



To determine yields, fruit were weighed in the rootstock trials.

# Early performance of orange rootstocks in commercial settings

By Ariel Singerman, Stephen H. Futch and Brandon Page

**T**his article provides estimates on the performance of different rootstocks grafted with Valencia sweet orange scions in commercial field conditions. These are the first estimates obtained from side-by-side trials that compare the performance of rootstocks developed by two breeding programs: The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) and the U.S. Department of Agriculture. These estimates can be particularly useful in helping growers decide which rootstocks to plant. This analysis combines yield and economic performance.

## MATERIALS AND METHODS

Data consist of annual yields from grower-run trials under a completely randomized design conducted by the Citrus Research and Development Foundation (CRDF). There was a total of three trials in Florida with two sites in Central Florida (Lake Placid and Babson Park) and one in Southwest Florida

(Felda). Each site was managed by a different grower.

The following rootstocks were evaluated in each site: UFR-2 UFR-3, UFR-4, UFR-16, US-812 and US-942. Rootstock US-897 was also evaluated in the Babson Park site. The majority of the trees were planted in 2015. However, trees on rootstocks UFR-3 and UFR-16 in Lake Placid and Babson Park were planted between two and 12 months later than those on the other rootstocks, so the data of those rootstocks on such sites were not analyzed.

The trials also included trees on traditional commercial rootstocks used in each region, which were used as controls. The Lake Placid control was sour orange, in Babson Park it was Carrizo, and in Felda it was Swingle. Each rootstock was replicated five times. There was a total of 25 plots in Lake Placid, 30 in Babson Park and 35 in Felda. Yield data were collected during three seasons (2017–18, 2018–19, and 2019–20) in Lake Placid and Babson Park. In Felda, data were also collected in 2016–17. The tree planting density for each site was

**Table 1.** Differential revenue relative to the control by citrus rootstock, season and site

Site	Control	Rootstock	Season				
			2016-17	2017-18	2018-19	2019-20	Total
Lake Placid	Sour orange	UFR-2		-56.04	-555.12	-254.87	-866.03
		UFR-4		-46.22	-483.32	-185.96	-715.50
		US-812		-2.61	307.89	200.66	505.94
		US-942		42.49	362.12	63.40	468.01
Babson Park	Carrizo	UFR-2		-353.81	-925.09	-514.07	-1,792.98
		UFR-4		-174.24	-699.45	-99.79	-973.48
		US-812		265.92	590.17	156.27	1,012.36
		US-897		-125.75	44.25	-233.32	-314.81
		US-942		89.73	343.73	68.39	501.84
Felda	Swingle	UFR-2	-71.02	-19.01	-2.62	43.14	-49.50
		UFR-3	74.45	-84.13	-495.87	-270.12	-775.67
		UFR-4	-32.76	-37.10	94.39	100.35	124.88
		UFR-16	3.70	-60.92	-528.95	-174.76	-760.93
		US-812	72.92	-32.22	601.42	117.12	759.24
		US-942	79.80	-24.53	666.24	114.19	835.71

as follows: Lake Placid, 240 trees per acre; Babson Park, 303 trees per acre; Felda, 202 trees per acre.

Regression analysis was used to analyze the yield data for each site through time. In Lake Placid, rootstocks UFR-2 and UFR-4 attained, on average across all replications, lower levels of yield relative to the control. US-812 and US-942 attained higher levels. Moreover, all coefficients were statistically significant either at the level of 1% or 5%, except for rootstock US-942 in 2019–20.

In Babson Park, the only statistically significant coefficients across both seasons were for rootstock UFR-2 (which were negative). Only in season 2018–19, the coefficient of rootstock UFR-4 and US-812 were statistically significant, which were negative and positive, respectively. In Felda, the only statistically significant coefficients were for rootstocks US-812 and US-942 in 2018–19 (which were positive) and for UFR-3 in 2019–20 (which were negative).

*This analysis provides evidence that rootstocks can be a significant factor affecting yield and economic return.*

## REVENUE DIFFERENTIALS

Based on the yield data, the differential revenue by season was computed for each of the rootstocks relative to the control at each site (Table 1). The prices used to calculate revenue were the actual average prices for Valencia oranges in each season as reported by

the Florida Department of Citrus. Thus, the prices for 2016–17, 2017–18, 2018–19 and 2019–20 were \$2.85, \$3.09, \$2.42 and \$1.25 per pound of solids, respectively.

Table 1 shows the differential revenue for all rootstocks, not just those found to have statistically significant differences in yield relative to the control. The table shows that in Lake Placid, both UFR-2 and UFR-4 attained a lower level of revenue compared to sour orange in each of the seasons there was data and, therefore, a negative cumulative revenue over the three seasons of -\$866/acre and -\$715/acre. Contrastingly, US-812 and US-942 attained a cumulative revenue of \$506/acre and \$468/acre above that of the control.

Despite the similar cumulative revenue, US-812 seems to be a better choice because even though in 2019–20 both rootstocks attained a lower positive difference with respect to control, that of US-812 was larger. It is also noteworthy that negative and positive revenue differences for all evaluated rootstocks decreased in 2019–20 compared to 2018–19, either due to lower yield or lower fruit prices.

In Babson Park, rootstocks UFR-2 and UFR-4 attained negative revenue in all three seasons compared to Carrizo, with a cumulative revenue of -\$1,793/acre and -\$974/acre. Therefore, a grower would be better off using Carrizo to graft Valencia rather than UFR-2 or UFR-4 in such a soil profile. While US-897 performed somewhat better compared to the UFR rootstocks, it also had a negative cumulative revenue. Both US-812 and US-942 attained positive revenue differences compared to Carrizo in all three seasons. But at \$1,012/acre, US-812 attained cumulative revenue that doubled that of US-942.

In Felda, trees on rootstock UFR-2 performed similar to Swingle but with an intrinsic higher risk because its performance through time is still unknown. The cumulative revenue on

rootstocks UFR-3 and UFR-16 over four seasons was similar; they obtained revenues of -\$776/acre and -\$761/acre relative to Swingle, respectively. Thus, a grower would be better off using Swingle to graft Valencia in such a soil profile. US-812 and US-942 obtained the largest differences in yield and revenue compared to the control, but the differences decreased considerably in 2019–20 due to a combined decrease in yield differential and prices. While UFR-4 did not attain large differences, it increased over the seasons with data available and, therefore, would be worthwhile to continue to collect data to evaluate its performance over a longer period.

### SUMMARY


This analysis provides evidence that rootstocks can be a significant factor affecting yield and economic return. Moreover, finding rootstocks that yield returns (and revenue) sooner can be particularly valuable for growers to achieve breakeven (and profits) more quickly. Thus, these estimates should prove useful to help citrus growers in their decision-making process of determining which rootstock to use in the current endemic-HLB environment in Florida.

The positive differences in performance attained in some of the evaluated rootstocks decreased in the last season of data. Therefore, it remains to be seen whether the observed trend in performance will continue beyond the first few seasons. Follow-up studies that include more seasons will be needed to address this issue.


These findings have no implications for how well the evaluated rootstocks would perform with other scions (e.g., early- and mid-season) or in other locations. Even for the rootstock/scion combinations evaluated here, the findings are the result of specific growing conditions (e.g., grower practices and weather) and should not be viewed as a guarantee of performance. 🍊

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