Factors affecting citrus production and quality

By Mongi Zekri

Citrus fruit production and quality are influenced by many factors, including climatic conditions and production practices.

In subtropical climates, the temperature usually falls below 70°F for several months during winter. This period of cool temperatures causes growth to cease and citrus trees to become dormant for about three months. The cool temperatures during this dormant period promote floral induction. When warm spring temperatures, among other things, stimulate the resumption of vegetative growth, induced buds grow and produce flowers.

In tropical climates, there is no period of cold temperature to induce dormancy. However, with periods of less than ample soil moisture (drought stress), flushes of bloom and vegetative growth normally follow these drought periods.

It is well documented that vegetative and reproductive fruit growth compete for available resources, such as carbohydrates (sugars) and mineral nutrients. Flushes of heavy vegetative growth will reduce the resources available to developing fruit, resulting in fruit with lower total soluble solids (TSS). A period of dormancy, during which there is little or no vegetative growth, reduces this competition for resources and results in fruit with increased TSS. The competition for resources between vegetative and reproductive growth is one of the reasons that citrus fruit grown in tropical climates tend to have lower TSS than that grown in subtropical climates.

CLIMATE

Within fairly broad parameters of adequate soil and reasonably good cultural and crop protection practices, climate is the most important component of the climate-soil-culture complex causing differences in fruit quality among commercial citrus production areas.

There is considerable diversity among citrus cultivars in their response to climate, especially as regarding market quality of the fruit. For example, navel orange develops its best eating and eye appeal qualities in a Mediterranean-type climate with cool, wet winters and hot, dry summers. In wet, tropical regions, navel fruit tends to be large with poorly colored rinds and low TSS and acid in the juice.

Unlike navel, most grapefruit cultivars develop optimum internal quality in warm climates with little winter chilling. Valencia orange is adapted to a broad range of climates, producing excellent to acceptable fruit quality in most of the world's important citrus regions.

Some — but not all — of these climate-induced differences can be overcome with cultural practices. For example, there is no known cultural practice that allows California (a Mediterranean climate) to produce low-acid, thin-peel grapefruit similar to the world's top-quality grapefruit grown in Florida (a humid, subtropical climate).

Worldwide climate has a significant effect on citrus yield, growth, fruit quality and economic returns. In growing regions where the average temperatures remain high all year (tropical climates), fruit peel chlorophyll does not degrade and oranges and tangerines remain green, whereas in cool-winter subtropical climates, oranges and tangerines develop more intense orange peel color and greater

eye-appeal at maturity.

In lowland tropical areas, due to high respiration rates at warm temperatures, fruit mature quickly and do not have sufficient time to accumulate high TSS, and acidity declines rapidly so that the soluble solids/acid ratio increases sharply, and the fruit quickly become insipid and dry. TSS in fruit accumulate most slowly in cool coastal areas. Maximum levels of TSS are usually attained in the mid-tropics and in humid subtropical regions with warm winters. Total acid (TA) levels are generally greatest in semiarid or arid subtropical and coastal climates and decline more slowly as fruit mature, compared with other climates. Decrease in TA is primarily a function of temperature (heat unit accumulation) and the rapid respiration of organic acids at those higher temperatures.

GROWTH REGULATORS

Application of plant growth regulators (PGRs) can provide significant economic advantages to citrus growers when used in appropriate situations. Depending on cultivar and timing, PGRs may improve fruit set, increase fruit size by reducing cropload, extend the harvest season by delaying rind aging, and reduce preharvest fruit drop.

Gibberellic acid (GA) is recommended for citrus hybrids that are weakly parthenocarpic and without sufficient cross-pollination to improve fruit set. Applied from full bloom to two-thirds petal fall, GA can effectively set and produce an excellent crop of seedless Robinson, Nova, Orlando, Minneola or other self-incompatible mandarin hybrids. Application of GA to citrus fruit approaching maturity enhances peel firmness and delays peel senescence.

Application of GA in the fall often increases juice extraction from sweet oranges. It is likely that GA enhances juice extraction efficiency because increased peel firmness provides better mechanical support for fruit within extraction cups.

Applied in winter during floral induction to cultivars that routinely flower heavily but set poor crops such as Navel, Ambersweet and Ortanique, GA reduces flowering and often results in increased fruit set. A combination of GA and 2,4-D has been used in many fresh fruit-growing regions to enhance peel strength and extend the harvest seasons for grapefruit and sweet oranges.

Naphthalene acetic acid (NAA) is used to thin fruit when excessive set occurs. Thinning heavily cropping trees with NAA increases fruit size. The greatest thinning response to NAA has been shown to occur when applications are made when the average fruit diameter is about 1/2 inch, which typically occurs from six to eight weeks post bloom. Thinning of Murcott and Sunburst tangerines with NAA was found to increase fruit size, average fruit weight and percent packout through improved fruit appearance.

CULTIVAR/ROOTSTOCK

The most important determinant of fruit production and quality under the grower's control is cultivar selection. Under comparable conditions, Hamlin orange always has poorer juice color and lower TSS than Midsweet or Valencia orange. On the other hand, Hamlin produces higher, more consistent yields per acre than any other sweet orange cultivar. Worldwide, Valencia produces premium quality fruit with excellent internal quality, high sugars, superior flavor and deep orange juice color at maturity.

Besides cultivar, many of the horticultural characteristics of cultivars are

influenced by the rootstock, including tree vigor and size, and fruit yield, size, maturity date and quality. One of the best-known examples is the small fruit size of Valencia budded on Cleopatra mandarin (Cleo) rootstock. Cleo is well suited for use with Temple orange, tangerines and tangerine hybrids. Sweet orange and grapefruit cultivars on Cleo generally produce small fruit and are not precocious, thus Cleo is not commonly used for these varieties. Low yield associated with Cleo rootstock is the result of poor fruit set and size, and fruit splitting. Scions on Cleo are most productive on heavier soils.

Larger fruit with thicker, rougher peel and lower concentrations of TSS and acid in the juice are generally associated with cultivars budded on fast-growing, vigorous rootstocks such as rough lemon, Volkamer lemon, *Citrus macrophylla* and Rangpur. However, these rootstocks impart high vigor to the scion and induce high yield. Tangerine fruit from trees grown on vigorous rootstocks tend to be puffy, hold poorly on the tree and have high incidence of granulation.

Cultivars on slower-growing rootstocks generally do not produce vigorous vegetative growth, but tend to produce small- to medium-size fruit with smooth peel texture and good quality fruit with high TSS and acid content in the juice. This latter group of rootstocks includes trifoliate orange and some of its hybrids (citranges and citrumelos). Sweet oranges budded on Carrizo citrange have been among the most profitable combinations over the long term in Florida. Planted on the right soils, trees on Swingle citrumelo are very productive at high-density plantings.

IRRIGATION AND NUTRITION

Although citrus trees develop largely in response to their genetic endowment and the climate, good production practices can have favorable influences on fruit production and quality. Cultural practices that attempt to cope with climatic or weather problems include irrigation and nutrition. Irrigation is of particular importance during the spring, which coincides with the critical stages of leaf expansion, bloom, fruit set and fruit enlargement.

Proper irrigation increases fruit size and weight, juice content and soluble solids: acid ratio. Soluble solids per acre may increase due to yield increase. However, soluble solids per box and acid contents are reduced. Through its tendency to stimulate vegetative growth, irrigation in the dry fall and winter may reduce soluble solids in the fruit. Decline in total acid levels can also be aggravated by excessive irrigation.

Citrus trees require a good water management system and a balanced nutrition program formulated to provide specific needs for maintenance and for expected yield and fruit quality performance. Adequately watered and nourished trees grow stronger, have better tolerance to pests and stresses, yield more consistently and produce good quality fruit. On the other hand, excessive or deficient levels of water or fertilizer will result in low fruit yield and oversize fruit with poor quality and diluted soluble solids content.

The most important nutrients influencing fruit quality are nitrogen, phosphorus and potassium. However, when any other nutrient is deficient or in excess, fruit yield and quality are negatively altered. Nitrogen (N) increases juice content, TSS per box and per acre, and acid content. However, excessive N can induce excess vigor and promote a vegetative rather than a flowering tree, and can result in lower yields with lower TSS per acre. In contrast, low N levels promote extensive flowering, but fruit set and yields are poor.

Phosphorus reduces acid content, which increases soluble solids: acid ratio. Potassium (K) increases fruit production, fruit size, green fruit and peel thickness. Foliar spray of potassium nitrate or monopotassium phosphate in the spring often increases fruit size of tangerine and grapefruit, and fruit size and total pound solids of Valencia orange. Foliar application (six to eight weeks before bloom) of urea can increase flowering and fruit set.

SUNLIGHT AND PRUNING

Even though citrus trees can tolerate shade and still flower and fruit, maximum flowering occurs when trees are grown in full sun and light penetration through the canopy is maximized. Therefore, pruning — including topping and hedging — to avoid crowding is extremely important

for optimum flowering. The amount of fruit that is set has a very significant effect on fruit quality. There is a positive correlation between the number of fruit per tree and fruit quality. When the number of fruit per tree is low, the peel texture, shape of fruit and often fruit color are poor. Quality of individual fruit varies significantly, even on the same tree. Heavily shaded fruit borne on the interior of the canopy have less TSS than fruit on the exterior of the canopy. Insufficient light contributes to reduced TSS concentration of interior fruit nourished by heavily shaded leaves.

It is well established that shoots with fruit do not flower the following year. A heavy fruit crop tends to deplete carbohydrates and results in a small crop and increased vegetative growth the following year. Pruning after a heavy crop additionally stimulates vegetative growth and reduces fruit yield the following year. Pruning after a light crop and before an expected heavy crop can increase fruit size and help reduce alternate bearing. Pruning or topping and hedging usually increase fruit size and packout of fresh-market fruit by reducing crop load, thus increasing net cash returns to growers.

CONCLUSION

The improvement in citrus fruit production and quality that a grower can achieve through choice of scion/rootstock combinations, good irrigation management, balanced nutrition and proper pruning may easily be overwhelmed by pests, diseases and other injuries. Excessive leaf loss will noticeably reduce flowering the following spring and subsequent fruit production. The primary causes of leaf loss are freeze, tropical storm injury, salt and water stress problems including drought stress and flooding injuries, mites, greasy spot, herbicides and pesticide toxicities. Excessive leaf loss in the fall and in early winter is the worst thing that can happen to citrus trees. It will reduce accumulation of carbohydrates affecting flowering, fruit set and fruit yield. Therefore, good practices in citrus groves should be adapted to minimize negative plant physiological stresses, improve tree health and performance, and enhance citrus trees to produce high yield of good fruit quality.

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Outlook for Florida Citrus Remains Positive

By Bob Norberg
Deputy Executive Director, Research and Operations

The Florida Department of Citrus (FDOC) provides growers with up-to-date resources to make informed business decisions. In addition to a variety of monthly reports including economic indicators, retail sales trends, processed products statistics, imports and exports and fresh citrus shipments, the FDOC compiles an annual *Florida Citrus Outlook* with supply, demand and price projections to help growers plan for the upcoming season.

Dr. Mark Brown, senior economist, utilizes information from the USDA October 2011 citrus crop estimate to calculate potential scenarios for the 2011-2012 season. Once again, the numbers predict that Florida citrus will continue to be a sustainable, vibrant industry and a key economic contributor to the state.

This season, both Florida and Brazil orange juice production levels are projected to increase, by 6 percent and 31 percent, respectively. Combined Florida-Brazil orange juice production is expected to be up about 22 percent, but these increases are offset by relatively large declines in the beginning inventories for the 2011-2012 season. As a result, the aggregate Florida-Brazil orange juice availability (new production plus beginning inventory) is projected to increase by 5.5 percent from last year.

Much of the increase in Brazil's production, however, is expected to be used to rebuild inventories in Brazil. Therefore, the aggregate Florida-Brazil orange juice availability for the market may be similar to or decline from last year's level. Overall, orange juice availability and movement levels in 2011-2012 support relatively strong pricing. Retail orange juice sales and U.S. orange juice consumption in 2011-2012 are estimated to decline by about 3 percent from last year due to lower availability and higher prices.

This season's Florida grapefruit crop is expected to be slightly larger than last year. Domestic fresh grapefruit shipments are projected to increase moderately due to an estimated 19 percent decrease in Texas grapefruit production.

Grapefruit juice availability is expected to be down from last season as a result of a reduction in the beginning inventory level. Grapefruit juice movement is projected to be down from last year due to lower availability and higher prices. Overall, the grapefruit juice supply and demand situation supports relatively high grapefruit prices.

Total on-tree revenue for oranges, grapefruit and specialty citrus is projected to be $1.38 million, up 20.5 percent from last season, and the second highest total in history.

In spite of challenging economic conditions, the ongoing viability of the Florida citrus industry remains strong. There are currently 71 million citrus trees in commercial production, and the industry continues to contribute approximately $9 billion to the state economy.

FDOC will continue to help grow the market for the Florida citrus industry to ensure its sustainability for future generations, as well as its important contributions to Florida's agriculture and economy.

The complete *Florida Citrus Outlook* report is posted on FDOCGrower.com at https://fdocgrower.box.net/shared/2n5zfo2cur. Please join me in thanking Dr. Brown for 28 years of dedicated service to the citrus industry and wishing him well in his retirement. You can expect a seamless transition as Dr. Matt Salois joins FDOC as director of Economic and Market Research.

Please feel free to contact me at 863-537-3957 or bnorberg@citrus.state.fl.us if you have any questions.

The mission of the Florida Department of Citrus is to grow the market for the Florida citrus industry to enhance the economic well-being of the Florida citrus grower, citrus industry and the state of Florida. For more information, visit www.FDOCGrower.com

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