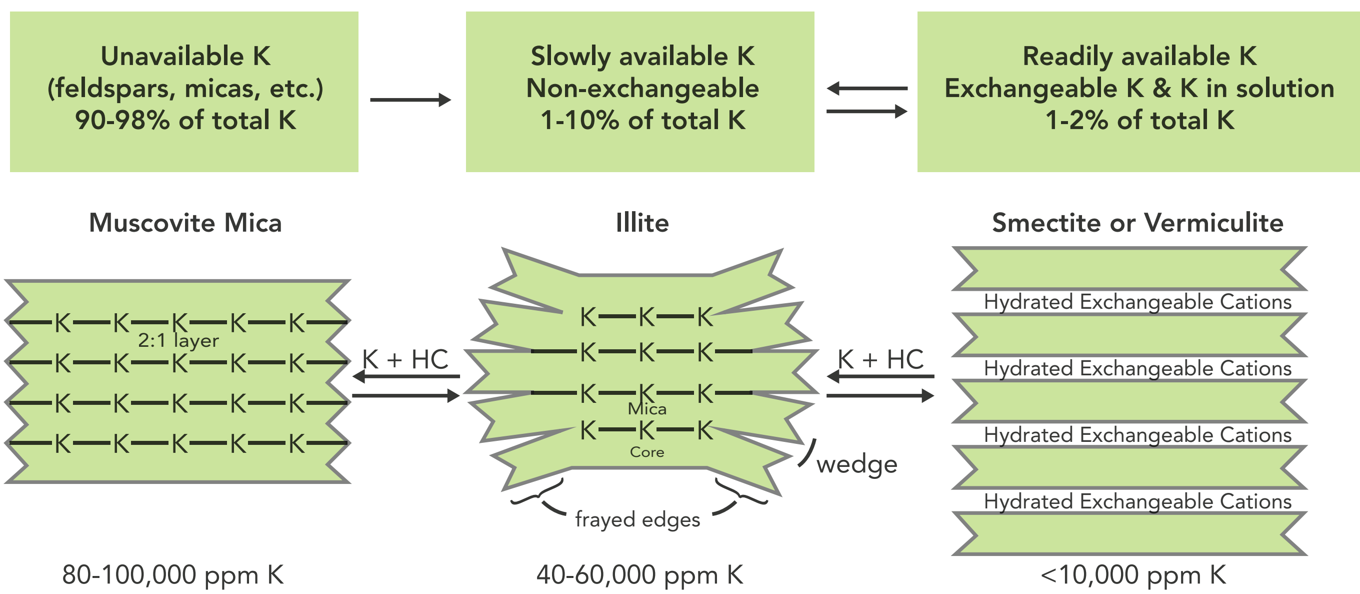
Even in areas that have higher potassium reserves, the amount of potassium that is available for plant growth may be low due to the soil clay type and the soil's cation exchange capacity (CEC). Both soil clay type and CEC are physical properties of the soil that cannot be changed. However, these factors can be managed.

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. These three soil clay types are shown below in Figure 1.

Muscovite 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 the plant roots. Picture this kind of soil as a brick wall with the potassium being the mortar that holds the bricks together.

Figure 1. Forms of Potassium in the Soil



Illitic clay types are the product of weathered muscovite and mica clays. Using the brick-wall analogy, an illitic clay would be a muscovite or mica brick wall needing repair. As shown in **Figure 1**, the edges of the illitic clay are frayed and wedged open, exposing the interior potassium located 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 clays are present because of this entrapment process.

The third clay type is montmorillonite or vermiculite. These clay types are lacking all of the interior potassium that normally binds the clay layers together. This allows these clay types to expand and contract during wetting and drying cycles and the exchangeable potassium (K) and other hydrated cations (HC) can move into the soil solution. These clay types hold onto the potassium in a manner that makes the potassium readily available for plant roots.

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, for soils dominated by illitic clays, it would be difficult to increase soil-test potassium levels by applying potash. Most soils have a mixture of clay types; therefore, soils vary in their ability to hold and trap applied potassium.

Keep all soil-test potassium records and yearly potash application rates to determine if soil-test levels are building as expected. Due to potassium trapping or "fixation," one will need eight pounds of K_2O per acre to increase the soil test K value by one ppm on average. If soils contained only montmorillinite clay, about 2.2 pounds of K_2O per acre would be required to increase the soil test one ppm K. If a soil requires more than eight pounds of K_2O per acre, then the soil contains more trapping types of clays, and the economics of building soil-test levels become increasingly cost prohibitive.

Cation Exchange Capacity (CEC)

Clay and organic matter are negatively charged particles 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 of K caused by soil clay types, holding potassium and these other cations is a good thing. The ability to hold these positively charged cations is called the soil's cation exchange capacity and is an important measure of the soil's fertility. CEC measures the number of available exchange sites – the quantity of cations that can be held by the soil.

The availability of potassium increases as the percentage of the 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 three to five percent of exchange sites.

For example, a soil-test result of 125 ppm of potassium availability may be adequate or inadequate depending on the CEC of the soil. Determine the percentage of exchange sites by taking the potassium ppm, dividing that number by 390, and then dividing by the CEC of the soil. For a sandy-textured soil with a CEC of five, 125 ppm of potassium calculates to be 6 percent of the exchange sites occupied with potassium (125 ÷ 390 ÷ 5 = 6 percent) which would be more than adequate for most crops. On the other hand, a heavy textured soil with a CEC of 30 and a soil-test result of 125 ppm potassium would only represent about one percent of the exchange sites, which would be inadequate.

Conclusion

Clay type and CEC control the amount of potassium that is available for plant uptake. It is difficult to increase the soil's potassium levels in soil that contains a high percentage of clay types that trap the potassium. For such soils, the build philosophy is uneconomical.

Trapping clay types can be identified by tracking soil-test levels and the amount of applied potash. On average, soil-test levels for potassium should increase one ppm for every eight pounds of K_2O applied per acre. The amount of potassium in soil solution increases directly in proportion to the relative amount of potassium occupying the exchange sites (based on CEC). Ideally, three to five percent of the exchange sites should be occupied by potassium to ensure adequate potassium is available for plant uptake.