

What's new in sweet orange improvement?

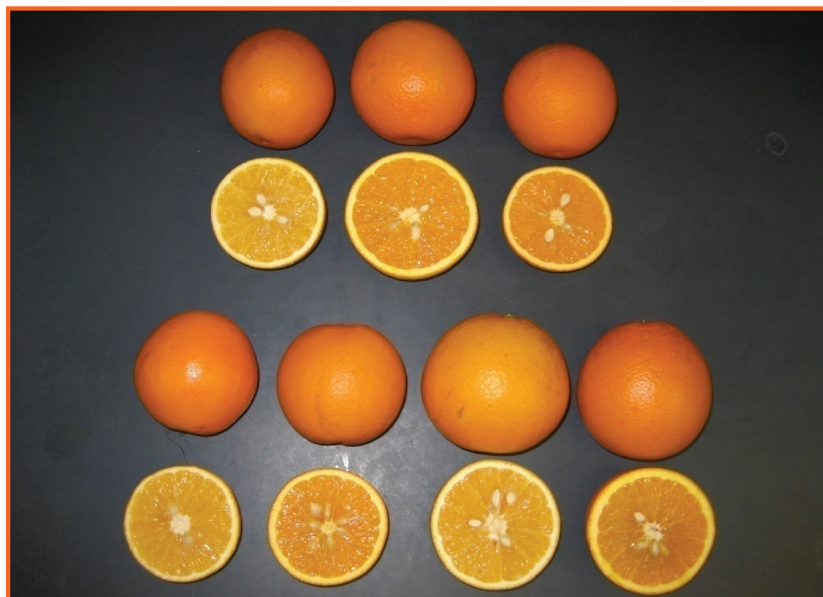


Figure 1. Top row: Barao, Seleta Branca, Serra D'Agua
Bottom row: Hamlin, Earlygold, Ouro, Rosa
(Photo taken in December 2008)

**By Jude Grosser, Bill Castle,
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Have you ever wondered why there are so few research programs in the world working to develop new sweet oranges and why there are so few new sweet orange cultivars available for processing?

The answer is that developing new sweet oranges by making crosses is nearly impossible. The 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 weak plants that will produce fruit that could not be classified as a sweet orange. Thus, the CREC (Citrus Research and Education Center) Variety Improvement Team has 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 describe the methods and highlight promising new selections from each approach. The goal of the CREC's sweet orange improvement program is 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

Table 1. New promising sweet oranges (unpatented) introduced via seeds.

Selection	Remarks (as compared to 'Earlygold')
Ouro*	Early season: good juice solids; later maturity.
Rosa*	Early season: slightly earlier maturity, but superior juice color, solids and flavor. Best color.
Seleta Agrocitros*	Early season: similar to 'Earlygold'
Seleta Branca*	Early season: latest maturity with excellent flavor and juice solids.
Seleta Vermelha*	"Earlygold"
Serra D' Agua*	Early season: Later maturity and better all-around juice quality

* The season for these oranges would normally be from early October to the end of December.

available throughout the season, to allow our industry to efficiently produce the absolute best NFC (not-from-concentrate) juice products.

NEW SEEDLING INTRODUCTIONS

The seed introductions Earlygold, Itaborai and related selections were brought here in the 1990s for evaluation with subsequent release of the more promising selections. More recently, another set of 14 interesting Brazilian cultivars were introduced as seed for evaluation locally because of their potential for processing, based on juice quality and color, yield and season of maturity. They were chosen for evaluation in

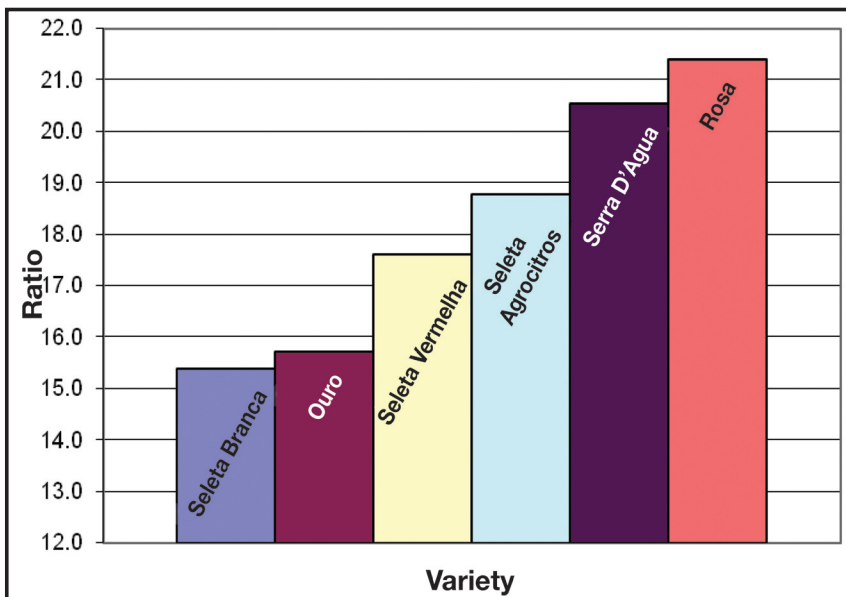


Figure 2. Data for 2008-09 season from samples collected at the CREC, Lake Alfred, on Dec. 3. State Hamlin data for Dec. 1: Brix-11.1; ratio-14.3

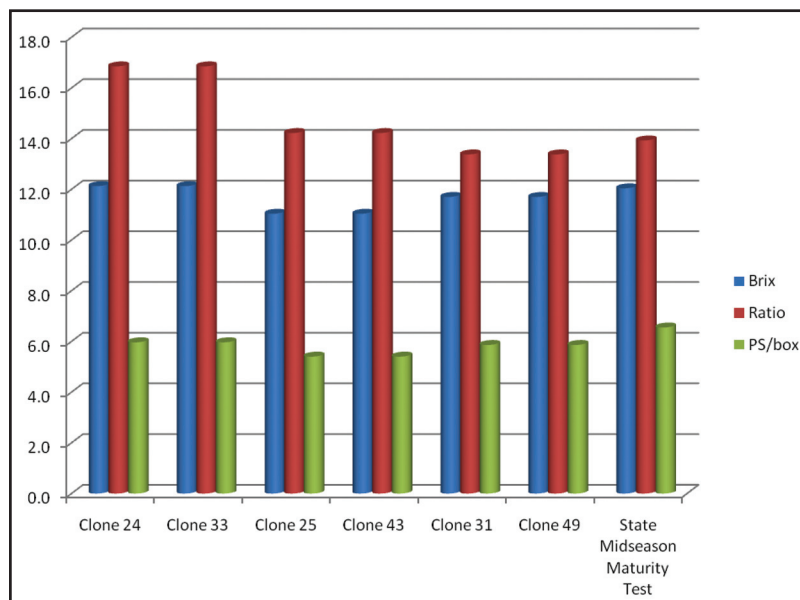


Figure 3. 2008-2009 season juice quality data from new seedless Midsweet clones, fruit harvested early January, 2009 from the Conserve II trial.

Florida mostly for their possible impact on the early season, and extending the Valencia season; also, two other selections are reported to exhibit field canker tolerance in Brazil.

Among the original 14 selections, five listed in Table 1 and shown in Figure 1 seem to be the most promising based primarily on their consistent juice quality traits. From yield observations and estimates, those selections have produced normal-appearing trees with acceptable yields by commercial standards (see also Ratio data in Figure 2). Furthermore, their commercial potential is supported by limited formal taste panel evaluations comparing their likeability to Hamlin and favorable responses received from commercial evaluators during CREC fruit displays. These cultivars are being presented to the IFAS Cultivar Release Committee for approval of a public (non-patented) release to the Florida industry.

Research to evaluate additional seed introductions is under way including selections from China. Also under evaluation are IAPAR-73, a selection acquired from Brazil where substantial evidence indicates good field canker tolerance (with canker tolerance being evaluated in cooperation with Jim Graham), and Folia Murcha, a late-season cultivar that produces above-average yields of acceptable quality fruit with purported field tolerance to canker.

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). The breeding strategy is most commonly used to eliminate seeds from otherwise promising cultivars or selection.

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. Second-generation trees of selected seedless clones, primarily from Midsweet, have been evaluated for juice quality

and yield across the past five seasons. We have selected six irradiated seedless Midsweet clones that have continuously exhibited outstanding quality index values in Brix, soluble solids, juice color, juice content and yield (Figure 3). We expect to release the best of these clones in the near future.

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 well-suited 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 and Valencia sweet oranges, the two most important cultivars in Florida.

We have produced and evaluated approximately 1,000 somaclones from each cultivar, 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.

NEW RELEASES: The first two selections approved for release by the IFAS Cultivar Release Committee are Valencia somaclones SF14W-62 and N7-3 (patents pending).

Valencia 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



Figure 4. Fruit of Valencia somaclone SF14W-62 (patent pending), a new sweet orange cultivar being released by the University of Florida/IFAS.



Figure 5. Seedless fruit of Valencia somaclone "N7-3" (patent pending), a new sweet orange cultivar being released by the University of Florida/IFAS.

Hamlin or Midsweet sweet 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. This somaclone can also be grown as a single-crop plant that would be more amenable to mechanical harvesting than standard double-crop Valencia.

Valencia somaclone N7-3 is a moderately vigorous tree that produces normal Valencia fruit, but the fruit are seedless and mature later (two to eight weeks) than standard Valencia. 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, the highest quality juice orange currently available. Thus, N7-3 is a dual-use, late-season cultivar that can be used for fresh market or processing.

Several additional somaclones of Hamlin and Valencia are being prepared for near-term release. These include somaclones of Valencia selected for higher soluble solids, higher yield, seedlessness or altered maturity date, and somaclones of Hamlin with improved soluble solids and color, and earlier maturity. We have also produced small somaclone populations from other promising sweet oranges, including Vernia (not to be confused with Berna or Verna),

a mid-season orange with Valencia quality; and OLL, a very high-colored selection provided by Orie Lee. Selected somaclones produced from both of these original sources are showing promise.

CONCLUDING REMARKS

The three approaches we have employed to develop and release improved sweet orange cultivars to the Florida industry are all paying dividends. We are making significant progress toward providing a set of improved sweet orange cultivars that can be used in a progressive harvesting scheme to provide high yielding, Valencia-quality oranges in Florida from mid-October to June. The new seedling introductions described in this article should impact early season juice quality and color. We are especially excited to be releasing our first two selections, Valencia SF14W-62 and N7-3 (patents pending), that will extend the Valencia season in both directions. We look forward to additional releases in the near future.

Our team is also conducting other important research on sweet oranges, including the development of genetic engineering methods for our most important commercial cultivars, and the production and testing of genetically engineered oranges containing anti-bacterial genes to develop plants resistant to HLB, canker and CVC. We have recently applied to USDA-APHIS for permission to plant our first genetically engineered oranges with such genes at field sites with high HLB pressure. Further, we are now employing a novel non-GMO approach to develop canker resistance in sweet orange, by transferring kumquat mitochondria that contain a gene for canker resistance.

Finally, our team has taken a lead role internationally in citrus genomics, to sequence the sweet orange genome and to utilize the power of sequence information in studies aimed at understanding the basis of HLB disease progression, so new genetic strategies might be formulated to develop disease resistant oranges. The genome sequence will also open up many new avenues of exploration for improving virtually any characteristic of sweet oranges. We are confident that our research will play a critical role in the short- and long-term sustainability and profitability of the Florida citrus industry.

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