Citrus Rootstock Acquisition and Evaluation — 2019[1]

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Introduction

Citrus macrophylla and *C. volkameriana* are the standard, vigorous rootstocks used widely across the Arizona and California desert lemon industry. They are both vigorous and produce high-yielding trees with fruit of excellent size. Lemon trees on both rootstocks are relatively cold-sensitive and are susceptible to the brown wood rot fungi (*Fomitopsis meliae)* that plague desert lemons. Also, *C. volkameriana* is susceptible to "winter yellows", and tends to produce excessive numbers of trunk suckers.

Many years ago, sour orange (*Citrus aurantium* L.) was the common rootstock for lemon in Arizona as it was the only rootstock available and is quite adaptable to the highly alkaline desert soil. Sour orange is of medium vigor and may be used to reduce the vigor of lemon scions (Ferguson *et al*., 1990, Roose 2014). However, its yields are less than more recently introduced rootstocks, such as Carrizo. Carrizo is not commonly used for lemons in Arizona because yield and fruit size are less than for trees budded to *C. macrophylla* and *C. volkameriana*, and because it is not particularly tolerant of alkaline soils. Rangpur lime (*Citrus limonia*) has never been widely used in the United States, but in Brazil, Rangpur is known to confer drought tolerance on the scion, is vigorous and produces well on deep sandy soils. Bitters (C-22), Carpenter (C-54) and Furr (C-57) citrandarin (*Citrus sunki* x Swingle citrumelo [*Citrus paradisi* x *Poncirus trifoliata*]) are hybrids of 'Sunki' mandarin and Swingle citrumelo. All three were developed at the USDA citrus breeding program in Indio, CA and were released by the University of California in 2009. Information on these rootstocks can be found in Siebert *et al*., (2010).

In January 2016, we initiated a new lemon rootstock trial, the first to be planted at the University of Arizona's Yuma Mesa farm since 1993. The purpose of the trial was to evaluate the effect of the above-mentioned rootstocks on yield, fruit size, precocity, tree size, interior and exterior fruit quality, and disease tolerance (especially tolerance to brown wood rot – *Fomitopsis meliae*). A secondary purpose was to compare the effects of traditional flood irrigation with pressurized drip irrigation on the above attributes, and to measure water savings using the pressurized system.

High yielding, precocious trees with large fruit size are favored by the desert lemon industry. Desert lemons are marketed from mid-August to February. During the early and middle part of that window, lemons from other suppliers can be limited and sizes can be small, so high quantities of large fruit translate to good returns to the grower. Rootstocks are also known to affect drought tolerance, peel thickness, peel smoothness, fruit total soluble solids and acid levels, and percentage of juice in the fruit (Ferguson *et al*., 1990). Also, rootstocks can affect the growth of the brown wood rot fungi, *Antrodia sinuosa*, in the scion (Matheron and Porchas, unpublished data).

The experiment is located in block 6E (Flood irrigated trees) and 6W (Drip irrigated trees) at the Yuma Mesa Agriculture Center, near Somerton, AZ. The 2016 through 2018 reports for this experiment can be found as a PDF files at: https://agriculture.az.gov/arizona-citrus-research-council-previously-funded-research-projects.

Materials and Methods

The drip irrigation system components required many changes and adaptations to increase function and reliability to allow change over to primarily drip. The following issues were solved or addressed through the course of the year:

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1. Clogging before the filter
2. Rodent control
3. Drip line deterioration

1) **Clogging -** Water flow to the system was unacceptably slow. We discovered that the problem was that fish had entered from the canal that supplies the water to the system (the screen on the canal wall was missing – probably removed during canal cleaning and maintenance in November 2020). Figure 1 shows the quantity of fish bones we found in the system that were clogging the filter. We added another cleanable filter downstream from the canal wall, and this problem has been resolved.

2) **Rodent Control** - A more aggressive rodent identification and control program continues to control field damage. We are seeing a significant reduction in burrows and damage

3) **Drip Line Deterioration** – Some of the damage that we initially attributed to rodent damage in block 6W was actually due to UV radiation (Fig. 2). This was highly disappointing and led to the decision to remove the Rainbird line. Considering that we have been flooding block 6W, we decided that conversion to dripline during Spring 2021 would harm the trees as the root system that was formed with flood irrigation would not easily adapt to the reduced water pattern of the drip system. Therefore, we decided to convert the pressurized system to microsprinklers, and irrigation line purchased from Netafim. The new lines and sprinklers will be installed in April 2021.

Figure 1. Fish bones found in the pipe leading to the pump.

Figure 2. Damage to irrigation line due to UV radiation.

Figure 3. Dosatrons in the pumphouse.

As an improvement on the system, we added three Dosatrons injectors to the system so that when the system is finally running, we can inject fertilizer.

For 2019 and 2020, tree growth data was again collected in June, including tree height, canopy volume (spherical), Also, a subjective tree health rating was taken, where 0 = dead, 1 = almost dead, 2 = poor vigor, 3 = adequate vigor, 4 = good vigor and 5 = excellent vigor. No trees produced fruit in 2018, but many of them flowered and set fruit in 2019. Yields were collected in January 23, 2020 and again on February 17, 2020 for the 2019-2020 season. For the 2020-2011 season,

yields were collected on November 19, 2020 for Block 6W and December 8, 2020 for Block 6E. We had expected to pass the November and December 2020 fruit through our automated fruit sizer to collect packout data. However, there was a failure of the weight cell in the middle of the run. Therefore, only about 15% of the fruit packout data was collected for Block 6W and none for Block 6E. Since there was no difference in irrigation treatments between Block 6E and 6W, all the data is pooled for the seasons.

Since 2018, three trees have been lost to brown wood rot.

Results and Discussion

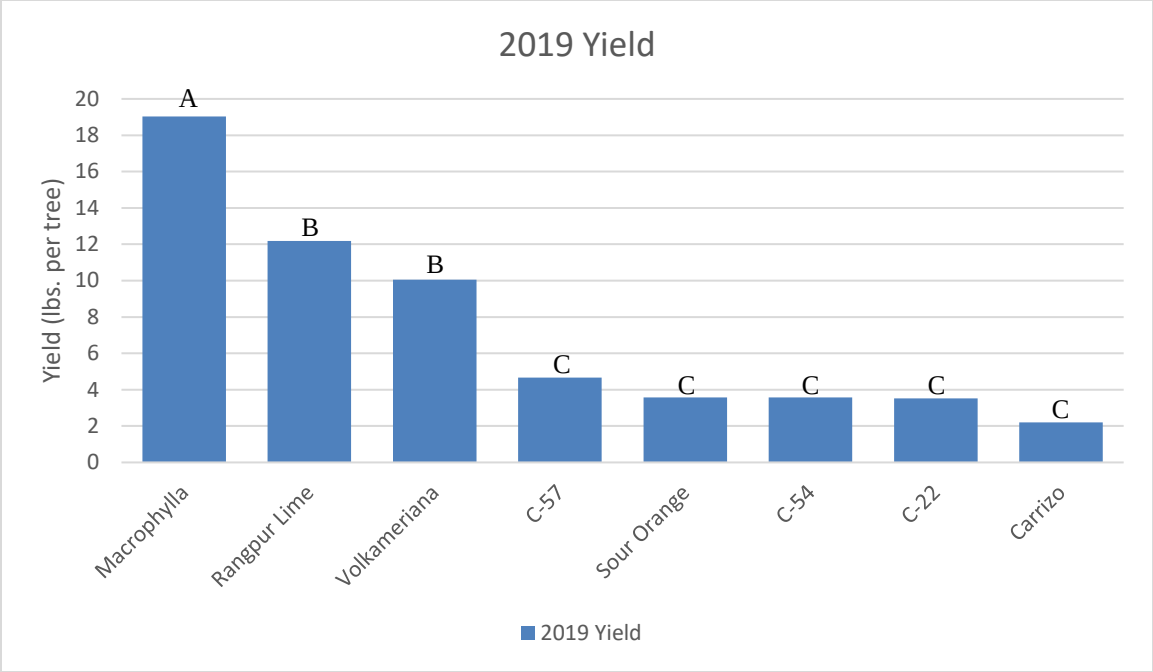
Results from the 2019 and 2020 tree size and health measurements are shown in Table 1.

Table 1. 2019 and 2020 Lemon tree height, canopy volume and health rating.

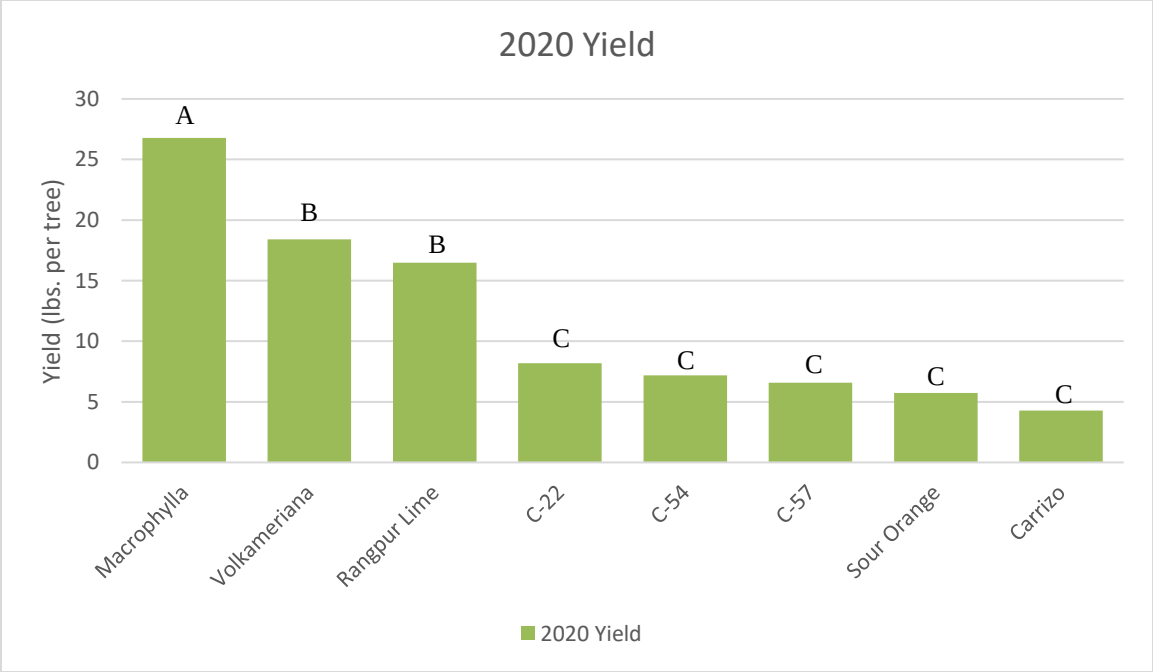
Rootstock Variety	Tree Height (m)		Canopy Volume (m^3)		Tree Health Rating (0 to 5)	
	2019	**2020**	**2019**	**2020**	**2019**	**2020**
Macrophylla	1.91 a	2.51 a	1.77 a	5.03 a	4.80 a	4.63 a
Volkameriana	1.87 a	2.38 b	1.41 b	4.16 b	4.74 a	4.43 abc
Rangpur Lime	1.74 b	2.24 c	1.16 c	3.53 c	4.82 a	4.26 bc
C-57 'Furr' Citrandarin	1.61 c	2.19 cd	0.78 d	2.48 d	4.62 ab	4.50 ab
C-54 'Carpenter' Citrandarin	1.57 c	2.15 cde	0.78 d	2.40 d	4.61 ab	4.21 c
Carrizo Citrange	1.50 c	2.18 cd	0.57 e	2.34 d	4.36 b	4.19 c
Sour Orange	1.49 c	2.04 e	0.57 e	1.99 d	4.37 b	4.17 c
C-22 'Bitters' Citrandarin	1.50 c	2.09 de	0.58 e	2.18 d	4.65 ab	4.22 c

For data within columns with different letter designations there is at least a 95% chance that the values are significantly different. Data in different columns cannot be statistically compared.

Not surprisingly, trees on Macrophylla and Volkameriana rootstock were the largest, as shown by height and canopy volume. Rangpur lime produced intermediate sized trees, while the other rootstocks produced smaller sized trees. The citrandarins (C-22, C-54, and C-57) have produced smaller trees in studies conducted in California, and so their relatively small stature in relation to the others is not surprising.

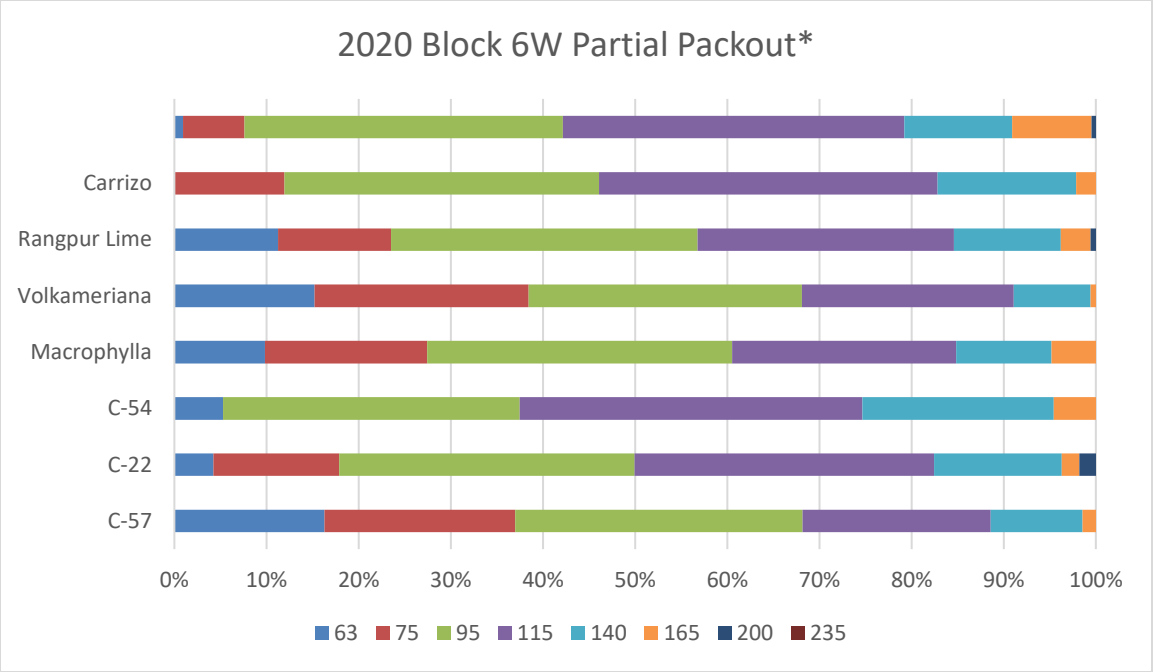


For bars with different letter designations there is at least a 95% chance that the values are significantly different.



For bars with different letter designations there is at least a 95% chance that the values are significantly different.

Yields for 2019 was expectedly small, being the first year that the trees produced fruit. Yields for 2020 did not increase as much as we had expected, perhaps due to excessive fruit drop as a result of the extremely hot summer the region experienced in 2020. We expect that yields will increase in 2021.



* Data represents only 15% of the total yield.

Plans for the Next Fiscal Cycle

In early 2020, we expect to replace the defective line and begin irrigating the trees in Block 6W exclusively with microsprinkler irrigation. We will begin to collect data on water use at that time. Meanwhile, we will carry out normal fertilization, pest control and weed control in both blocks, apply flood irrigation in Block 6E in accordance with normal horticultural practices. We expect to collect tree size and health data in June 2021 and yield in fall and/or winter 2021.

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