



# Potassium Nutrition in Plants

## FACT SHEET

Potassium is absorbed by plants in larger amounts than any other mineral element except for Nitrogen.

In order for a plant to use nitrogen it must combine  $\text{NO}_3$  with  $\text{K}^+$  at the root surface for transport up the Xylem of the plant.

Potassium is the most abundant cation in the cytoplasm of the plant, and potassium salts are responsible for the osmotic potential of cells and tissues.

The high concentration of potassium in the cytoplasm and chloroplasts is responsible for maintaining the pH of the cell and tissue between 7 and 8. In potassium deficient plants if the pH drops below 7 many plant processes will stop. An example of this is that a cell pH of 6.7 nitrate reductase activity almost completely stops.

Other such activities that Potassium takes part in, in plant nutrition include over 60 enzyme systems. It is difficult to imagine a growth or reproduction process in plants that is not directly or indirectly impacted in a very significant way by K.

### Potassium plays the following roles:

#### **Photosynthesis**

Coloration of leafy vegetables (healthy green colour)  
Uniformity of ripening  
Growth Rate

#### **Syntheses of amino acids and proteins**

Food quality

#### **Carbohydrate synthesis and translocation**

Bud development  
Sugar content  
Enhanced flavour

#### **Lignin and Cellulose development**

Firm stems and stalks  
Resistance to bruising and physical breakdown  
Longer shelf life

#### **Disease and insect resistance**

Thicker epidermal layer  
Fewer Blemishes  
Higher market grade  
Less culls and waste  
Better insect tolerance  
Better frost protection

#### **Root growth**

More effective utilization of soil moisture  
Improved nutrient uptake  
Greater vigor

## Soil Potassium Availability

Potassium levels in plants for optimal growth are between 2 and 3 % of the dry weight. When  $\text{K}^+$  is

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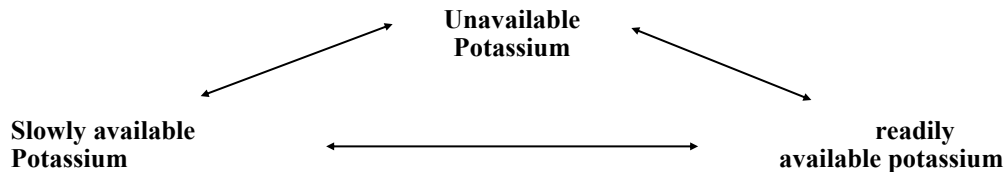
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limited to the plant life processes from Photosynthesis to moisture regulation of the plant are effected.

Soil potassium levels are very much a function of the availability and uptake by the plant. In soils only a fraction of the potassium is available to the plant for uptake. In fact many soils containing large amounts of total potassium will respond to additions of potassium fertilizer do to its availability.

Soil potassium exists in 3 forms: 1) relatively unavailable, 2) slowly available, and 3) readily available.



In soils the unavailable form is that which is not available to plants and is contained in unweathered or slightly weathered minerals. This makes up or accounts for 90 – 98% of the total potassium in soils.

Slowly available potassium is gradually taken up or fixed depending on the soil type and Equilibria of the soil. This portion of the soil potassium accounts for 1 – 10 % of the soil potassium.

Readily available potassium is a combination of water soluble and exchangeable potassium. In some soils reversion back to slowly available can occur in the process of fixation. This accounts for only a small portion of the total soil potassium at .1 – 2 per cent depending on the soil type.

In soils, potassium never comes to equilibrium because of the removal by plants, leaching and the addition potassium fertilizers. A constant conversion of potassium from the unavailable forms to the readily available forms takes place, with some conversion from readily available back to the slowly available with heavy applications or fertilizers in some soils.

The readily available form of potassium that is measured in laboratory procedure is the portion that is available to plants and is found in soil solution and on the exchangeable fraction of the soil particle.

An increase in the concentration of  $K^+$  ions in solution when fertilizer is added to the soil will increase the amount of  $K^+$  available to the plant contained on the exchangeable portion of the soil. In the case of low  $K^+$  levels in the soil in the available form an application of fertilizer  $K^+$  will increase the conversion of  $K^+$  to the slowly available form (fixation). In these soils the addition of  $K^+$  close to the growing season will reduce the amount of  $K^+$  that will be converted to the slowly available form or fixed.

As soil equilibria is approached and the readily available pool of  $K^+$  is increased or reaches saturation the amount of  $K^+$  fixed is reduced. However this is very dependent on soil type and other conditions that effect the fixation of  $K^+$ .

### **Potassium and Photosynthesis**

Potassium plays a major role in the process of Photosynthesis. A plant that has an optimum level of  $K^+$  in its cytoplasm will be a more efficient in photosynthesis.

| <b>Leaf<br/>Potassium<br/>(mg/g dry weight)</b> | <b>Photosynthesis</b> | <b>Photorespiration</b> |
|---|-----------------------|-------------------------|
|---|-----------------------|-------------------------|

|      |      |     |
|------|------|-----|
| 12.8 | 11.9 | 4.0 |
| 19.8 | 21.7 | 5.9 |
| 38.4 | 34.0 | 9.0 |

From this chart as you can see as we increase the level of K in the Leaf, the rate of Photosynthesis also increases.

### **Water regulation in the Plant**

As potassium is responsible for regulating the salt concentration of the cell and cytoplasm it plays a major role in the water retention and uptake of the plant. Potassium plays a major role in the turgor pressure and changes in turgor pressure in the guard cells during stomatal movement.

A typical symptom of potassium deficiency is the loss of turgor or the wilting of plants in prolonged dry weather. Therefore, a plant that has adequate  $K^+$  nutrition will be able to withstand longer periods of low soil moisture.

This high requirement for  $K^+$  in the leaf tissue protects the plant during other adverse weather conditions such as frost. High concentrations of  $K^+$  in leaf tissue acts as an anti freeze to the leaf tissue and protect it from frost to a certain degree.

### **Insect and Disease Protection**

Potassium plays a major role in the construction of the cuticle layer. This cuticle layer is the plants first line of defense to disease and insect attack.

Plants receiving adequate  $K^+$  nutrition have a stronger enzyme activity and are capable of withstanding more fungal attack. Increasing  $K^+$  nutrition will reduce the amount of disease both in the root and in the above ground parts of the plant.

The most significant impact that we see with adequate  $K^+$  nutrition is that of the increased defense that the plant has to sucking insect. When the  $K^+$  levels are adequate and the sap pH is in the 7 – 8 range sucking insects are not attracted to the sap.

### **Quality and Consumers Demand**

High produce quality is essential for profitable production. Quality can be measured in many ways. High on the list for consumer acceptance is produce of uniform size, colour, and maturity, with enhanced flavour, free of blemishes or unusual marking, and free of any sign of disease. Potassium plays a significant role in all of these considerations.

### **Summary**

In the final analysis, Potassium does not work alone; rather, it functions with other essential nutrients and crop management inputs to produce the final product. The importance of balanced nutrition and efficient use of all plant nutrients is recognized. The special role of Potassium in crop quality is of particular importance for overall production.