The Importance of “K” in Plants

BY COLIN BELL, PHD
CHIEF REVENUE OFFICER AND CO-FOUNDER, GROWCENTIA

Potassium (K) is one of 17 essential elements required by plants for healthy growth and reproduction. Along with nitrogen (N) and phosphorus (P), K is classified as a macronutrient, and is considered second only to nitrogen in terms of its importance to plant growth. In this article, we highlight why K is so important.

In contrast to N and P which are primarily needed to produce plant biomass, plants require K for vital intracellular functions which indirectly support plant growth, including nutrient transport, photosynthesis and stomata regulation (a small opening on the under-surface of plant leaves where carbon dioxide diffuses into the cell for photosynthesis). Potassium also acts as a catalyst by regulating at least 60 enzymatic activities involved in growth processes within the plant cell and helps facilitate the translocation of sugars and nutrients. article_k_fig-1

The importance of K for stomatal activity, enzyme activation, and photosynthesis:

Plants depend upon K to regulate the opening and closing of stomates, which is essential for photosynthesis (Fig. 1). In brief, K accumulates in the cells surrounding the stomates (also known as guard cells) causing water to accumulate in the cell (via osmosis) due to the higher K ion concentrations and swell. The swollen guard cells apply pressure to stomata pores and cause them to open. When stomata are open, CO2 and other gases are able to exchange between the plant and its surrounding environment (Fig. 1). If the supply of K is inadequate, stomata activity rates (opening and closing) will slow down. When this happens, stomata closure may take hours rather than minutes and as a result plants will grow slower.

Potassium catalyzes chemical reactions by regulating > 60 enzymes associated with plant growth. Furthermore, the amount of K present in the cell determines how many enzyme-driven reactions can be activated at any one time. For example, potassium acts as a catalyst by activating enzymes involved in regulating the rate of photosynthesis and the production of adenosine triphosphate (ATP). These high-energy molecules drive all the necessary cellular reactions which support plant growth from seedling through bloom. During ATP production, the plant uses K (ions) to regulate electrical charge, which is important to maximize ATP production during photosynthesis. This is likely the most critical role of K for healthy plant functioning (even more so than regulating stomatal activity), because when plants are deficient in K, both photosynthesis and the rate of ATP production declines, which subsequently limits all aspects of plant development.

The transport of sugars, nutrients and water use:

article_k_fig-2An adequate supply of K is necessary to maintain the function of phloem (the vascular tissue that transports sugars and other metabolic products downward from the leaves) and xylem (the vascular tissue that transports water and nutrients from roots to shoot and leaves) transport systems. For example, sugars produced in photosynthesis must be transported through the phloem (Fig. 2) to other parts of the plant for utilization and storage. When plant K levels are inadequate, less ATP is produced and the transport system slows. When a plants transport system slows, photosynthate (i.e. sugar) builds up in the leaves and further reduces photosynthesis reactions. As a result, plant development is significantly stunted. As with phloem, K interacts with specific enzymes in the xylem transport system to deliver water, nitrates, phosphates, calcium (Ca), magnesium (Mg), and amino acids to the plant (Fig. 2). Without adequate K, the translocation of nutrients slows and the rate of plant growth subsequently declines.

Potassium deficiency in plants:

The lack of potassium will reduce the yield and quality of your crop. Symptoms of potassium deficiency include yellowing or browning of the lower leaves. It may be difficult at first glance to differentiate potassium deficiency from a lack of nitrogen or phosphorus, as all three conditions may induce yellowing and dying of the lower leaves which progresses upwards. This can happen because like nitrogen and phosphorous, potassium is considered “mobile” in plants and can be scavenged from lower older leaves up to newer growth high in the canopy in times of scarcity. In many cases, potassium deficiency can also resemble nutrient burn. However, unlike nutrient burn, more yellowing will occur in the leaf margins near the affected edges and the necrosis on the leaf surface appears more severe that typical nutrient burn symptoms.

Delivering adequate potassium to plants:

The availability of potassium to the plant is highly variable due to complex soil dynamics which are strongly influenced by root-soil interactions (Fig 3). In nature, up ~ 95% of the total potassium is tightly bound in mineral soil and unavailable for plant uptake. A smaller portion (~ 5%) is chemically sorped to the mineral and media exchange sites which can be mobilized for plant uptakearticle_k_fig-3via microbial desorption activities. Plants readily absorb soluble K in the soil solution. Since only ~1% of the total K pool is available in the soil solution for plant uptake, K management is more complicated that simply adding sufficient fertilizer.

Harnessing the natural power of soil microbes can help maximize plant nutrient use efficiency. In agriculture systems, K is mainly applied to soils for plant uptake in the form of potash (K_2O). Potash is commercially available as muriate (KCI), sulfate (K_2SO_4), double sulfate and magnesium (K_2SO_4 $2MgSO_4$), and nitrate (KNO_3). These fertilizers can quickly become unavailable to the plant after applying into the soil. In these cases, soil microbes can naturally unlock bound nutrients, transforming nutrients back into plant available forms, maximizing K availability to significantly increase plant K uptake. The adoption of microbial bio stimulants (i.e. beneficial bacteria) in cannabis production can greatly increase K cycling and plant K uptake, leading to increased cannabis health, quality and yield.