Citrus Rootstock Acquisition and Evaluation — 2018[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 and 2017 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:

1. Filter and flowmeter reliability
2. Rodent control
3. Vandalism
4. Additional Concerns

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The original RainBird filter became inoperable and unserviceable and was replaced with an automated Netafim disk filter system. The Netafim water meter was jammed and required repeated dismantling to remove debris. This may require relocating the water meter down stream from the new water filter. See figure1.

Figure 1. New filter system and repaired water-meter.

Figure 2. Rodent Control identification.

A more aggressive rodent identification and control program was initiated to control field damage. About 60% of the trees had one or more gophers at the base. The green flag in figure 2 shows one of the identified rodent burrows that required baiting. The rodent control effort is continuing, and we are seeing a significant reduction in burrows and damage.

Figure 3. Rodent damage.

Figure 4. Damage due to equipment or possibly vandalism

Both rodent damage (figure 3) and vandalism (figures 3, 4, 5, 6 and 7) had the same effect of creating breaks in the irrigation lines and wasting water by flooding areas of the field and creating dry spots in others. Some of the vandalism involved opening and closing exposed valves and while some lines appeared to be entangled in equipment and pulled out of location (see figure 4). The soil moisture probe was found to be faulty and will be replaced.

Figure 5. Vandalism

Figure 6. Vandalism by hunters

Figure 7. Vandalism (opened valves)

Figure 8. Proper drip irrigation

After all the adjustments and repairs to the system were made the drip irrigation system appears ready for full time service once the faulty soil moisture probe is replaced. Figure 8 shows the water infiltration to 24” depth after about a 3-hour irrigation sequence.

For 2019, tree growth data was again collected including tree height, canopy volume (spherical), scion and rootstock trunk circumference and the ratio of the scion and rootstock trunk circumference. A ratio of scion to rootstock trunk circumference that is less than one indicates that there is the potential for overgrowth of the rootstock, which may indicate a slight potential for rootstock-scion incompatibility. However, certain citranges, such as 'Carrizo', normally show scion to rootstock ratios of less than one without ever exhibiting any sign of incompatibility, and some other rootstocks. 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.

Results and Discussion

Results from the tree size and health measurements are shown in

Table 1. 2018 and 2019 Lemon tree height, canopy volume and health rating.

Rootstock Variety	Tree Height (m)		Canopy Volume (m^3)		Tree Health Rating (0 to 5)	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**
Macrophylla	1.55 a	1.91 a	0.47 a	1.77 a	4.91 a	4.80 a
Volkameriana	1.53 a	1.87 a	0.31 b	1.41 b	4.79 ab	4.74 a
Rangpur Lime	1.44 ab	1.74 b	0.30 bc	1.16 c	4.62abc	4.82 a
C-57 'Furr' Citrandarin	1.37 bc	1.61 c	0.15 d	0.78 d	4.26 c	4.62 ab
C-54 'Carpenter' Citrandarin	1.35 bc	1.57 c	0.20 bcd	0.78 d	4.58 abc	4.61 ab
Carrizo Citrange	1.30 c	1.50 c	0.18 cd	0.57 e	4.33 bc	4.36 b
Sour Orange	1.28 c	1.49 c	0.14 d	0.57 e	4.23 bc	4.37 b
C-22 'Bitters' Citrandarin	1.26 c	1.50 c	0.12 d	0.58 e	4.29 c	4.65 ab

Plans for the Next Fiscal Cycle

Some of the activity for the next fiscal cycle, January 2019 to March 2020 is reported here since there is overlap in the ACRC project fiscal cycles. In late 2019, we expect to replace the faulty probe, move the water meter, install injectors and begin irrigating the trees in Block 6W exclusively with drip 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 yield in fall or winter 2019.

References

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