A closer look at CUPS-grown grapefruit

By Arnold Schumann, Ariel Singerman and Yu Wang

Grapefruit production in Florida has been drastically reduced by huanglongbing (HLB) disease, from 40.9 million boxes in 2003–04 to 4.5 million boxes in 2018–19, according to the U.S. Department of Agriculture. Grapefruit varieties are particularly vulnerable to HLB due to cumulative losses from stunted tree growth, low fruit yield, high-percentage fruit drop, small fruit size, low-percentage packout and compromised internal quality. The resulting low net revenue generated by HLB-impacted grapefruit groves and their inflated production costs compromise the economic viability of growing grapefruit for the fresh fruit market in HLB-endemic Florida.

Growing using the citrus under protective screen (CUPS) system is being developed as an immediately available, interim solution for HLB. CUPS prevents HLB by excluding the Asian citrus psyllid insect vector. Grapefruit varieties may be well suited for growing in the HLB-free environment of CUPS if they are highly productive, and the enterprise shows long-term economic viability. This article presents four seasons of production data from five years of growing Ray Ruby grapefruit in the Citrus Research and Education Center (CREC) CUPS, a 10-year projected economic assessment, and selected consumer preference results from 2018.

The CREC CUPS is a 1.33-acre screen house constructed with poles, cables and 50-mesh high-density polyethylene screen. The roof height of 14 feet is designed to accommodate trees up to 10 feet high. A planting density of 871 grapefruit trees per acre is achieved with a 5-foot by 10-foot tree spacing and 4-foot hedged row middles. Grapefruit

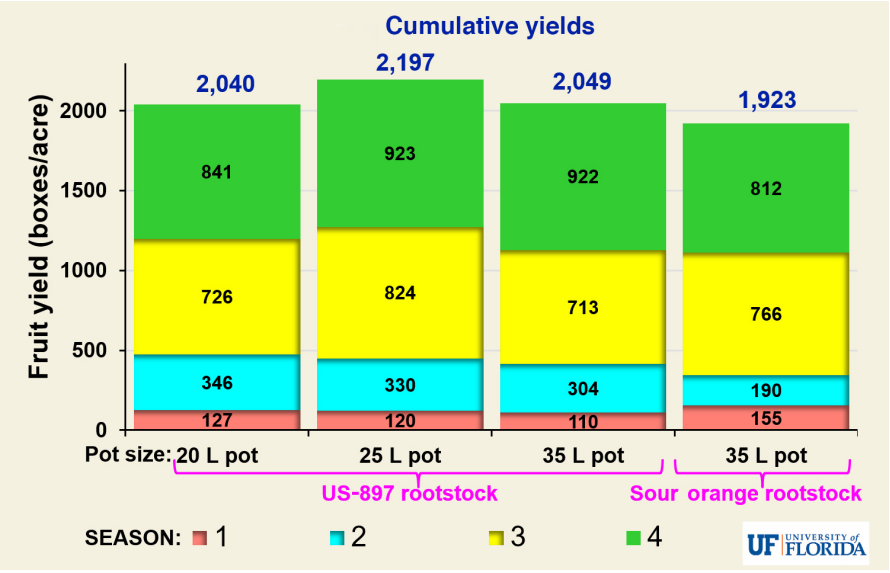

Figure 1. Four seasons of Ray Ruby grapefruit yield grown in the Citrus Research and Education Center citrus under protective screen with 871 trees per acre. Trees were planted in August 2014. Season 1 is 2015–16 and Season 4 is 2018–19. The volumes of the GroPro pots are 20, 25, and 35 liters.

trees are being managed for a target height of 8 feet since a 2:1 ratio of height:row middle is optimal for sunlight interception.

The trees are grown hydroponically with drip fertigation in GroPro pots filled with equal proportions of Canadian peat moss and perlite. For seasons one to four, annual hedging with a 10-foot sicklebar blade was conducted after harvesting to create a 5-foot-wide row middle. No canopy topping was required in years one to five.

HIGH YIELDS AND QUALITY

Cumulative yields of grapefruit from the 2015–16 to 2018–19 season are shown in Figure 1 (page 14). Yields for all combinations of rootstock and pot size were high, but the maximum cumulative yield of 2,197 boxes per acre was achieved with 25-liter pots and US-897 rootstock.

Fruit quality was also good, packing 70 percent US #1, with an average net fruit revenue of $26 per box. Overall packout in CUPS was 100 percent, which is difficult to achieve with conventional field-grown grapefruit in the presence of HLB. Larger fruit is a hallmark of CUPS-grown grapefruit, with 79 percent of the packed fruit being in the desirable 40, 36, 32 or 27 size classes (Figure 2).

Photo by Dundee Citrus Growers Association

Figure 2. Ray Ruby grapefruit from the Citrus Research and Education Center citrus under protective screen was ready for shipping at the packinghouse in December 2018.

CONSUMER SENSORY TEST

In December 2018, a sensory test was conducted with 120 volunteers to compare the consumer preference for 1) Ray Ruby grapefruit grown in the CREC CUPS or 2) grown in

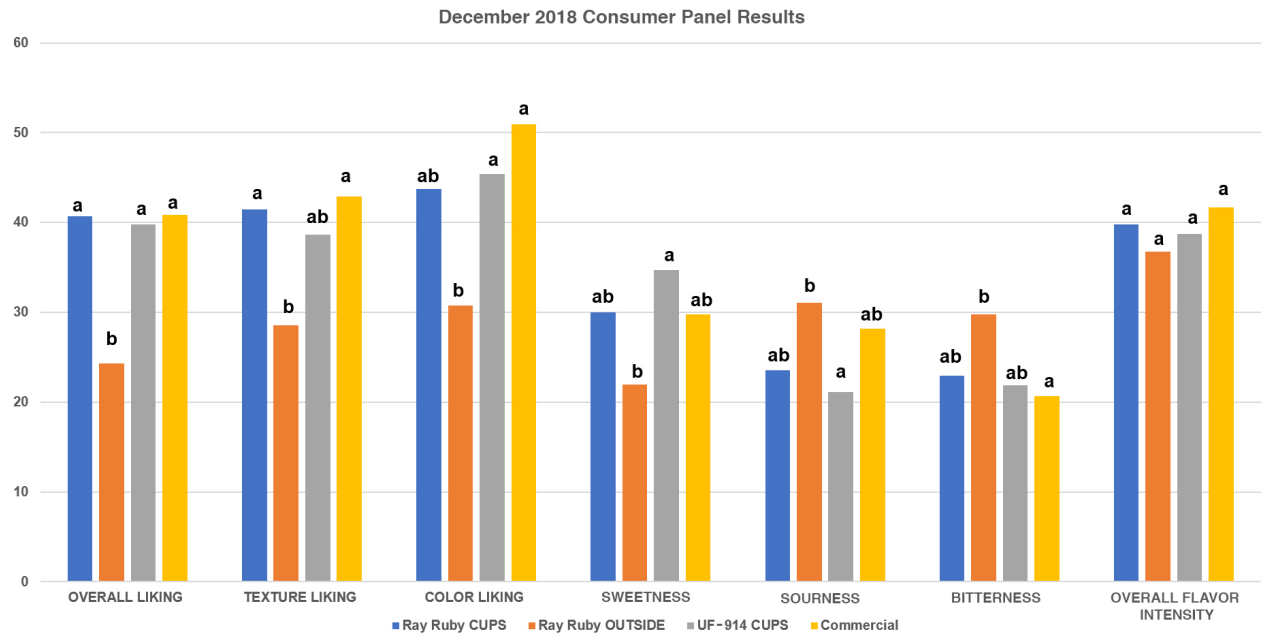

Figure 3. Results of a panel taste test comparing fresh red grapefruit from the citrus under protective screen (CUPS), outside-grown control trees, commercial Florida red grapefruit from a grocery store and the UF-914 grapefruit hybrid grown in CUPS. Treatment means in each category with different letters are significantly different.

outdoor control plots, compared with 3) commercial red Florida grapefruit obtained from a grocery store and 4) UF-914 grapefruit hybrid grown in CUPS. The general Labeled Magnitude Scale (gLMS) was used to rate sensory quality of the different fruit batches (Figure 3).

There was a significant difference in overall liking, texture liking and color liking between grapefruit from outside and inside the CUPS. There was no

significant difference in preferences among CUPS-grown UF-914, Ray Ruby and commercial red grapefruit. Researchers concluded that the commercially grown Florida grapefruit had been effectively screened so that only the fraction of harvested fruit with no or minimal HLB symptoms was shipped to the store.

ECONOMIC ANALYSIS

Assumptions

An economic analysis of the CREC CUPS grapefruit was based on several assumptions that include the following:

1. The land is already owned.
2. The investment is for fresh Ray Ruby grapefruit trees planted in pots.
3. Spacing is 5 feet between trees by 10 feet between rows, resulting in 871 trees per acre.
4. Calculations for the investment and fixed costs of most machinery and irrigation assume a 20-acre operation.
5. The irrigation system is planned for 20 acres.
6. The time horizon for the analysis is 10 years.
7. The cost of the structure and nets is $43,000 per acre.
8. Prices used for the analysis are the actual prices obtained by selling the fruit to a packinghouse.
9. Production costs and prices are assumed to be constant from year four through year 10.
10. The season-average packout was assumed to be 100 percent.
11. The annual cost of insuring the structure per acre is $2,200.
12. The real increase in land value per acre after 10 years is $1,245.

There are also a few caveats worth noting. First, the quotes for chemicals in this budget are based on retail prices. But growers — depending on the size of their operation — may get a discount for volume. Second, the actual investment in machinery and irrigation will depend on whether growers start a new operation or whether the equipment is already available to them. For this budget, all equipment was assumed to be new and prices were obtained from machinery dealers and irrigation supply companies. Third, production and input data are available

for the first four years only, so the remainder of the estimates are projections based on current data.

Methodology

To evaluate the profitability of the long-term investment in CUPS, investment analysis was used. The net present value (NPV) can be used as a methodology for such evaluation, which consists in summing all the discounted cash flows. The choice of the discount rate to compute the NPV is key because it represents the cost of capital (or its opportunity cost) plus the inflation rate and risk premium.

As a rule of thumb, investments with a positive NPV should be accepted, and those with a negative NPV, rejected. The rationale for accepting investments with positive NPVs is that they yield higher returns than the discount rate. However, it is impossible to estimate a discount rate that would be meaningful for all growers; each individual grower has a different opportunity cost of capital and risk premium preference. Therefore, the results of the investment analysis using the internal rate of return (IRR) methodology are shown. The IRR is the actual rate of return on the investment; it is the discount rate that makes the NPV be zero in the equation above. As such, it depends only on the cash flows of the investment.

Results

Table 1 summarizes the results of the investment analysis by providing the IRR and payback period for three scenarios. In the baseline scenario, where the grower is assumed to be self-insured, and the increase in the value of the land is not considered, the IRR is 10.33 percent and the payback period eight years. In the scenario in which the increase in the value of the land is considered, the IRR increases marginally to 10.45 percent. In the scenario in which the grower is assumed to purchase insurance for the structure against hurricanes, the IRR is 7.07 percent and the payback period is nine years.

Given that the cost of the structure is significant, what is referred to as a sensitivity analysis was performed; that is, the calculations were performed several times using different cost estimates so as to obtain the IRR for each case. The results of the analysis are summarized in Figure 4. The figure shows how the IRR changes when the cost of the structure and nets changes under two hurricane insurance scenarios: self-insuring and purchasing insurance.

Table 1. Internal rate of return (IRR) and payback period for citrus under protective screen

	IRR	Payback period (years)
Baseline: self-insured; no increase in land value	10.33%	8
With increase in land value	10.45%	8
With increase in land value and insurance for structure	7.07%	9

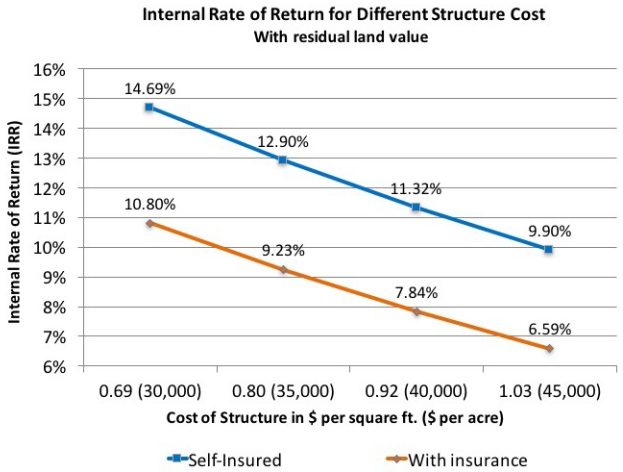

Figure 4. Internal rate of return and different costs of the structure for citrus under protective screen for self-insured and insurance-purchasing scenarios

The results show that growing fresh Ray Ruby grapefruit with CUPS is economically profitable under the assumptions made. Therefore, while this technology demands a high establishment and production cost, it also enables fresh citrus growers to reap the benefits of premium quality fruit with 100 percent packout, resulting in higher market prices and ensuring a profit.

In conclusion, the results of growing grapefruit for five years in the CREC CUPS has produced four very productive seasons of high-quality, HLB-free fruit. Economic projections for 10 years look profitable, provided that the assumptions hold. CREC researchers are actively engaged with commercial growers using CUPS to help ensure that similar results will be achieved with grapefruit and other citrus varieties that are being grown in the ground instead of in pots.

Acknowledgements: The authors thank Laura Waldo, William Holmes, Tim Ebert, Napoleon Mariner and Gary Test for technical support and managing the CREC CUPS, and Laura Reuss for conducting the sensory panel tests. The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Citrus Initiative, Citrus Research and Education Foundation, U.S. Department of Agriculture (USDA)/National Institute of Food and Agriculture/Citrus Disease Research and Extension (Award #2018-70016-27387) and USDA/Florida Department of Agriculture and Consumer Services/Specialty Crop Block Grant (Award #00092195) funded this research.

Arnold Schumann (schumaw@ufl.edu) is a professor, and Ariel Singerman and Yu Wang are assistant professors — all at the UF/IFAS Citrus Research and Education Center in Lake Alfred.