Figure 1. The OLL sweet orange/rootstock trial took place at the Orie Lee Family Groves in St. Cloud, Florida. All the fruits used in this study were harvested from this trial block.

Rootstock and scion affect orange juice flavor

By Yu Wang, Fred Gmitter and Jude Grosser

A major concern for the citrus industry is a significant decline in production due to huanglongbing (HLB). In addition to the production shortfalls are losses due to fruit rejection by packinghouses and juice processing plants as a result of inadequate size and low sugar content. Bitterness and metallic off flavors in the HLB-affected fruit can make the negative effect of HLB even worse.

Breeding and screening of HLB-tolerant scion and rootstock cultivars have been recognized as effective ways to control the disease and increase the supply of quality citrus fruit under these adverse circumstances. However, successful development of HLB-tolerant/resistant cultivars or treatments should also be consumer-driven because this is key to driving product success in the contemporary marketplace. Most consumers indicate that flavor is the most important factor impacting their preferences and purchases. Therefore, a short-term research objective is to characterize the flavor and consumer preference of HLB-tolerant scion/rootstock combinations.

ORIE LEE LATE TRIAL

Trees of Orie Lee Late (OLL) sweet oranges in a trial located in St. Cloud, Florida (Figure 1), which are all affected by HLB, have demonstrated great field performance such as high yield, canopy density, juice quality, Brix and titratable acidity. These trees were grafted with field budwood and have been in the ground for almost seven years. After the second year, psyllid control was not applied, but the trial block was continuously treated with supplemental controlled-release fertilizer containing an enhanced micronutrient package.

A scion grafted on certain rootstocks could be an effective way to enable the specific scion to be more productive and disease resistant. However, how the sensory and consumer preference is affected by

scion, rootstock or their combination is still unknown.

In this study, two commercially available OLL scions (OLL-4 and OLL-8) and three rootstocks (Orange 3 released as UFR-1, Orange 14 and Orange 16) were selected based on good tree health and productivity, to study effects on sensory quality and consumer preference in 2018 and 2019. Orange 3, 14 and 16 are siblings from a cross of complex allotetraploid somatic hybrids. Samples were coded by the format scion-rootstock-year. For example, 8-16-18 is OLL-8 grafted on Orange 16 and harvested in 2018.

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CONSUMER RATINGS

A consumer panel containing 100 people from age 18 to 65 were asked to evaluate the sensory attributes of orange juice, including color, sweetness, sourness, bitterness, freshness and overall orange flavor as well as the intensity of consumer preference. Juice samples from all these trees were of high quality, with Brix ranging from 11 to 12 and Brix/acid from 12 to 14.

Consumer panelists rated overall liking and overall flavor using the ranges from -100 to +100 (-100 = greatest disliking, +100 = greatest liking). The sensory attributes color, sweetness, sourness, bitterness, freshness and overall orange flavor intensity were rated from 0 to 100 (0 = no sensation, 100 = most intense sensation).

All the ratings were fitted into a statistic model to determine scion/rootstock combination effects on sensory attributes (Figure 2, page 14). In both 2018 and 2019, sensory attributes such as overall liking, overall orange flavor, freshness and sweetness were grouped into one cluster on the center-left of the plots indicating these attributes are positively correlated

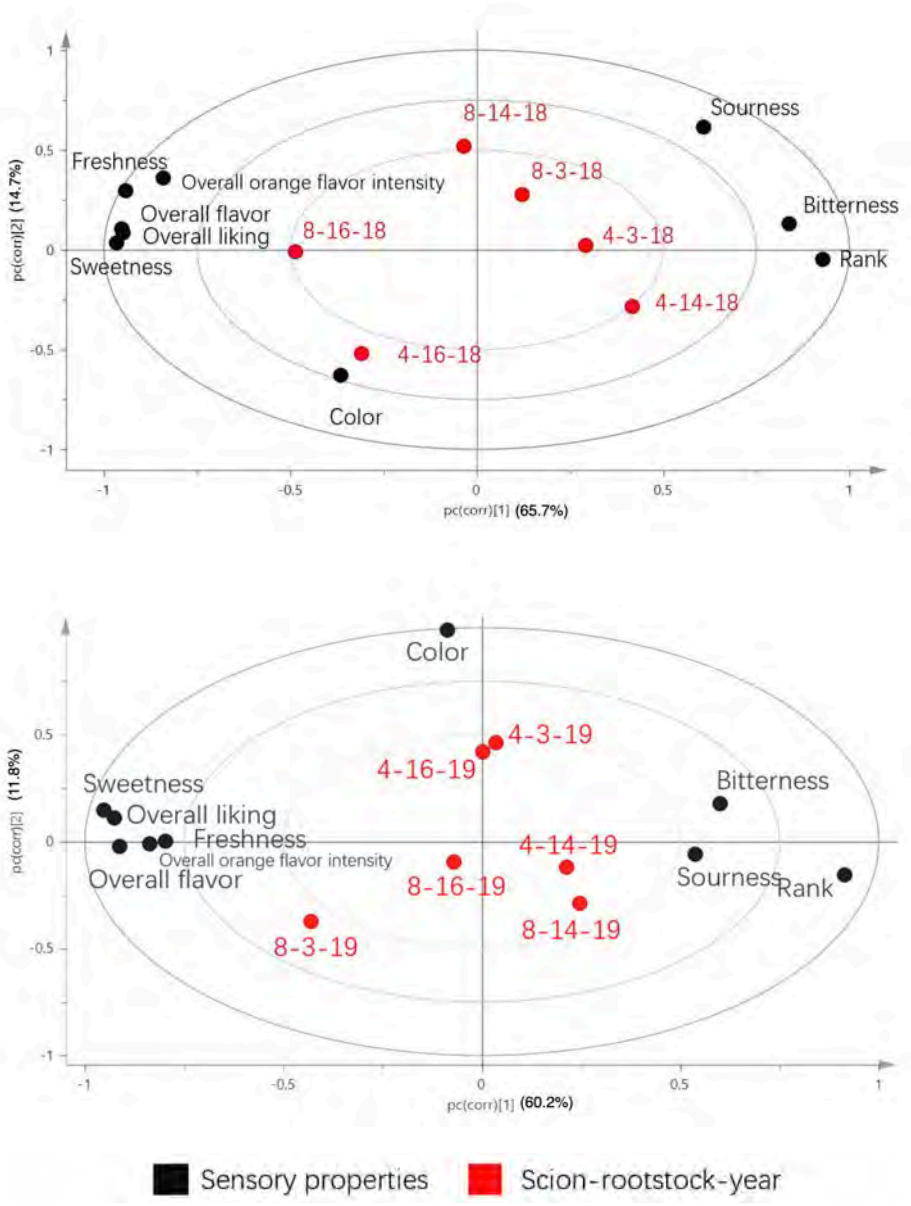

Figure 2. Biplots of consumer overall liking and sensory attributes of the orange juices from different scion/rootstock combinations in 2018 (top) and 2019 (bottom). The format of scion/rootstock combination sample code was presented as scion-rootstock-year.

with each other. For example, the higher intensity of overall orange flavor, sweetness, freshness, etc., the better overall consumer liking.

On the center-right of the plots, rank, sourness and bitterness were clustered, because at the sensory test, panelists were asked to rank the most favorable orange juice as No. 1 and the least favorable as No. 6. In other words, the higher the intensity of sourness and bitterness of orange juice, the higher the ranked number. Therefore, sourness and bitterness are negatively related to consumer preference.

Overall flavor, sweetness and overall liking are almost overlapped in the figure, suggesting that overall liking of the orange juice could be primarily affected by overall flavor and sweetness.

Sample OLL-8 grafted on Orange 3 (8-3) and harvested in 2019 was the closest to overall liking, indicating it was the most favorable juice among all the samples in 2019. Rootstock Orange 16 grafted with either OLL-4 or OLL-8 showed a consistent consumer liking within the two seasons.

Within all the tested rootstocks, OLL-8 had a better flavor quality than OLL-4. OLL-8 grafted on Orange 16 was the most positively correlated with consumer liking and overall flavor.

In order to further understand how rootstocks and scions affect sensory quality of orange juice, a significant variance analysis was performed. As a result, both rootstock and scion significantly affected the color of orange juice samples. A significant variance of overall liking, sweetness and overall flavor was observed only within different rootstocks, indicating that grafting with either OLL-4 or OLL-8, rootstocks could affect sweetness, consumer liking and overall flavor. Freshness and overall orange flavor were significantly influenced by the scion varieties.

OLL-8 grafted on Orange 16 was the most positively correlated with consumer liking and overall flavor.

CONCLUSION

In conclusion, rootstock, scion, and scion/rootstock combination can affect orange juice sensory attributes. For maximum juice quality from HLB-impacted trees, such relationships should be considered when choosing scion/rootstock combinations in the future.

In addition, this is the first time studying the sensory attributes and consumer preference for orange juice from two commercially available high-juice-quality OLL cultivars grafted on sibling rootstocks in an HLB-affected grove treated with enhanced micronutrient formulations. What was learned in this study will be useful to modify orange fruit quality through scion/rootstock breeding optimization in the HLB era.

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