

# Quality: Potassium Management is Critical for Horticultural Crops

By Robert Mikkelsen

## Quality, What is it?

Potassium is frequently referred to as the “*quality*” nutrient for plants. Quality has many characteristics and the most important aspects of quality will depend on the specific crop. For example, with citrus, it may be the thickness of the peel and Vitamin C concentration, for apples, sugar concentrations, while for tomatoes, the development of uniformly red fruit rich with lycopene. The specific quality parameters for each crop will vary and should be well understood to maximize crop nutritional practices and market profitability (Kumar et al., 2006).

While many “quality” benefits are generally understood, it can be difficult to define and quantify the exact benefits of K (Lester et al., 2010a). Most notably, the lack of quality is frequently observed when the plant K supply becomes



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deficient. An inadequate K supply becomes especially important for horticultural crops where the visual appearance of the fruit and leaves is critical for marketing. Although the total yield may be reduced with insufficient K, it is possible that the entire crop may be unsalable due to poor quality and visual appeal.

The growth and longevity of cut flowers and ornamentals can also be diminished by a lack of adequate K. Shipping, handling, and freshness are particularly important for ornamental horticulture.

## Consumer Preference

Consumers have a strong preference for fresh fruits and vegetables with appealing appearance and texture. Quality and freshness of fruits and vegetables are often cited as the primary characteristics for making purchase decisions.

Potassium plays a critical role in many of the metabolic processes that enhance the quality, nutrition, flavor, appearance, and longevity of fresh food crops. These beneficial improvements clearly are desirable for farmers and will add to the marketability of crops.

## Vitamin C

Application of K to the soil or plant foliage has been shown to increase the concentration of Vitamin C in a variety of fruit crops. While citrus is the most frequently cited example, increased Vitamin C has been reported in crops such as cucurbits, cauliflower, onion, banana, guava, and papaya (Imas, 2013). Muskmelon also had higher concentrations of Vitamin C as a result of foliar K sprays (Lester et al., 2010b).

## Nitrate Assimilation and Protein Synthesis

Potassium plays an important role in converting nitrate into amino acids and proteins. An insufficient supply of K may result in both lower nitrate uptake from the soil and slower nitrate assimilation into amino acids and proteins. Potassium deficiency can result in accumulation of low molecular weight sugars and carbohydrates, along with soluble-N compounds in the plant.

Nitrate accumulation in K-deficient plants can be a concern where limits have been established (such the European Union nitrate limit for leafy vegetables). When nitrate is rapidly converted to protein, the concern for healthier food is satisfied.

## Appearance of Fruits and Vegetables

An adequate K supply has been linked to improved visual appearance of many horticultural crops. For example, banana is a crop that frequently responds favorably to K fertilization. Sufficient K improves banana fruit weight and number of fruits in each bunch, increases soluble solids, sugars, and starch. Low K results in thin and brittle bunches with a shorter shelf life. A lack of K has been linked with premature color development and harder, dry fruit sacs in

Potassium is essential for the growth of all plants, but particular attention has been placed on its role in improving the quality of horticultural crops because of their high value and short shelf-life. Parameters of quality are expressed differently in each plant species, but the fundamental role of K for promoting quality is consistently and widely reported. This brief review examines the role of K in producing quality food that meets consumer demands and preferences.

### KEYWORDS:

crop quality; human nutrition; functional foods.

### ABBREVIATIONS AND NOTES:

K = potassium.

<https://doi.org/10.24047/BC102224>





<https://uconnladybug.wordpress.com>

**Lower K concentrations** in tissue analysis studies have preceded the development of yellow shoulder symptoms in tomato.

citrus. Potassium-deficient grapes are less firm and have less juice.

An adequate supply of K increased marketability traits of muskmelon fruit (maturity, yield, firmness, and sugars) and quality parameters (ascorbic acid and  $\beta$ -carotene) (Lester et al., 2010a). The yield, quality, and shelf-life of tomatoes are improved with an adequate K supply. A lack of sufficient K results in uneven ripening, yellow shoulder fruit, and irregularly shaped fruit with poor internal quality (Hartz et al., 2005).

### Extending Shelf-life and Reducing Food Waste

Potassium has been shown to have a beneficial impact on properties that improve shelf life, storage, and shipping of many fruits and vegetables. Some of this occurs as an adequate K supply generally increases the firmness and strength of skins, allowing greater resistance to damage during transport and storage. Extending the longevity of freshness provides immediate benefits to both the farmers and the consumers.

The positive impact of K on fruit storage has been re-



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**A comparison of banana shelf-life after 19 days.** The banana bunch on the right came from a plant that was adequately supplied with potassium while the plant producing the bananas on the left did not receive potassium.

ported on many crops, including bananas (shelf-life), citrus (decreased post-harvest mold and rot), potatoes (storage longevity), carrots (crispness), pineapple (greater vitamin C leading to reduced browning and rot), figs, and apples.

### Disease and Insects

Plants that are deficient in K are likely to be more sus-

ceptible to infection and insect damage than when sufficient K is present. In a significant literature review, Perrenoud (1990) examined 2,449 scientific citations and concluded that the use of K reduced the incidence of fungal diseases by 70%, bacterial infection by 69%, insects and mites by 63%, viruses by 41%, and nematodes by 33%. Reducing these pathogens and insects had a large benefit of allowing higher yields to be achieved.

A review by Wang et al. (2013) presented an excellent summary of how optimal K nutrition imparts significant plant resistance to both biotic and abiotic stresses. They reviewed the important role of K in protecting plants against diseases, pests, drought, salinity, cold and frost, and water-logging.

Consumers are sensitive to the use of plant protection chemicals in production of horticultural crops. This sensitivity partially accounts for the growth of the organic farming sector (Mikkelsen, 2007). Whenever possible, providing adequate K should be used as a first line of protecting plant health. Decreased damage to harvested fruits and vegetables from pathogens and stresses will also result in a more attractive, marketable, and hence profitable crop.

## Nutrient Composition

Fruits and vegetables are the most important sources of dietary K in the human diet. However, a trend for a decline in the mineral concentration of many foods has been suggested for over 75 years (Davis, 2009). A decline of 5% to 40% or more in minerals, vitamins, and proteins has been measured in many foods, especially vegetables. The cause for this decline may be due to dilution, changes through plant breeding, and changes in farming cultural practices. Recent reviews indicate that the decline in nutrient concentration of fruits and grain may not be as severe as earlier claimed (Marles, 2017).

Whatever the cause of this dilution, clearly there is a need to reexamine how the K concentration of food can be enhanced to better meet the dietary and health needs of consumers.

## Functional Foods

“Functional food” is a term used to describe foods that provide health benefits in addition to the regular vitamins and minerals contained in common foods. Including them in a human diet is often considered to promote health beyond a more typical diet. Lycopene found in tomatoes, alliin present in garlic, and resveratrol in grapes are examples of nutraceutical compounds in functional foods that may provide health benefits.

The concentrations of all these functional food compounds listed above have been shown to increase in the presence of an adequate or abundant K supply to plants. The direct metabolic link between K and these functional food compounds is not always clear, but the trends are consistent.

## Human Health

Animals and humans have an absolute requirement for K for proper growth and health. Potassium is involved in many essential functions in nerves, biochemical reactions, muscle function, heart health, and water balance. However, almost all human diets are quite low in K compared with the recommendations for health (Weaver, 2013). For example, in the United States the average daily K consumption is only 55% of the recommended dietary intake.

A diet rich in fruits and vegetables is one of the best ways to increase K intake, with potatoes being one of the highest sources of dietary K. Increasing the K concentration of the harvested portion of fruits, vegetables, and other plant-based products would make an important contribution to improving human health.

## Conclusions

Potassium is essential for sustaining both the yield and the quality of many horticultural crops. Enhanced quality is frequently observed in many vegetables and fruits from an abundant supply of K. This quality can be observed in different ways for each species, but includes parameters such as size, appearance, longevity of storage, sugar and acidity, soluble solids, and nutritional benefits. Damage from disease, insects, and environmental stresses are frequently reduced when adequate K is present. All these considerations combine to underline the importance of maintaining an adequate supply of K for the production of high quality horticultural crops. **BC**

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