

Lemon Rootstock Trials in Arizona – 2004-05¹

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Abstract

In a rootstock evaluation trial planted in 1993, five rootstocks, ‘Carrizo’ citrange, Citrus macrophylla, ‘Rough Lemon’, Swingle citrumelo and Citrus volkameriana were selected for evaluation using ‘Limoneira 8A Lisbon’ as the scion. 1994-2004 yield and packout results indicate that trees on C. macrophylla, C. volkameriana and ‘Rough Lemon’ are superior to those on other rootstocks in both growth and yield. C. macrophylla is outperforming C. volkameriana. For the second year in a row, ‘Rough Lemon’ trees performed similarly to C. macrophylla and better than C. volkameriana. ‘Swingle’ and ‘Carrizo’ are performing poorly. In two other rootstock evaluation trials, both planted in 1995, C. macrophylla and/or C. volkameriana are outperforming other trifoliolate and trifoliolate-hybrid rootstocks under test.

Introduction

There is no disputing the importance of citrus rootstocks to desert citrus production. The ideal citrus rootstock must be compatible with the scion, be adaptable to the appropriate soil and climactic factors and should also improve one or more of the following characteristics: pest and disease resistance, cold tolerance, precocity, internal and external fruit quality, yield and/or post-harvest quality. Ultimately, the value of a rootstock lies in its ability to improve production and/or quality of the fruit.

Climactic and edaphic characteristics of the desert citrus growing regions impose stress upon a citrus tree. Many times, rootstocks that are suitable for other areas are not suitable in the desert. Conversely, rootstocks that may be of limited value in other citrus growing areas might be more useful under desert conditions. It cannot be assumed that rootstocks will perform similarly across all climactic and edaphic conditions.

The first rootstock trial that we planted in 1993 was established to fill a large knowledge gap as to which were the appropriate lemon rootstocks for the Arizona industry. This trial includes rough lemon (*C. jambhiri*), a vigorous and formerly popular rootstock that is susceptible to *Phytophthora* root rot, and *C. macrophylla*, also popular, but susceptible to brown wood rot (*Coniophora eremophila*. and *Antrodia spp.*) and *Macrophylla* decline. Also included are *C. volkameriana*, a newly popular but untested rootstock, as well as ‘Carrizo’ citrange and ‘Swingle’ citrumelo as experimental rootstocks for the desert (‘Carrizo’ is commonly used as a rootstock for lemon in coastal California). ‘Limoneira 8A Lisbon’ lemon is the scion. Data collected from these trials has included tree growth, mineral nutrition, fruit quality, fruit size and total yield. Previous results from this trial have been reported in Wright and Peña (2004), Wright and Peña (2002), Wright and Peña (2001), Wright and Peña (2000), Wright *et al.* (1999), Wright (1998), Wright (1997), Wright (1996) and Wright (1995).

Materials and Methods

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This trial was established in March 1993 in Block 26 of the Yuma Mesa Agricultural Center, near Yuma, Arizona. The land was laser leveled and fumigated prior to planting. Trees were planted on a 10-m x 10-m spacing. Ten replicates of each of the 5 rootstocks were planted for a total of 50 trees. Experimental design is randomized complete block.

Irrigation is border flood, and normal cultural practices are used. Growth data, expressed as trunk diameter, was taken annually through 1997. Measurements were taken about 4 inches above the bud union. These locations are permanently marked with paint. Trunk diameters were taken annually in March, so as to quantify any differential growth rates that might have occurred. Leaves are collected annually in August for mineral analysis; however there have been no significant differences in leaf nutrient content. Yield data is collected during the fall and winter. Trees were ring or strip-picked as noted below. Prior to 1999-2000, about 30 lbs of fruit was sampled from each tree, and fruits were sized by hand and graded by observation. Since 1999-2000, the entire harvest from each tree has been passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit. Fruit packout data is reported on a percentage basis. Fruit quality data was collected at each harvest time. These data include °brix, peel thickness, percentage juice, pH, and total soluble solids to total acid ratio. There was no effect of rootstock on fruit quality (data not shown).

All data was analyzed using SPSS 8.0 for Windows (SPSS Inc., Chicago, Illinois).

Results

For 2004-05, trees on *Citrus macrophylla*, *Citrus volkameriana* and 'rough lemon' rootstocks had greater yields (about 70% more) than those on 'Carrizo' citrange and 'Swingle' citrumelo (Figure 1). This continues a trend that has been apparent since the 1996-97 season. However, for the first time since the 1997-98 season, trees on *C. macrophylla* did not have the greatest yield among all the rootstocks tested. Although trees on 'rough lemon' had the greatest yield (Figure 2), the majority of that yield was from the second harvest. *C. macrophylla* and *C. volkameriana* trees had the greatest first harvest yield, while trees on 'Carrizo' and 'Swingle' lagged. Trees on 'rough lemon' were not significantly different than any of the other rootstocks tested. For the second harvest, trees on 'rough lemon' had the greatest yield, followed by trees on *C. volkameriana*.

Packout for the 10-12-04 harvest is shown in Figure 3. There was a minimal amount of fruit of size 95, but there were significant differences among the rootstocks tested for size 115 fruit, where trees on trees on *Citrus macrophylla*, *Citrus volkameriana* and 'rough lemon' had more of this size fruit, while trees on 'Carrizo' and 'Swingle' had less. The opposite was true with size 165 and 200 fruit. There was no effect of rootstocks on the quantity of size 140 fruit. There was also no effect of rootstock on packout for the second harvest (Figure 4).

Rootstock affected fruit shape and color (Table 1). For the first harvest, fruit of trees on 'Swingle' were rounder than fruit of trees budded to *Citrus macrophylla*, *Citrus volkameriana* and 'rough lemon', while those on 'Carrizo' were intermediately round. This effect of rootstock upon fruit shape was not apparent for the second harvest. Fruit of trees on 'Swingle' was also the most yellow for the first harvest. Fruit of trees on *C. macrophylla* and 'Carrizo' citrange were the greenest, while the other tested rootstocks led to intermediate color. For the second harvest, fruits were more yellow, but fruit of trees on *C. macrophylla* and 'Carrizo' citrange were most yellow, while the fruit on 'Swingle' had the least yellow color.

Discussion and Conclusions

It is still apparent that all rootstocks other than *C. macrophylla*, *C. volkameriana* and 'Rough Lemon' are unsuitable as rootstocks for lemon in Arizona in high pH soils. Reduced vigor, late fruit sizing and ultimate small fruit size are characteristics that have not yet been overcome.

Differences between *C. volkameriana* and *C. macrophylla* were becoming increasingly clear. From 1997-98 until 2003-04, yield of trees on *C. macrophylla* has equaled or surpassed the yield of trees on *C. volkameriana*. However, for this season, yields of trees on these two rootstocks were virtually the same. There is no clear trend as to which of these rootstocks produces earlier fruit, and overall fruit size appears to be similar. Arizona packinghouse managers report that fruit of trees on *C. macrophylla* have a smoother peel, which leads to better overall fruit quality. Growers also report that *C. volkameriana* produces more water sprouts on the trunk than does *C. macrophylla*, and that trees on *C. volkameriana* show more transient nutrient deficiencies in the winter (winter yellows), than do trees on *C. macrophylla*. Perhaps an altered fertilizer regime with more fall micronutrient application would improve the yield of *C. volkameriana* trees. It remains to be seen if yield for *C. macrophylla* will continue to decline, and yield of *C. volkameriana* will continue to surpass that of *C. macrophylla*, or if this is a one-season phenomena.

After a slow start, 'Rough Lemon' has not had significantly different yield than *C. volkameriana* for the past five years. 'Rough Lemon' has not typically produced as well as *C. macrophylla*, but for the first time in 2004-05, it had the greatest yield. 'Rough lemon' continues to produce less early-season fruit compared to the other two vigorous rootstocks tested. 'Rough Lemon' is more difficult to grow in the nursery due to its greater susceptibility to Phytophthora root rot, so its availability is somewhat limited unless trees are special ordered on this rootstock.

Based on the results thus far, *C. macrophylla* appears to be a superior rootstock for lemons in Arizona; although the possibility exists that it may decline sooner than 'Rough Lemon' or *C. volkameriana*. It is probably not a good idea to plant all ones acreage on only one rootstock, thus either *C. volkameriana* or 'Rough Lemon' would be a good complementary rootstock as well.

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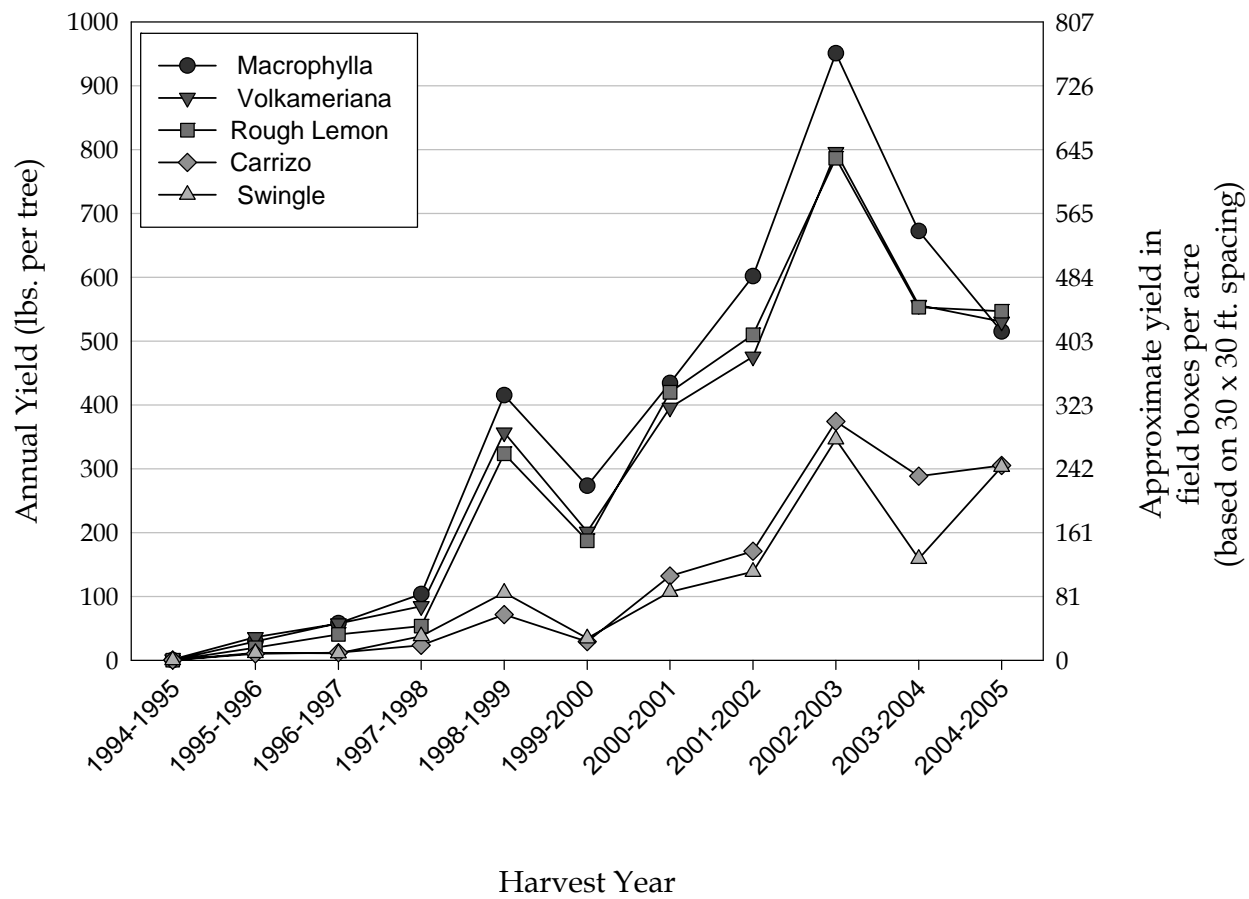


Figure 1. 1994 – 2004 'Limoneira 8A Lisbon' lemon yields on five rootstocks.

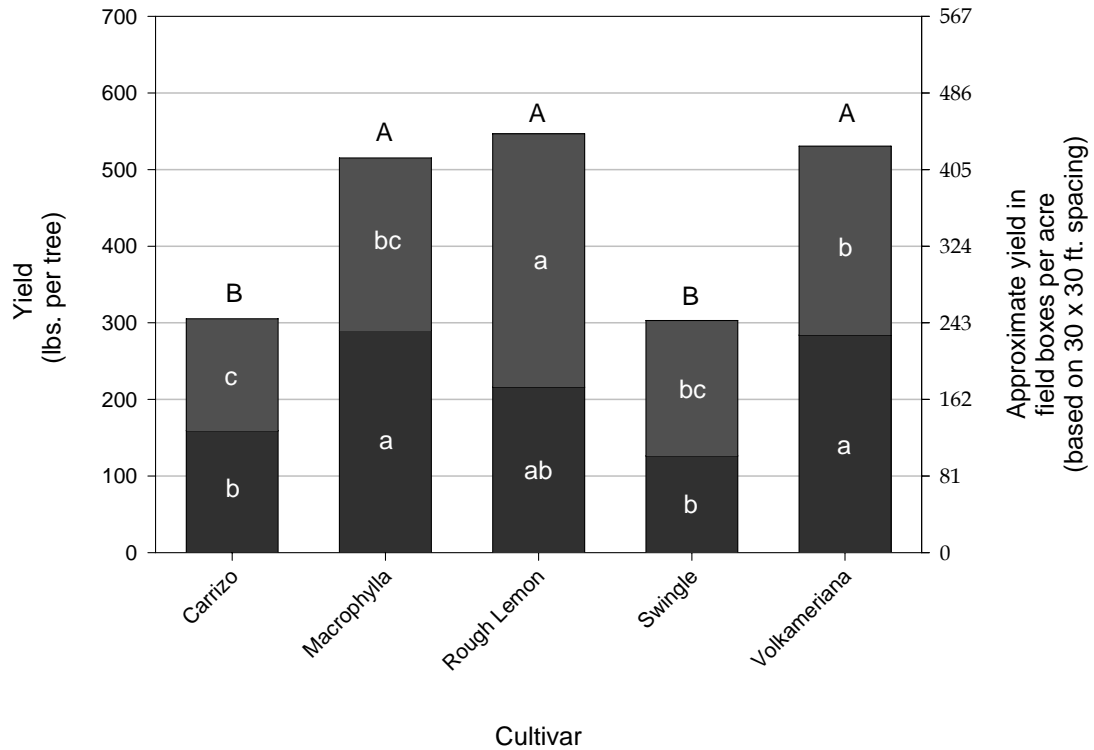


Figure 2. 2004 and 2005 yield of 'Limoneira 8A Lisbon' lemon yields on five rootstocks. Means separation within harvest dates by Duncan's multiple range test, 5% level. Bars of the same shade are significantly different if the letters within them are different. Bars of different shades cannot be compared.

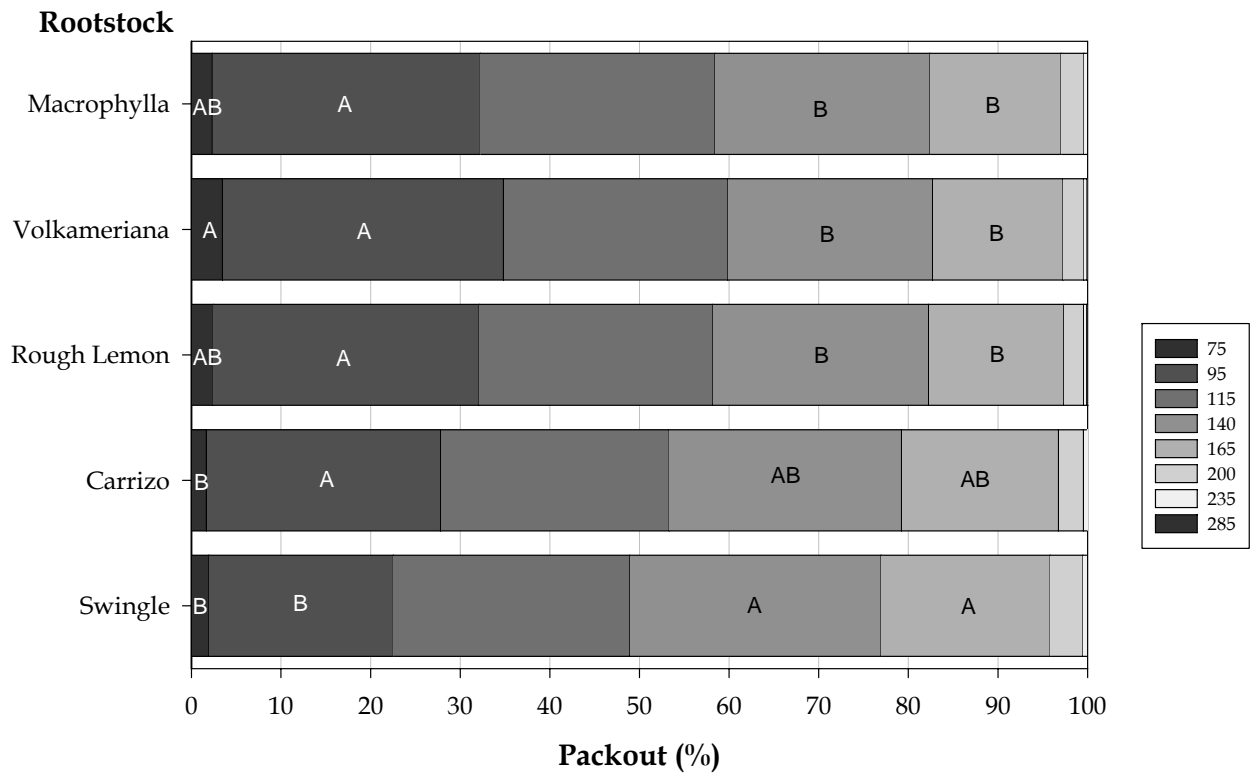


Figure 3. Packout of 'Limoneira 8A Lisbon' lemons on five rootstocks from the October 12, 2004 harvest. Means separation within fruit sizes by Duncan's multiple range test, 5% level. Bars of the same shade are significantly different if the letters within them are different. Bars of different shades cannot be compared.

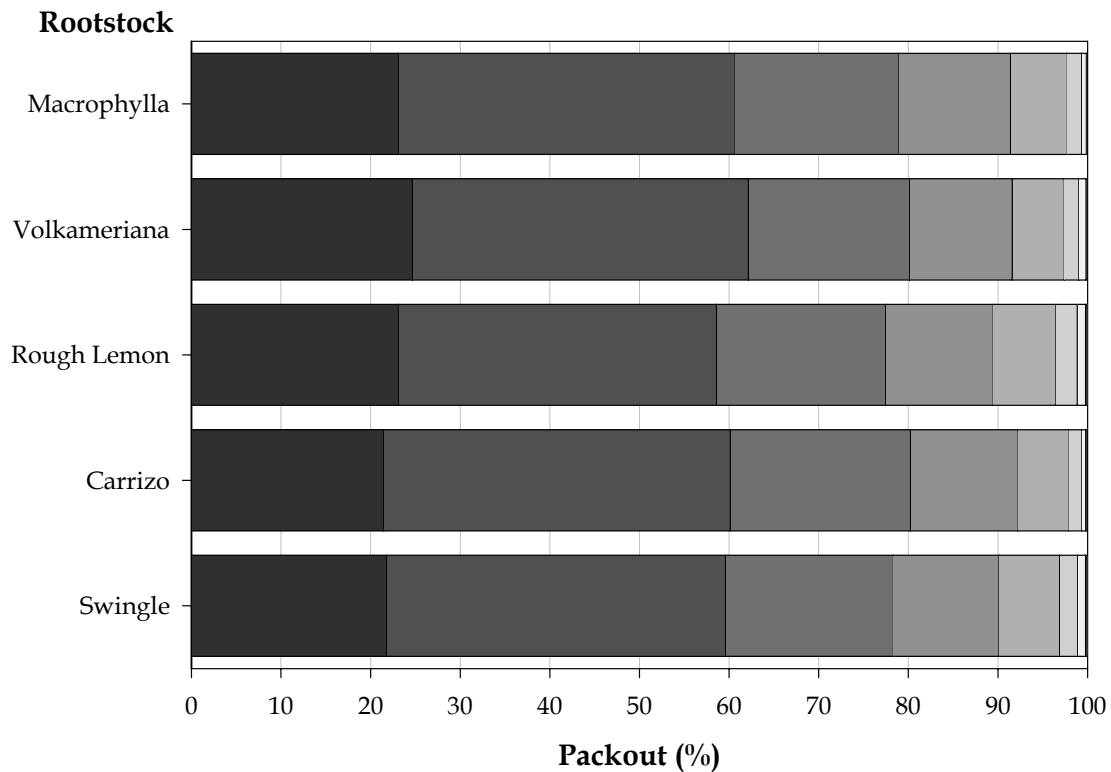


Figure 4. Packout of 'Limoneira 8A Lisbon' lemons on five rootstocks from the December 22, 2004 harvest. There were no significant differences in fruit sizes among the rootstocks tested.

Table 1. Fruit shape and color of 'Limoneira 8A Lisbon' lemon budded to five different rootstocks.

Selection ^z	10-12-04 Harvest		12-22-04 Harvest	
	Fruit Shape	Fruit Color	Fruit Shape	Fruit Color
<i>C. macrophylla</i>	0.758 b ^y	0.779 b ^x	0.751 a	1.166 a
<i>C. volkameriana</i>	0.754 b	0.796 ab	0.758 a	1.153 ab
Rough lemon	0.740 b	0.802 ab	0.752 a	1.150 ab
Carrizo citrange	0.764 ab	0.793 b	0.749 a	1.160 a
Swingle citrumelo	0.779 a	0.819 a	0.740 a	1.130 b

^z Values are the means of 10 trees.

^y Means separation in columns by Duncan's Multiple Range Test, 5% level. For fruit shape, a larger number indicates a more round fruit.

^x For color, a larger number indicates a greater degree of redness.