Various rootstock and poncirus trifoliate hybrids

DISCOVERY

of citrus aromatics

A friend once told me that he tried to grow roses throughout the year in his garden, to pick one every day for his wife – impressive. By **Jon Roberts**

Citrus is practically in my blood. I've picked it most days of the season, for the fruit bowl, and have taken on picking a rose whenever my poorer rose garden has one (they're conveniently counter seasonal). However, I discovered my big trick over many years of reaping citrus rootstock fruit for seed extraction, for our nursery. The beautiful citrus aroma in the seed extraction room surpassed the scent of any potpourri, scented candle or man-made perfumed room spray. One day, at close of play, I took a handful of Trifoliate citrange rootstock fruit home and placed it in our fruit bowl in the kitchen to impress my wife. But I forgot to mention it to her, as she had been out.

Remarkably, on walking into the kitchen a few hours later, there was a wonderfully pervasive citrus scent. This has now become somewhat of an institution in our home. In fact, the bowl is nearby as I write this article.

We have picked different rootstock hybrids – Flying Dragon, Carrizo, Swingle, Poncirus Trifoliate – each with a different aroma profile, telling our brains we are smelling an alluring sweet citrus scent. The aroma is so appealing that one is tempted to taste this citrus fruit. But do so at your peril – it's sour and leaves a lingering bitter taste in your mouth. Hence, over the years, my pickings of citrus have led to my family being wary of tasting fruit in the bowl without first asking me.

So, it was interesting to read Plotto and Bae's "Discovery Speeds Push for HLB-Tolerant Citrus" in the *Florida Citrus Industry*, 8 March 2024. I have read a lot of articles and research papers in recent years, some of which I have reported on in my previous articles in the *SA Fruit Journal*. But this "new discovery" struck a note regarding the scent of citrus aromatics that I had experienced, but not understood.

Recently Citrus Growers' Association CEO Justin Chadwick put out an article, "Reflections on the orange juice sector", elaborating on two causes of the shortage of orange juice worldwide. Currently, the main cause is the effects of drought due to a strong El Niño effect in the Brazilian 2024 season. The Brazilian citrus industry produces three out of five glasses – 60% – of juice worldwide, so any change there has a significant knock-on effect on the global orange juice industry. The other identified cause is the effects of increased Asian Greening Disease (HLB) infection on parts of the Brazilian industry (I spoke of this in a previous article). Regarding this second cause, Justin states, "HLB could play a bigger role in crop forecasts in the future. The extent of this role will depend on the development of new insecticides to target ACP, the HLB Vector." This is being seen as a potential medium- to long-term cause of the citrus juice shortage.

Jon Roberts

The potential threat remains high if taken in the context of what has happened in the Floridian juice industry. Florida – previously the biggest orange juice producer in the world – currently produces only 6% of its pre-HLB yield. From research papers that I have read, it's unanimous: There's no single "silver bullet" to control HLB. An integrated approach will be required that harnesses all disciplines (entomology, pathology, virology, genetics etc.). In my area of cultivar interest, I have written previously about plant breeders worldwide working towards breeding HLB-resistant citrus rootstocks and scion (fresh fruit) varieties.

Sweet orange, the source of orange juice, is highly susceptible to HLB. The limited genetic diversity of sweet orange makes it unlikely that a resistant source will be discovered within the species. To prevent the demise of orange juice as we know it, an option would be to cross it with HLB-tolerant citrus varieties. In the 1960s scientists bred citrus hybrids for cold tolerance, using the cold-hardy Poncirus Trifoliate crossed with mandarin or orange. After the arrival of HLB in Florida in 2005, it became apparent that some of these Poncirus hybrids were also HLB-tolerant. Unfortunately, field tests and flavour evaluations of these hybrids produced juice that was virtually unpalatable. This excludes US SunDragon, which retained HLB tolerance while also bearing a resemblance to an orange-like flavour. But it takes up to four to five years of waiting for crosses to start bearing fruit, to then be evaluated for HLB tolerance and taste.

Swingle Citrumello

Carrizo Citrange

Plotto and Bae's team noted that the sweet aroma profiles of some of these hybrids were similar to sweet orange, (the same sweet, orange-like aroma we had experienced from Poncirus hybrid in our fruit bowl).

In layman's terms, the team's analyses of these aromatic compounds and juice flavonoid chemicals revealed 26 compounds and seven esters as being important in predicting a typical orange juice flavour. This led them to pinpoint the esters "master" gene CsAAT1. According to Plotto and Bae, breeders could now use this CsAAT1 gene as a marker to fast-track the screening of their hybrid seedlings for desired flavour profiles at a very early stage, discarding the seedlings that did not carry the CsAAT1 gene. This is like the PCR test that many of us had done during the COVID-19 pandemic, where scientists identified six to seven markers, (depending on the COVID strain), to test for infection.

Therefore, if it is found that the gene is incorporated into the genetic make-up of a Poncirus hybrid, breeders could confirm early on if their newly bred orange-like hybrids are HLB tolerant, while maintaining the characteristic sweet, orange-like flavour. HLB tolerant rootstocks and scions (fresh fruit varieties) could go a long way with other treatments in an integrated approach, in ensuring the survival of orange juice as we know it.

However, the researchers cautioned that "even with the use of high-tech tools like machine-learning, the first commercial releases of orange-like hybrids with HLB tolerance will be contingent on several more years of testing and refinement".

Plotto and Bae, the principal investigators with ARS Citrus and the Subtropical Products Research Unit in Florida, co-authored the paper together with 11 other collaborators. The USDA-ARS collaborators are from the US Horticultural Research Laboratory in Florida and the US Pacific Basin Agricultural Research Center in Hawaii. And the UF/IFAS collaborators are from the Citrus Research and Education Center and Gulf Coast Research and Education Center.