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Potassium in Crop Nutrition

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Soil Potassium

The average Potassium (K) content of the earth's crust is in the order of about 2.3%. Most of this K is bound in primary minerals or is present in the secondary clay minerals which largely make up the clay fraction of the soil of particle size less than 2 micrometers. It is this reason that soils rich in clay are also generally rich in K. Mature soils which have been subjected to strong weathering conditions are often low both in clay and K contents. Highly weathered sandy soils contrast markedly to young soils derived from volcanic material in which clay and K contents are generally high. Organic soils are frequently low in clay and therefore have low K contents.

Potassium in Physiology

Potassium is an essential element for all living organisms. In plant physiology it is the most important cation not only in regard to its content in plant tissues but also with respect to its physiological and biochemical functions.[1]

Within the plant, potassium is very mobile, with its main transport direction being towards the meristematic tissues (actively dividing cells). Potassium also plays a critical role in the regulation of osmotic potential (diffusion of fluids through membranes). The mechanism of stomatal closure and opening depends entirely upon K flux. It has also been shown that K enhances the translocation of assimilates. Another main function of K is the activation of various enzyme systems. There are more than 60 different enzymes that require univalent cations for activity. In most cases the K^+ ion is the most efficient cation in effecting this activation.[1]

FIGURE 1. POTASSIUM DEFICIENCY IN GRAPES

Potassium Deficiency

Potassium deficiency does not immediately result in visible symptoms. At first there is only a reduction in growth rate (hidden hunger), and only later do chlorosis and necrosis occur. These symptoms generally begin in the older leaves, due to the fact that these leaves supply the younger ones with K+. Plants suffering from K deficiency show a decrease in turgor (rigidity of plant cells), and under water stress they easily become flaccid. Resistance to drought is therefore poor and the affected plants show increased susceptibility to frost damage, fungal attack, and saline conditions.

Plants suffering from severe K deficiency often show an abnormal development of tissues and cell organelles. K deficiency also results in a collapse of chloroplasts and mitochondria.

Correcting Potassium Deficiencies

There are many various forms of potassium fertilizers available for ground application. While this method should not be ignored, it is often ineffective at supplying adequate amounts of potassium at various developmental stages of crop production. In these cases, foliar applications of Metalosate potassium have proven to be extremely effective at providing the crop with adequate amounts of potassium at certain developmental stages.

FOLIAR APPLICATION OF POTASSIUM

It is well known that a portion of a crop's nutritional needs may be met by directly applying fertilizer solutions to the foliage.

In certain situations, such as those involving micronutrients, foliar nutrition may offer the most economical and reliable method for correcting and/or preventing deficiencies. For most crops, only a portion of the primary and secondary nutrient requirements can be supplied through the foliage. As a general rule, foliar nutrition programs should supplement sound soil fertilizer programs.

Certain crop conditions benefit from a foliar application of Metalosate® Potassium because the soil uptake is not sufficient.

One example of an instance when foliar application of Metalosate Potassium proves to be very beneficial is at the developmental stage on grapes known as verasion. This signifies the change from berry growth to berry ripening. The berries change color and also begin to accumulate sugars. Large amounts of potassium are required to facilitate the transport of the sugars from the leaves of the vine into the berries or grapes. We have found that applications of Metalosate Potassium right at verasion and again 2 weeks later results in significantly higher levels of sugar accumulation in the berries.

Another example of Metalosate Potassium benefits is the increase of sugars and human nutrition in melons. Dr. Gene Lester from the USDA ARS in Weslaco, Texas, has performed extensive studies on the use of Metalosate Potassium on muskmelons aka cantaloupe.[2]

In one study Dr. Lester looked specifically at the effects of foliar applied Metalosate potassium on Cantaloupe quality, sugar content and related compounds. It was found that fruit having received weekly foliar applications of Metalosate Potassium during growth and maturation reached harvestable maturity significantly earlier (Table 1) than the control fruit. Potassium concentrations in the edible portion of the fruit were affected by potassium treatments. Fruit receiving weekly Metalosate Potassium treatments had significantly higher (15%) potassium concentration than controls. Soluble solids concentration (SSC) was significantly higher in fruit receiving weekly Metalosate Potassium applications. There are minimum levels of SSC that must be met in order for the melons to be legally marketable.

It was also demonstrated in this study that the application of Metalosate Potassium can increase fruit sugar levels as shown in Table 2. Total sugars in fruit receiving weekly applications of Metalosate Potassium were significantly greater (8% more sugars) than in control, non-treated fruit. Fructose and glucose were 17% and 8% greater respectively in fruit receiving weekly treatments. High fructose content in melons is a positive fruit characteristic, as such, fruit may be perceived to be sweeter. Fructose is perceived to be 42% sweeter than sucrose and 57% sweeter than glucose. Thus, a high-fructose melon should taste sweeter than a melon with equal total sugars but less fructose.[2]

Two important human-wellness compounds; ascorbic acid (vitamin C) and beta carotene (provitamin A), essential in the

TABLE 1. DIFFERENCES IN MATURATION, EDIBLE TISSUE POTASSIUM CONCENTRATION AND SSC.

Foliar Application	Maturity (days to harvest)	Potassium concentration mg/g dry wt.	SSC %
Weekly	35.2 b	37.3 a	9.0 a
Bi-Weekly	36.3 ab	37.0 a	8.4 ab
None	37.0 a	32.0 b	8.0 b

* Different letter in column denotes statistical significance ($p<0.05$)

TABLE 2. DIFFERENCES IN EDIBLE TISSUE FRUCTOSE, GLUCOSE, SUCROSE AND TOTAL SUGARS OF CANTALOUPE MELONS.

Foliar Application	Fructose mg/g dry wt.	Glucose mg/g dry wt.	Sucrose mg/g dry wt.	Total sugar mg/g dry wt.
Weekly	154 a	89 a	300 a	543 a
Bi-weekly	153 ab	87 a	290 a	531 ab
None	128 b	82 b	292 a	502 b

* Different letter in column denotes statistical significance ($p<0.05$)

human diet and synthesized only in plants, are found in very high concentrations in orange-fleshed cantaloupe melons. Potassium is highly influential in the accumulation of these compounds in melon fruit. Table 3 shows that ascorbic acid was 13% higher in fruit receiving weekly Metalosate Potassium applications. Beta-carotene was 22% higher in fruit receiving weekly applications vs. fruit receiving bi-weekly applications and 45% higher than control fruit. [2]

The application of Metalosate Potassium to fruits, berries, and melons has resulted in sweeter fruit, improved color, and increased fruit quality.

For more information on Metalosate Potassium or any of the Metalosate products please contact your local Albion Plant Nutrition representative.

TABLE 3. TOTAL ASCORBIC ACID AND BETA-CAROTENE CONCENTRATION OF CANTALOUPE FRUIT

Foliar Application	Ascorbic Acid mg/g Dry Weight	Beta-carotene µg/g Dry Weight
Weekly	25.4 a	39.5 a
Bi-weekly	24.4 ab	30.8 b
None	22.0 b	21.6 c

* Different letter in column denotes statistical significance ($p<0.05$)

REFERENCES

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