

Functions of Potassium in Plants

Potassium is vital to many plant processes. A review of its role involves understanding the basic biochemical and physiological systems of plants. While K does not become a part of the chemical structure of plants, it plays many important regulatory roles in development.

Enzyme Activation

Enzymes serve as catalysts for chemical reactions, being utilized but not consumed in the process. They bring together other molecules in such a way that the chemical reaction can take place. Potassium “activates” at least 60 different enzymes involved in plant growth. The K changes the physical shape of the enzyme molecule, exposing the appropriate chemically active sites for reaction. Potassium also neutralizes various organic anions and other compounds within the plant, helping to stabilize pH between 7 and 8...optimum for most enzyme reactions.

The amount of K present in the cell determines how many of the enzymes can be activated and the rates at which chemical reactions can proceed. Thus, the rate of a given reaction is controlled by the rate at which K enters the cell.

Stomatal Activity (Water Use)

Plants depend upon K to regulate the opening and closing of stomates...the pores through which leaves exchange carbon dioxide (CO₂), water vapor, and oxygen (O₂) with the atmosphere. Proper functioning of stomates is essential for photosynthesis, water and nutrient transport, and plant cooling.

When K moves into the guard cells around the stomates, the cells accumulate water and swell, causing the pores to open and allowing gases to move freely in and out.

When water supply is short, K is pumped out of the guard cells. The pores close tightly to prevent loss of water and minimize drought stress to the plant.

If K supply is inadequate, the stomates become sluggish – slow to respond – and water vapor is lost. Closure may take hours rather than minutes and is incomplete. As a result, plants with an insufficient supply of K are much more susceptible to water stress.

Accumulation of K in plant roots produces a gradient of osmotic pressure that draws water into the roots. Plants deficient in K are thus less able to absorb water and are more subject to stress when water is in short supply.

Photosynthesis

The role of K in photosynthesis is complex. The activation of enzymes by K and its involvement in adenosine triphosphate (ATP) production is probably more important in regulating the rate of photosynthesis than is the role of K in stomatal activity.

When the sun’s energy is used to combine CO₂ and water to form sugars, the initial high-energy product is ATP. The ATP is then used as the energy source for many other chemical reactions. The electrical charge balance at the site of ATP production is maintained with K ions. When plants are K deficient, the rate of photosynthesis and the rate of ATP production are reduced, and all of the processes dependent on ATP are slowed down. Conversely, plant respiration increases which also contributes to slower growth and development.

In some plants, leaf blades re-orient toward light sources to increase light interception or away to avoid damage by excess light,

Potassium (K) increases crop yield and improves quality. It is required for numerous plant growth processes.

in effect assisting to regulate the rate of photosynthesis. These movements of leaves are brought about by reversible changes in turgor pressure through movement of K into and out of specialized tissues similar to that described above for stomata.

Transport of Sugars

Sugars produced in photosynthesis must be transported through the phloem to other parts of the plant for utilization and storage. The plant's transport system uses energy in the form of ATP. If K is inadequate, less ATP is available, and the transport system breaks down. This causes photosynthates to build up in the leaves, and the rate of photosynthesis is reduced. Normal development of energy storage organs, such as grain, is retarded as a result. An adequate supply of K helps to keep all of these processes and transportation systems functioning normally.

Water and Nutrient Transport

Potassium also plays a major role in the transport of water and nutrients throughout the plant in the xylem. When K supply is reduced, translocation of nitrates, phosphates, calcium (Ca), magnesium (Mg), and amino acids is depressed. As with phloem transport systems, the role of K in xylem transport is often in conjunction with specific enzymes and plant growth hormones. An ample supply of K is essential to efficient operation of these systems.

Protein Synthesis

Potassium is required for every major step of protein synthesis. The "reading" of the genetic code in plant cells to produce proteins and enzymes that regulate all growth processes would be impossible without adequate K. When plants are deficient in K, proteins are not synthesized despite an abundance of available nitrogen (N). Instead, protein "raw materials" (precursors) such as amino acids, amides and nitrate accumulate. The enzyme nitrate reductase catalyzes the formation of

How potassium works to increase crop yields:

- Increases root growth and improves drought resistance
- Activates many enzyme systems
- Maintains turgor; reduces water loss and wilting
- Aids in photosynthesis and food formation
- Reduces respiration, preventing energy losses
- Enhances translocation of sugars and starch
- Produces grain rich in starch
- Increases protein content of plants
- Builds cellulose and reduces lodging
- Helps retard crop diseases

proteins, and K is likely responsible for its activation and synthesis.

Starch Synthesis

The enzyme responsible for synthesis of starch (starch synthetase) is activated by K. Thus, with inadequate K, the level of starch declines while soluble carbohydrates and N compounds accumulate. Photosynthetic activity also affects the rate of sugar formation for ultimate starch production. Under high K levels, starch is efficiently moved from sites of production to storage organs.

Crop Quality

Potassium plays significant roles in enhancing crop quality. High levels of available K improve the physical quality, disease resistance, and shelf life of fruits and vegetables used for human consumption and the feeding value of grain and forage crops. Fiber quality of cotton is improved. Quality can also be affected in the field before harvesting such as when K reduces lodging of grains or enhances winterhardiness of many crops.

The effects of K deficiency can cause reduced yield potential and quality long before visible symptoms appear. This "hidden hunger" robs profits from the farmer who fails to keep soil K levels in the range high enough to supply adequate K at all times during the growing season. Even short periods of deficiency, especially during critical developmental stages, can cause serious losses.

Quality factors are addressed in more detail on pages 28 and 29. **BC**