FLORIDA

Importance of Potassium in a Florida Citrus Nutrition Program

By T.A. Obreza

Citrus groves cover more than 830,000 acres in Florida. Most commercial groves are located south of Orlando, where freeze danger is minimized. Commercial groves thrive from the rolling, excessively-drained, deep sand hills of the central Florida ridge to the low-lying, poorly-drained flatwoods and marsh soils of the coastal areas. Regardless of location, most of the soils used for citrus production have root zones dominated by quartz sand, with very low concentrations of clay or organic matter. As a result, citrus grove managers have a challenging task irrigating and fertilizing their groves because the soils are extremely low in natural fertility and water-holding capacity.

Citrus trees use large quantities of potassium (K), so their yield response is on the same order of magnitude as nitrogen (N) response. The ideal K fertilizer rate is about 200 lb K_2O/A. Fresh citrus growers need to be aware that K affects fresh fruit qualities like size and sweetness, as well as yield. These factors should all be taken into account when formulating a fertilization program.

In a typical citrus fertilization program for mature trees, N and K fertilizers are applied at relatively high rates each year. Annual N application ranges between 150 and 250 lb/A, and K_2O is applied at 1.0 to 1.25 times the N rate. The inefficiency of N fertilizer, primarily due to nitrate (NO_3^-)-N leaching, is well known throughout the humid regions of the world because NO_3^- is a mobile ion in most soils. However, in places other than the Florida peninsula, K is often considered to be a nutrient that is only slightly mobile in the soil. The mobility of K can be limited in soils containing appreciable amounts of organic matter or clay because the positive charge of the K ion enables it to be held by the soil's negatively-charged cation


These two 4-year-old grapefruit trees were grown on a sandy Florida soil, with sufficient N fertilizer. The tree at left received no K fertilizer – note the tight, compact growth and no visible fruit. The tree at right received 200 lb K_2O/A each year – note the increased branching and expansive tree canopy with visible grapefruit.

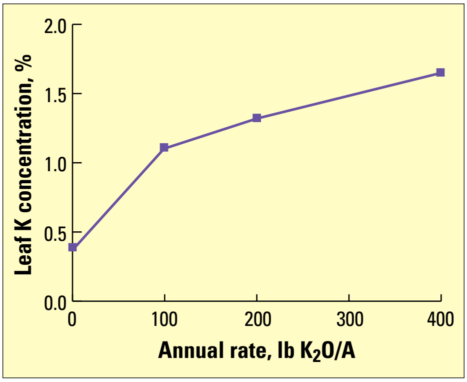

Figure 1. Citrus response to fertilization is reflected in leaf tissue nutrient concentrations.

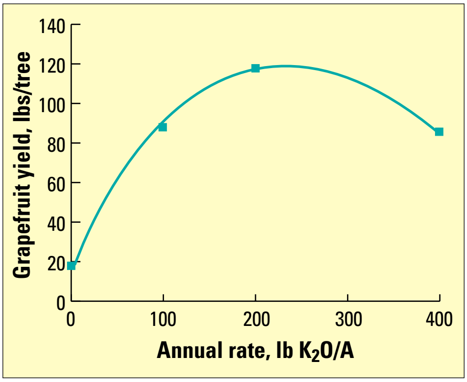

Figure 2. Grapefruit yield response to annual K application rate.

exchange complex. However, if a soil is composed primarily of chemically-inert sand particles, the ability to hold K against leaching can be almost non-existent. Such is the case in most soils where Florida citrus has been planted.

Potassium Use by Citrus

Citrus fruits remove large amounts of K compared with other nutrients. Potassium moves from leaves to fruit and seeds as they develop. Potassium is necessary for basic physiological functions such as formation of sugars and starch, synthesis of proteins, and cell division and growth. It is important in fruit formation and enhances fruit size, flavor, and color. Potassium helps reduce the influence of adverse weather conditions like drought, cold, and flooding.

Potassium also helps regulate the carbon dioxide (CO_2) supply to citrus trees by controlling the opening and closing of stomata. Consequently, the rate of photosynthesis drops sharply when plants are K deficient. A shortage of K can result in lost crop yield and quality. Moderately low plant K concentrations will cause a general reduction in growth without visual deficiency symptoms. The appearance of visual deficiency symptoms means that production has already been seriously impaired.

Evaluating the Response of Citrus to Potassium

Florida citrus growers are advised to annually test their soils for pH and extractable K, phosphorus (P), calcium (Ca), and magnesium (Mg). The information provided by these soil tests increases in value after citrus groves have been annually sampled for 4 to 5 years, because observing year-to-year changes in test values can provide evidence of the degree to which a nutrient is either accumulating in the soil or is perhaps being leached out. While soil test values typically increase following the application of relatively immobile nutrients like P, Ca, and Mg, most citrus grove soils do not show a substantial increase in soil test K even after many years of annual K fertilizer applications.

In 1998, we initiated a P and K fertilizer experiment in a young grapefruit grove planted on a typical flatwoods citrus soil that had not been previously fertilized. The objectives were to calibrate P and K soil tests for Florida citrus production, determine the effects of P and K fertilization on yield and fresh fruit quality, and develop fertilization recommendations that will produce qualities most desired by fresh fruit consumers. After three years of applying P and K fertilizer, we determined that calibrating a K soil test would not be possible because K was not accumulating in the soil. In 1998, soil test K by the Mehlich 1 extraction method was 10 parts per million (ppm), considered very low. By 2001 it had increased to only 19 ppm (low) after three annual applications of 200 lb K_2O/A. In contrast,

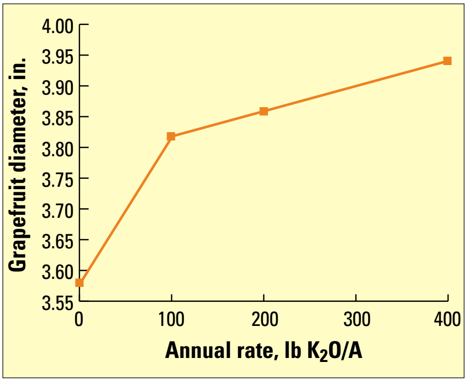

Figure 3. Grapefruit size increased with higher K fertilizer rate.

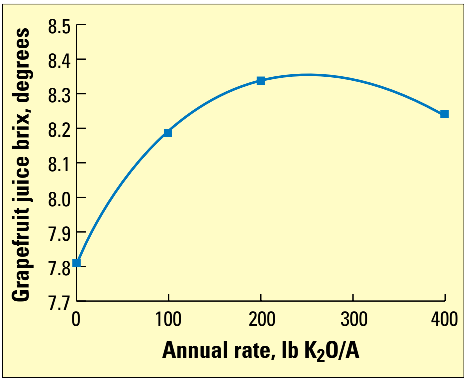

Figure 4. Grapefruit juice brix (sugar content) was maximized at about 200 lb K_2O/A.

soil test P increased from 5 ppm (very low) to 53 ppm (high) following three annual applications of P fertilizer.

Our objective to calibrate a K soil test quickly changed into a K fertilizer rate experiment. We are now evaluating grapefruit tree response to annual K fertilizer applications of 0, 100, 200, and 400 lb K_2O/A. Response variables include canopy volume, fruit yield, and fruit quality factors. One tried and true method of evaluating citrus tree nutrition is leaf tissue analysis. Leaf tissue nutrient concentration standards developed from worldwide research have proven to be a reliable indicator of citrus nutritional status. Citrus response to fertilization is typically reflected in leaf tissue nutrient concentrations, as we observed with K in the study (**Figure 1**). The interpretations for leaf K concentration are: very low, < 0.7%; low, 0.7 to 1.1%; optimum, 1.2 to 1.7%; high, 1.8 – 2.3%; and very high, > 2.3%. The leaf K concentration of trees receiving no K fertilizer was very low; 100 lb K_2O/A raised it to the borderline between low and optimum, after which there was a linear increase of leaf K to the upper end of the optimum range as K fertilizer rate increased. The 200 lb K_2O/A rate was sufficient to maintain optimum leaf K.

The response of tree canopy volume (data not shown) and grapefruit yield (**Figure 2**) to K was characterized by a gradual rise to a maximum followed by a slight decline. The mathematically-fitted response curves predict that maximum tree size and yield will occur when fertilizer is applied at about 200 lb K_2O/A. Visually, the trees that received 200 lb K_2O/A had an expanded, branching canopy compared with the tight, bushy appearance of the trees that did not receive K (see photos). Fruit was easy to find on trees receiving K, but finding a grapefruit on the low-K trees was a difficult task. Interestingly, the low-K trees did not show any obvious visual leaf symptoms of K deficiency such as necrotic edges or off-green color. Rather, the lack of K was expressed as a compact canopy and almost no fruit production.

Three grapefruit internal quality factors important to citrus growers who produce for the fresh market are fruit size (expressed as fruit diameter), juice brix (sugar content), and peel thickness. Larger fruit command higher prices, increased brix may mean that fruit can be harvested earlier in the market season and tastes better, and consumers tend to favor thin-peeled grapefruit. Fruit size increased with increasing K fertilizer rate (**Figure 3**), but brix was maximized at about 200 lb K_2O/A (**Figure 4**). Therefore, it is important to supply sufficient K for fruit sizing, but too much can perhaps cause the brix to be less than maximum. Peel thickness also increased as K fertilizer rate increased (**Figure 5**), indicating that adding K to the system does not provide positive results in all aspects of fruit quality. Growers must consider all factors and strike a balance between them when deciding on the rate of K fertilizer to apply.

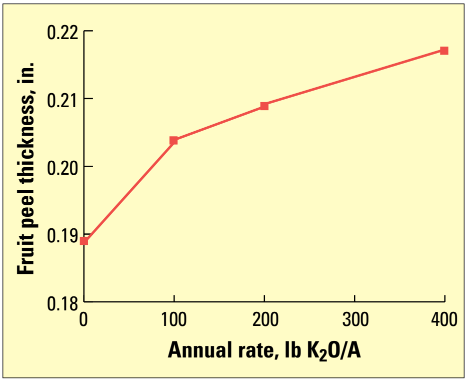

Figure 5. Grapefruit peel thickness increased (a negative effect) as K fertilizer rate increased.

Summary

Most citrus growers treat K as they do N, applying approximately the same rate of K_2O and N each year, in split applications or in small doses with irrigation water (fertigation). Soil testing for K is of little use, but leaf tissue tests can be used to gauge tree K nutrition. The ideal annual K fertilizer rate for citrus appears to be about 200 lb K_2O/A. Fresh market citrus growers should recognize that K affects fresh fruit quality factors ...size and sweetness...as well as yield, and then take all these factors into account when formulating a fertilization program. BC

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Tom W. Bruulsema Elected Chairman of ICCA Board

Dr. Tom Bruulsema, PPI/PPIC Regional Director for Eastern Canada and Northeast U.S., has been elected Chairman of the International Certified Crop Adviser (ICCA) Board for 2003. In the responsibility, he will be part of a leadership team for the organization of nearly 15,000 professional crop advisers across the U.S. and Canada.

Tom Bruulsema

"We've recently been putting together a strategic plan for the next three years. Our main goal is clearly to increase the value of certification," Dr. Bruulsema explained. "Certified crop advisers have an important role in assuring quality in crop production and in delivering an important message not only directly to their clients, but also to the food supply chain, and even to today's consumer."

The ICCA Program is a professional certification program offered by the American Society of Agronomy (ASA). It is voluntary and provides an entry level standard of knowledge through testing and seeks to raise that standard through continuing education. The program is administered locally by 37 state/regional/provincial boards (Local Boards) throughout the U.S. and Canada.

Dr. Bruulsema, a native of Ancaster, Ontario, directs the agronomic research and education programs of PPI/PPIC in his diverse region, which includes 14 states and the eastern provinces of Canada. He earned B.S. and M.S. degrees from the University of Guelph and a Ph.D. from Cornell University. Dr. Bruulsema joined the PPI/PPIC staff in 1994 and is located at Guelph, Ontario. He has recently served as Chairman of the Northeast Branch of ASA and the Soil Science Society of America. BC