# New sweet orange cultivars

The Florida citrus industry now has additional options, thanks to the Citrus Cultivar Improvement Team at the UF/IFAS Citrus Research and Education Center.

By Jude Grosser, Fred Gmitter and Bill Castle



lorida orange juice continues to be the gold standard among the growing portfolio of fruit juices available to consumers. However, orange juice prices are going up and orange juice consumption is going down. A good way to battle this negative trend is the development of new, improved sweet orange cultivars that reduce production costs and increase the quality of our NFC (not from concentrate) and concentrate juice products. Higher yields and lower production costs would lower the prices in the grocery stores, and increased quality (color and flavor) should lead to increased consumption — a win-win for everyone in the orange-juice business. The development of higher quality oranges in the early and mid-season categories would have a direct impact on juice quality and would reduce the need for blending with late-season Valencia to achieve adequate quality, thereby reducing the costs of juice production by minimizing the need for expensive cold storage of juice needed for blending. The Citrus Cultivar Improvement Team at the University of Florida/IFAS Citrus Research and Education Center (UF/IFAS CREC) has been working on the development of such improved sweet oranges for the past 30 years. Finally, this work is coming to fruition, and we have started to release new, improved sweet orange cultivars to the Florida citrus industry.

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#### TECHNIQUES FOR SWEET ORANGE IMPROVEMENT

All commonly grown sweet orange cultivars have originated by the selection of chance seedlings or branch mutations found by observant growers. It is difficult to obtain hybrid seedlings from crosses of orange cultivars with other oranges or with most mandarins, because the seedlings are of nucellar origin, essentially clones of the seed parent. The rare hybrids that might be recovered are generally weak plants that will produce fruit that could not be classified as a sweet orange.

Thus, we have been using three alternative methods to develop improved sweet oranges, namely: seedling introductions from other locations around the world; mutation breeding using irradiation; and somaclonal variation. The good news is that these approaches yield "true" sweet oranges, not hybrids with similar juice profiles. This article will feature our new releases, mostly products of somaclonal variation, along with one cultivar developed via budwood irradiation.

A major goal of the CREC's sweet orange improvement program has been to develop a set of cultivars that can be used in a progressive harvesting scheme to provide high-yielding, Valencia-quality oranges from mid-October to June. We intend to fill in mid-season gaps and expand the season so that high-quality oranges are always available throughout the season, to allow our industry to efficiently produce the absolute best NFC juice products.

Another important goal of our program is to provide new sweet orange clones that have improved cross-over value for fresh consumption with traits including seedlessness, improved external appearance and peelability, and better color and flavor.

# **SOMACLONAL VARIATION**

The term "somaclonal variation" defines genetic variation that is present in plants regenerated from tissue cultures, either uncovered or induced by a tissue culture plant regeneration process. Such somaclonal variation has been reported in a wide range of traits including plant height, overall growth habit, flower, fruit and leaf morphology, juvenility, maturity date, disease resistance, yield ,and biochemical characteristics. Sweet orange is wellsuited for studies of somaclonal variation due to its reproductive biology (nucellar embryony) and excellent performance in tissue culture.

For more than 20 years, we have been investigating the use of tissue culture methods to produce genetic variation in Hamlin, Vernia, Valencia and OLL (Orie Lee Late) sweet oranges. We have produced and evaluated approximately 1,000 somaclones from each of Hamlin and Valencia, and we have identified variation in numerous traits including fruit maturity date, juice quality (color, flavor and soluble solids), seediness and yield. After painstaking years of field work with the help of excellent industry collaborators, and overcoming the unexpected loss of advanced trials, we are now beginning to release improved selections from this research. Most of the new sweet orange cultivars described below were produced using this technology.

#### **BUDWOOD IRRADIATION**

Radiation-induced mutation breeding as a plant-breeding strategy has resulted in the development of more than 1,300 new plant varieties worldwide, including more than 80 fruits and vegetables. This approach has a successful history in citrus improvement, especially in grapefruit (Star Ruby) and more recently with mandarins (Tango; US Patent PP17863). It is most commonly used to eliminate seeds from otherwise promising cultivars or selections. Previously, we irradiated budwood from Hamlin, Midsweet and Valencia and produced several hundred trees. from which selections are now in the final stages of evaluation. Secondgeneration trees of selected seedless clones, primarily from Midsweet, have been evaluated for juice quality

and yield across six seasons. We have selected six irradiated nearly seedless Midsweet clones that have continuously exhibited outstanding quality index values in Brix, soluble solids, juice color, juice content and yield.

## **NEW RELEASES**

The first sweet orange selection approved for release by the IFAS Cultivar Release Committee was the early-maturing Valencia somaclone Valquarius® SF14W-62 (U.S. Patent PP21535). SF14W-62 is a moderately vigorous tree that produces fruit with a significantly earlier fruit maturation date (four to eight weeks) than standard Valencia. Fruit of SF14W-62 can generally be harvested from mid-January through February, depending on environmental conditions, with juice quality equivalent to that of Valencia, the highest quality juice orange currently available. This provides the processing industry with earlier blending opportunities with Hamlin or Midsweet oranges to improve the flavor and color of NFC orange juice.

In the event of January or February freeze-mandated harvests, using this variety would allow for Grade A juice recovery and no economic losses, as would be encountered with standard Valencia that hasn't reached full maturity at this time. It can also be grown as a single-crop plant that would be more amenable to mechanical harvesting than standard double-crop Valencia.

SF14W-62 can be very productive and has been out-yielding Vernia on most rootstocks in our St. Helena trial. Three-year cumulative yield data from the St. Helena trial showed that 20 of the 25 highest yielding scion/rootstock combinations had SF14W-62 scion. One issue with this clone has been the thorny nature of trees propagated from the original budline. Since then, a third-generation budline (Valquarius® DPI-435-0059) has been provided to the Division of Plant Industry that will produce trees that are much less thorny.

Our second sweet orange approved for release was **Valencia somaclone** 



**Figure 1.** Left: Seedless Valencia clone N7-3. Right: N7-3 on experimental rootstock WGFT+50-7, 5-year-old tree growing under heavy HLB pressure.



Figure 2. Left: Fruit of Valencia somaclone B9-65. Right: Fruit of Hamlin somaclone N13-32.



Figure 3. Left: 10-year old tree of Midsweet UF11-1-24 at Conserve II. Right: Fruit of sweet orange somaclone OLL-4.

#### N7-3 (U.S. Patent PP21224), a

moderately vigorous tree that produces normal Valencia fruit, but the fruit are seedless and mature later (two to eight weeks) than standard Valencia. The rind on N7-3 is slightly thicker than a typical Florida Valencia, giving it the appearance of a California fresh orange (Figure 1, left). In Florida, fruit of N7-3 can generally be harvested from mid-March through June, depending on environmental conditions. Juice quality from fruit of N7-3 is equivalent to that of commercial Valencia clones. Thus, N7-3 is a dual-use, late-season cultivar that can be used for the fresh market or processing. The combination of N7-3

on experimental rootstock WGFT+50-7 is showing good tolerance of HLB (Figure 1, right).

Another somaclone very similar to Valencia N7-3, the seedless, latematuring **Valencia somaclone T2-21** (the Uncle Tony orange) has been released and is expected to become available in summer of 2015. It also has very good processing/fresh fruit crossover potential.

Another Valencia somaclone, **B9-65** (U.S. Patent Pending), has been approved for release by the IFAS Cultivar Release Committee. B9-65 was selected based on six years of data from a collaborative trial of 30 late-maturing sweet orange clones conducted at Conserve II. B9-65 was the highestyielding clone in the trial, and was among the top-five selections for pound solids production all six years that data were collected. This superior clone also bears precociously and produces large fruit (Figure 2, left). It is an excellent candidate for use in new advanced citrus production system plantings, as a good crop can be expected in the third year with an appropriate rootstock(s). Fruit of B9-65 mature in the same window as fruit of standard Valencia.

It has been more difficult to make progress with Hamlin sweet orange clones, due to the higher level of genetic stability in this cultivar. To date, only one Hamlin somaclone, N13-32 (U.S. Patent Pending), has been approved for release. N13-32 can improve juice quality in the latter part of the Hamlin season. The minimum color score for Grade A orange juice is 36. Hamlin juice color from commercially available clones rarely exceeds a color score of 34.5; thus blending is required. N13-32 (Figure 2, right) offers no advantage over traditional clones in December, but if harvested in January, juice from this clone generally reaches the 36 color score needed for Grade A juice. Horticulturally, it is otherwise typical for Hamlin clones in yield and pound solids.

As mentioned, we have also evaluated numerous clones of Midsweet derived from budwood irradiation. We have released the nearly seedless Midsweet clone UF11-1-24, selected for high productivity and juice quality (Figure 3, left). From the initial experiment, 12 highperformance clones were selected for a replicated study conducted at Conserve II. Midsweet clone UF 11-1-24 was the winner in both yield and pound solids based on data from six consecutive harvests. The nearly seedless trait of fruit of this clone makes it more attractive for the fresh market than the traditional seedy Midsweet commercial clone.

The final two sweet orange cultivars approved for release are from a new

category of oranges we call the OLL series. The original OLL tree was discovered by Orie Lee as a remnant from an old block of experimental trees on his property. Long after the collaborative experiment was completed, Lee selected the OLL clone on the basis of superior fruit quality and the ability of the fruit to hold quality well into the summer. OLL fruit has exceptional external and internal color, usually exceeding that of Rhode Red Valencia. OLL fruit also has exceptional fresh fruit potential, due to its beautiful color and improved peelability compared with Valencia. When scored, the peel comes right off.

Propagations of the original OLL clone were unstable, with about half of the trees not exhibiting adequate growth and productivity; thus we made an embryogenic callus culture of the



original selection to regenerate stable clones. With the assistance of Lee, we have been evaluating approximately 30 somaclones of OLL for the past 13 years. Most of these appear to be more stress tolerant than other commercial sweet oranges.

The first OLL somaclone to be approved for release is OLL-8 (U.S. Patent Pending), as this was the most precocious bearing (shortest juvenility) clone among the group, which allowed us to begin data collection ahead of the other OLL somaclones. OLL-8 typically produces higher yields and higher pound solids than standard Valencia clones, and juice color scores usually exceed 40. Flavor profiles determined by the major orange juice companies show that the flavor profile of OLL-8 is either equivalent or exceeds that of Valencia; thus it has potential to improve the quality of Florida orange juice products.

More recently, after taking yield data from the original trees (now 13 years old on Swingle citrumelo, grown near St. Cloud) for the past three years, OLL-4 (U.S. Patent Pending) (Figure 3, right, page 14) has been approved for release, based on the fact that it has been the highest yielding OLL clone, averaging 5.71 boxes per tree over the 3-year period (2012-2014). Fruit quality is similar to OLL-8, with similar pound solids, juice color and flavor profile. Both OLL-8 and OLL-4 mature in the standard Valencia season, but some years they reach maturity two to four weeks ahead of Valencia.

Last year, OLL ratios were averaging 15 in March, when Valencias in the same block were having trouble reaching a ratio of 12. Fruit of the OLL clones also holds well on the tree, a quality that can extend their harvest season if need be.

There is anecdotal evidence that some of the OLL somaclones may be more tolerant of HLB than standard Valencia, thus experiments are underway to validate any potential enhanced HLB tolerance. Following ongoing evaluations, one or more additional OLL clones may be released in the future for commercialization.

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#### **AVAILABILITY**

Valencia somaclone Valquarius® SF14W-62 has been exclusively licensed by Florida Foundation Seed Producers, Inc. (FFSP) to the New Varieties Development and Management Corporation. For licensing information, contact Peter Chaires (pchaires@nvdmc.org). Other newly released sweet oranges (N7-3, B9-65, N13-32, OLL-8 and OLL-4) are being non-exclusively licensed by FFSP to Florida citrus nurseries. For licensing information, contact John Watson (jwatson@ffsp.net). T2-21 and UF11-1-24 are expected to become available for use in summer of 2015.

## **CONCLUDING REMARKS**

The UF/IFAS CREC has released six new sweet orange cultivars that have potential to improve productivity, NFC juice and fresh fruit quality, across the entire harvest season. Trees being replaced due to HLB and other problems can now be replaced with these improved selections. There are many more sweet orange selections being evaluated in our breeding pipeline, and focus now is concentrated on the identification of any clones that might show enhanced tolerance to HLB.

Another goal of our program is to replace Hamlin with early-maturing Valencia clones, as necessary to further improve the quality of our NFC and concentrate orange juice products. We have identified two early-maturing Valencia somaclones that this season had a 16 ratio in mid-November, when Hamlins from the same block were only at a 12 ratio. Fresh-squeezed juice from these selections was very favorably received at the December 2014 fruit display held at the CREC. Expedited cleanup and budwood increase of these selections is underway in preparation for commercial release. Continuous improvement of the Florida sweet orange portfolio will mean lower costs

to growers and higher quality (color and flavor) juice products that should increase consumer demand.

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