# Results of Scion and Rootstock Trials for Citrus in Arizona - 2000[1]

*Glenn C. Wright and Marco A. Peña*
*Department of Plant Sciences, U. of A., Yuma Mesa Agriculture Center, Yuma, AZ*

## *Abstract*

*Five rootstocks, 'Carrizo' citrange, Citrus macrophylla, Rough lemon, Swingle citrumelo and Citrus volkameriana were selected for evaluation using 'Limoneira 8A Lisbon' as the scion. 1994-2000 results indicate that trees on C. macrophylla and C. volkameriana are superior to those on other rootstocks in both growth and yield. C. macrophylla is outperforming C. volkameriana. Rough lemon is intermediate, and 'Swingle' and Carrizo' are performing poorly. For 2000-01, rough lemon trees performed similarly to C. macrophylla and C. volkameriana. In a similar trial, Four 'Lisbon' lemon selections, 'Frost Nucellar', 'Corona Foothills', 'Limoneira 8A' and 'Prior' were selected for evaluation on Citrus volkameriana rootstock. 1994-2001 results indicate that the 'Limoneira 8A Lisbon' and 'Corona Foothills Lisbon' are superior in yield and fruit earliness. Results from another lemon cultivar trial suggest that 'Cavers Lisbon', Limonero Fino 49' and ''Villafranca' lemons may be good candidates for plantings as well. Results from three other lemon scion trials, a navel orange cultivar trial and a 'Valencia' orange trial, and a 'Fallglo' mandarin trial are presented as well.*

## Introduction

There is no disputing the importance of citrus cultivars and rootstocks to desert citrus production. A successful citrus cultivar must be adaptable to the harsh climate, (where average high temperatures are often greater than 40°C), must be vigorous and must produce high yields of good quality fruit of marketable size. Likewise, 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, harvest date, internal and external fruit quality, yield and post-harvest quality. Ultimately, the value of a rootstock lies in its ability to improve production and/or quality of the fruit.

Therefore, the first scion and rootstock cultivar trials that we planted in 1993 are revealing the appropriate lemon scions and rootstocks for the Arizona industry. The lemon scion trial includes 'Limoneira 8A Lisbon', 'Prior Lisbon', 'Frost Nucellar Lisbon', and 'Corona Foothills Lisbon' lemon on *C. volkameriana* as the rootstock. The lemon rootstock trial includes rough lemon (*C. jambhiri*), *C. volkameriana, C. macrophylla,* 'Carrizo' citrange and 'Swingle' citrumelo as the rootstocks and 'Limoneira 8A Lisbon' lemon as the scion. Data collected from these

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trials includes tree growth, mineral nutrition, fruit quality, fruit size and total yield. Previous results from this trial have been reported in Wright *et al.* (1999), Wright (1998), Wright (1997), Wright (1996) and Wright (1995). These trials are hereafter referred to as 1993 Lisbon Lemon Scion Trial and 1993 'Lisbon' Lemon Rootstock Trial.

Two additional rootstock trials, planted in 1995, are now in production. The first of these has 'Limoneira 8A Lisbon' lemon as the scion, and an 'African' Shaddock x 'Rubidoux' trifoliate orange, 'C-35 Citrange', 'Citremon 1449', *C. taiwanica*, *C. volkameriana*, or "Yuma Citrange' as the rootstock. This trial is hereafter referred to as 1995 'Limoneira 8A' rootstock trial.

The second trial planted in 1995 has 'Limonero Fino 49' lemon as the scion. Fino 49 is the common fall and winter harvested lemon grown in Spain. Rootstocks in this trial include 'African' Shaddock x 'Rubidoux' trifoliate orange, 'C-35' Citrange, 'Carrizo' Citrange, 'Citremon 1449', *C. macrophylla*, *C taiwanica*, *C. volkameriana*, Rough Lemon (*C. jambhiri*), or 'Swingle' citrumelo. This trial is hereafter referred to as 1995 'Limonero Fino 49' rootstock trial.

We are now also able to collect lemon yield data from the citrus variety block. This trial, established in 1995, contains 'Allen Eureka', 'Cascade Eureka', 'Cook Eureka', 'Cavers Lisbon', 'Frost Nucellar Lisbon', 'Limoneira 8A Lisbon', 'Prior Lisbon', 'Rosenberger Lisbon', 'Limonero Fino 49' and 'Villafranca' all on *C. volkameriana* rootstock. This trial is hereafter known as 1995 Lemon Scion Trial.

The final lemon trial reported here is one planted in 1997. This trial compares 'Corpaci', 'Cavers Lisbon', 'Femminello Commune', 'Cook Eureka', 'Primofiori', 'Cascade Eureka', 'Allen Eureka', 'Femminello Santa Teresa', 'Villafranca', 'Limonero Fino 49', and 'Limoneira 8A Lisbon' all on *C. volkameriana* rootstock. This trial is hereafter known as 1997 Lemon Scion Trial.

2000-01 was the fourth year that we were able to get data from the navel orange trial. This trial, established in 1995, contains 'Lane Late', 'Atwood', 'Fisher', 'Parent Washington', and 'Tulegold' navel orange cultivars on 'Carrizo' rootstock.

2000-01 was the third year that we were able to collect data on a 'Valencia' orange trial. This trial, established in 1996 contains 'Olinda', 'Delta' and 'Midknight Valencia' oranges on 'Carrizo citrange', 'C-35' Citrange' or *C. volkameriana* rootstock.

Finally, 2000-01 was the second harvest year for our trial of 'Fallglo' mandarin, an early ripening recent release out of the University of Florida.

## Materials and Methods

*1993 Lemon Rootstock and 1993 Lemon Scion Trials.* These trials were 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, and 12 replicates of each of the 4 scions were planted, for a total of 98 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 scion or rootstock on fruit quality (data not shown).

*1995 'Limoneira 8A' Rootstock Trial*. This trial was established in June 1995 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. There are five complete blocks containing each of the six rootstocks, additionally, there are four blocks that lack the 'African' Shaddock x 'Rubidoux' trifoliate orange, and the 'Yuma' Citrange. Yields are expressed as lb. fruit per tree. Yield, packout and fruit quality data are collected as described above for the 1993 lemon trials.

*1995 'Limonero Fino 49' Rootstock Trial*. This trial was established in June 1995 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. There are ten complete blocks containing each of the nine rootstocks. Yields are expressed as lb. fruit per tree. Yield, packout and fruit quality data are collected as described above for the 1993 lemon trials.

*1995 Lemon Scion Trial*. This trial was established in March 1995 in Block 17 (Foundation Block) 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. Three to five trees of each scion were planted. Yields are expressed as lb. fruit per tree. Yield, packout and fruit quality data are collected as described above for the 1993 lemon trials.

*1997 Lemon Scion Trial.* This trial was established in March 1997 in Block 22 of the Yuma Mesa Agricultural Center, near Yuma, Arizona. The land was laser leveled and fumigated prior to planting. Trees were planted on an 8-m x 8-m spacing. Fifteen trees of each scion were planted. Yields are expressed as lb. fruit per tree. Yield, packout and fruit quality data are collected as described above for the 1993 lemon trials.

*1995 Navel Orange Trial*. This trial was established in March 1995 in Block 18 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. Twelve trees of each of five scions were planted, for a total of 60 trees. Yields are expressed as lbs. fruit per tree. Yield, packout and fruit quality data are collected as described above for the 1993 lemon trials. Granulation values are determined by visual inspection of fruit cut longitudinally and calculated as the average of a 15 or 25 fruit sample.

*1996 Valencia Orange Trial*. This trial was established in June 1996 in Blocks 18 and 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. There are ten complete blocks of each of the nine scion-rootstock combinations possible. Yields are expressed as lbs. fruit per tree.

*Fallglo Mandarin Trial*. This trial was established in June 1995 in Block 26 of the Yuma Mesa Agricultural Center, near Yuma, AZ. The land was laser leveled and fumigated prior to planting. Trees were planted on a 10-m x 10-m spacing. There are nine blocks of up to of the eleven scion-rootstock combinations. Not all scion rootstock combinations are bearing fruit yet, and some of the combinations have died. Yield, packout and fruit quality data are collected as described above for the 1993 lemon trials. Fruit quality measurements were taken on a 15 fruit sample per tree. Not all combinations had sufficient fruit for analysis.

All data was analyzed using SPSS 7.0 for Windows (SPSS Inc., Chicago, Illinois).

## Results and Discussion

*1993 Lemon Rootstock Trial*. Yield of trees on the five rootstocks was quite limited during the 1994-95 season. Nonetheless, significant yield differences appeared (Table 1), and trees on *C. volkameriana* rootstock had four to twelve times the yield of any other scion rootstock combination. From 1995-96 through 1997-98, both *C. macrophylla* and *C. volkameriana* gave the best yield (three to five times more than 'Carrizo' or 'Swingle'). It is

notable that 1996-97 was the first year that trees on *C. macrophylla* had more yield than those trees of *C. volkameriana*, although the difference was not significant. . This trend continued in 1997-98 and again in 1998-99, when trees on *C. macrophylla* had 22% and 16% more yield than trees on *C. volkameriana*. Trees on Rough lemon produced intermediate yields, while those on 'Carrizo' and 'Swingle' produced the least. This is due to the reduced vigor of these two rootstocks.

Yields in 1999-2000 were from 35% to 65% less than the previous year, regardless of rootstock. Nonetheless, many of the trends from previous years continued. For 1999-2000, trees on *C. macrophylla* had about 35% more total yield than those on *C. volkameriana*, and about 45% more yield than those trees on Rough lemon (Table 2). These differences were statistically significant. This continues the trend first noted in 1996-97. All three rootstocks led to about 30% of the fruit being harvested early in the first pick. Yield of trees on 'Swingle' and 'Carrizo' were much less than the other thee; yields were only 12% to 18% of that of the more vigorous rootstocks.

Total yields in 2000-01 were about 50 to 300 % greater than the previous year, but the general trends of the previous year remained unchanged (Table 3). For 2000-01, trees on *C. macrophylla* had the greatest yield for the first harvest, about 30% more than trees on *C. volkameriana*, and about 55% greater than trees on rough lemon. Rough lemon and *C. volkameriana* had the greatest yields for the second pick, while *C. macrophylla* lagged. Thus, the overall yield for these three rootstocks was statistically the same. This is the first time since the 1996-97 season that yields for these trees have been statistically the same. Yields for trees on Carrizo and Swingle were typically lower than yields for the other three rootstocks tested.

Annual yields for the five rootstocks tested can be seen graphically in Figure 1.

Packout for the 2000-01 harvest season is shown in Figure 2. Trees on all five rootstocks had fruit that peaked on size 140. However, *C. macrophylla* trees had somewhat more 95 and 115 size fruit than did the others tested, while Carrizo and Swingle trees had more size 200 and 235 size fruit. There was no effect of rootstocks on fruit grade (data not shown).

*1993 Lemon Scion Trial.* There were no yield differences among the scions tested during the 1994-95-harvest season (Table 4). Yields across the entire experiment in 1995-96 were light, but 'Limoneira 8A Lisbon' trees had 2 to 2.5 times the yield of the other scion cultivars. This same trend was repeated in 1996-97. For 1997-98, the yield of 'Limoneira 8A' was 2 to 3.7 times higher than the other cultivars tested. For the first time in 1998-99, 'Corona Foothills Lisbon' was the second best cultivar; following 'Limoneira

For the 1999-2000 harvest, 'Corona Foothills Lisbon' had the most fruit harvested in the first ring pick harvest, about 24% more than 'Limoneira 8A Lisbon' (Table 5). 'Prior and 'Frost Nucellar' lagged behind for the first pick. For the second pick, the yield of 'Limoneira 8A' was 35% to 50% more that of any other of the scions tested. For the third pick, 'Corona Foothills' had the greatest yield, although not significantly greater than the others. There was no significant difference between the scions in the total yield, or in the percent of fruit harvested in the first pick (data not shown). 1999-2000 was the second year that 'Corona Foothills', or any other scion, has performed as well as 'Limoneira 8A.

For the 2000-01 harvest year, total yields were 2 to 2.5 times those of 1999-2000 (Table 6). 'Limoneira 8A' trees reclaimed the top yielding spot for the first harvest, while 'Frost Nucellar' lagged. For the second harvest, there was no significant difference between the scions tested, nor were there any significant differences in total yield.

Annual yields for the four scions tested can be seen graphically in Figure 3.

Packout for the 2000-01 harvest season is shown in Figure 4. Trees on all four scions had fruit that peaked on size 140. However, 'Corona Foothills' and 'Prior' trees had somewhat more 95 and 115 size fruit than did the others tested, while 'Frost Nucellar' and 'Limoneira 8A' trees had more size 200 and 235 size fruit. There was no effect of scions on fruit grade (data not shown).

*1995 'Limoneira 8A' Rootstock Trial*. First through third year yields of 'Limoneira 8A Lisbon' on the five rootstock cultivars are shown in Table 7. For 1998-99 and 1999-2000, yields of trees on *C. volkameriana* were 2 ½

to 9 times greater than yields on any of the other rootstocks. For 2000-01, there was no significant difference among the rootstocks for the first harvest, but the trees on *C. volkameriana* had significantly greater yields than the others tested for the second harvest, which led to significant differences for the total 2000-01 yield.

*1995 Limonero Fino 49' Rootstock Trial*. First through year yields of 'Limonero Fino 49' scions on the nine rootstock cultivars are shown in Table 8. For 1998-99, yields of trees on *C. macrophylla* were 2 ½ to 8 times greater than yields on any of the other rootstocks. However, for 1999-2000, trees on *C. volkameriana* and 'Citremon 1449' rootstock were statistically the equal of *C. macrophylla*. For 2000-01, C. macrophylla regained its prominence with yields 2 to 8 times the yield of the other rootstocks tested.

*1995 Lemon Scion Trial*. Yields of the ten cultivars tested are shown in Tables 9 and 10. Cultivars are grouped according to type. 'Eureka' lemons are shown in normal font, 'Lisbons' in bold font, and other types in Italics. For 1997-98, all the 'Eureka' lemons had significantly less yield than the 'Lisbon' and other lemons, except the 'Frost Nucellar'. 'Villafranca', 'Rosenberger Lisbon' and 'Cavers Lisbon' had the highest yields for the first harvest, while 'Rosenberger' had the best yield for the second harvest. 'Limonero Fino 49', 'Villafranca' and 'Cavers' had the greatest percentage of fruit harvested early. For 1998-99, 'Cascade' and 'Cook Eureka' again performed poorly, while the 'Allen Eureka' was much improved over the previous year, with a yield surpassing all the 'Lisbon' lemons except 'Cavers'. Like the previous year, 'Cavers Lisbon', 'Limonero Fino 49' and 'Villafranca' were impressive, because of the large overall yield and the large percentage of their fruit harvested early. For 1999-2000, the 'Eureka' lemons again performed poorly. Also, the 'Limoneira 8A' and 'Rosenberger' Lisbon lemons performed poorly. For the third year in a row, the 'Cavers Lisbon' the 'Limonero Fino 49' and the 'Villafranca' performed the best, with yields similar to that of the previous years. For 2000-01, 'Cavers', and 'Limonero Fino 49' performed the best, followed by 'Rosenberger' and 'Frost Nucellar Lisbon'. Again, the Eurekas yielded less. 'Cavers', 'Limonero Fino 49' and 'Villafranca' had the greatest percentage of early fruit.

2000-01 packout for these ten cultivars is shown in Table 11. 'Cascade Eureka' had the greatest percentage of fruit of size 95, while 'Limonero Fino 49' had the greatest percentage of 115's and 140's.

*1997 Lemon Scion Trial*. First year yields for this trial are found in Table 12. 'Limoneira 8A' had significantly more fruit than any of the other scions tested for the 2000-01 harvest season. We also measured fruit length to width ratio. Round fruit have ratios closer to 1.0. 'Corpaci' appears to be a round fruit, while 'Cascade Eureka' is the most elongated.

*Fallglo Mandarin Trial.* 'Fallglo' trees on *C. volkameriana* had the greatest yield in 1999-2000, although high tree variability insured that there ware no significant differences among any of the rootstocks (Table 13). For 2000-01, trees on *C. volkameriana* rootstock had significantly greater yield than trees on any of the other rootstocks tested.

*1995 Navel Orange Trial*. Yields of the five orange cultivars are shown in table 14. In both 1997-98 and 1998-99, 'Tulegold' had significantly higher yield per tree than did the other trees, but in 1999-2000, 'Fisher' navels had the highest yield, with 'Parent Washington' and 'Tulegold' with significantly less. 'Lane Late' and 'Atwood' cultivars trailed the others. The early cultivar 'Fisher' had much higher granulation content than the other cultivars, although if the fruit from this had been harvested earlier, it is possible that this granulation would have been less. For 2000-01, 'Fisher' had significantly greater yield, but also the highest level of granulation. 'Tulegold' and 'Lane Late' had similar yields, about 50% of that of 'Fisher' but almost no granulation. These cultivars also had the greatest juice content, and the highest TSS:TA ratio (Table 15)

*1996 Valencia Orange Trial*. In 1998-99, 1999-2000 and 2000-01 there was no significant effect of either rootstock or scion upon yields of 'Valencia' oranges (Table 16), due to high tree variability.

## Conclusions

It is still apparent that 'Carrizo' and 'Swingle' are unsuitable as rootstocks for lemon in Arizona. Reduced vigor, late fruit sizing and ultimate small fruit size are characteristics that cannot be overcome. Differences between *C. volkameriana* and *C. macrophylla* which were becoming clear; were muddied in 2000-01. These two rootstocks, as well as rough lemon performed well in 2000-01. Whether this represents a long-term phenomenon is still in question It remains to be seen if yield or fruit size will decrease, especially for *C. macrophylla*, as has occurred on older groves in Arizona.

For the scions, both 'Limoneira 8A' and 'Corona Foothills' appear to be superior to the others at this point. 'Limoneira 8A' has been consistent for the last six years. Whether it will remain superior will not be known for several years. 'Corona Foothills' has equaled 'Limoneira' for the second year in a row. 'Prior also performed well for the first time. 'Frost Nucellar Lisbon' continues to be only average.

Growers and researchers should continue to watch other lemon cultivars that appear promising for Arizona. These include 'Villafranca' lemon 'Cavers Lisbon' lemon, and 'Limonero Fino 49' lemon. Finally, growers should continue to watch the results of our orange and mandarin trials.

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Table 1. 1994-98 yields of 'Limoneira 8A Lisbon' lemon trees on five different rootstocks.

| Rootstock[z] | Yield per tree (lb.). 1994-95 | 1995-96 | 1996-97 | 1997-98 | 1998-99 |
|---|---|---|---|---|---|
| 'Carrizo' Citrange | 0.33 b[y] | 10.16 c | 11.80 c | 23.61 c | 71.51 c |
| *C. macrophylla* | 0.11 b | 29.70 a | 58.25 a | 103.47 a | 415.20 a |
| Rough Lemon | 0.13 b | 19.60 b | 40.52 b | 53.54 b | 323.58 b |
| 'Swingle' Citrumelo | 0.15 b | 11.66 c | 11.13 c | 37.96 bc | 105.81 c |
| *C. volkameriana* | 1.28 a | 36.20 a | 57.71 a | 84.62 a | 356.51 b |

[z] Values are the means of 10 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 2. 1999-2000 yields and percentage of fruit harvested early of 'Limoneira 8A Lisbon' lemon trees on five different rootstocks.

| Rootstock[z] | Yield per tree (lb.). 9-22-99 | 11-18-99 | 2-3-00 | Total Yield | Pct. Fruit Harvested Early[x] |
|---|---|---|---|---|---|
| 'Carrizo' Citrange | 3.4 c | 17.7 c | 8.4 c | 29.4 c | 10.9 b |
| *C. macrophylla* | 73.5 a | 164.5 a | 35.2 a | 273.2 a | 26.5 a |
| Rough Lemon | 53.6 b | 107 5 b | 26.2 ab | 187.3 b | 31.3 a |
| 'Swingle' Citrumelo | 3.8 c | 16.5 c | 14.3 c | 34.5 c | 9.2 b |
| *C. volkameriana* | 64.5 ab | 120.8 b | 16.0 bc | 201.4 b | 32.3 a |

[z] Values are the means of 10 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.
[X] Fruit harvested on 9/22/99 as a percentage of the total fruit harvested during the season.

Table 3. 2000-01 yields and percentage of fruit harvested early of 'Limoneira 8A Lisbon' lemon trees on five different rootstocks.

| Rootstock[z] | Yield per tree (lb.). 9-28-00 | 12-4-00 | Total Yield | Pct. Fruit Harvested Early[x] |
|---|---|---|---|---|
| 'Carrizo' Citrange | 35.4 c | 96.5 c | 131.9 b | 25.1 c |
| *C. macrophylla* | 254.9 a | 179.3 b | 434.2 a | 60.1 a |
| Rough Lemon | 164.5 b | 255.4 a | 419.9 a | 38.9 bc |
| 'Swingle' Citrumelo | 32.3 c | 75.0 c | 107.3 b | 30.1 c |
| *C. volkameriana* | 197.2 b | 198.3 ab | 395.5 a | 47.7 ab |

[z] Values are the means of 10 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.
[X] Fruit harvested on 9/28/00 as a percentage of the total fruit harvested during the season.

Figure 1. Effect of Rootstock on Yield of 'Limoneira 8A Lisbon' Lemon.

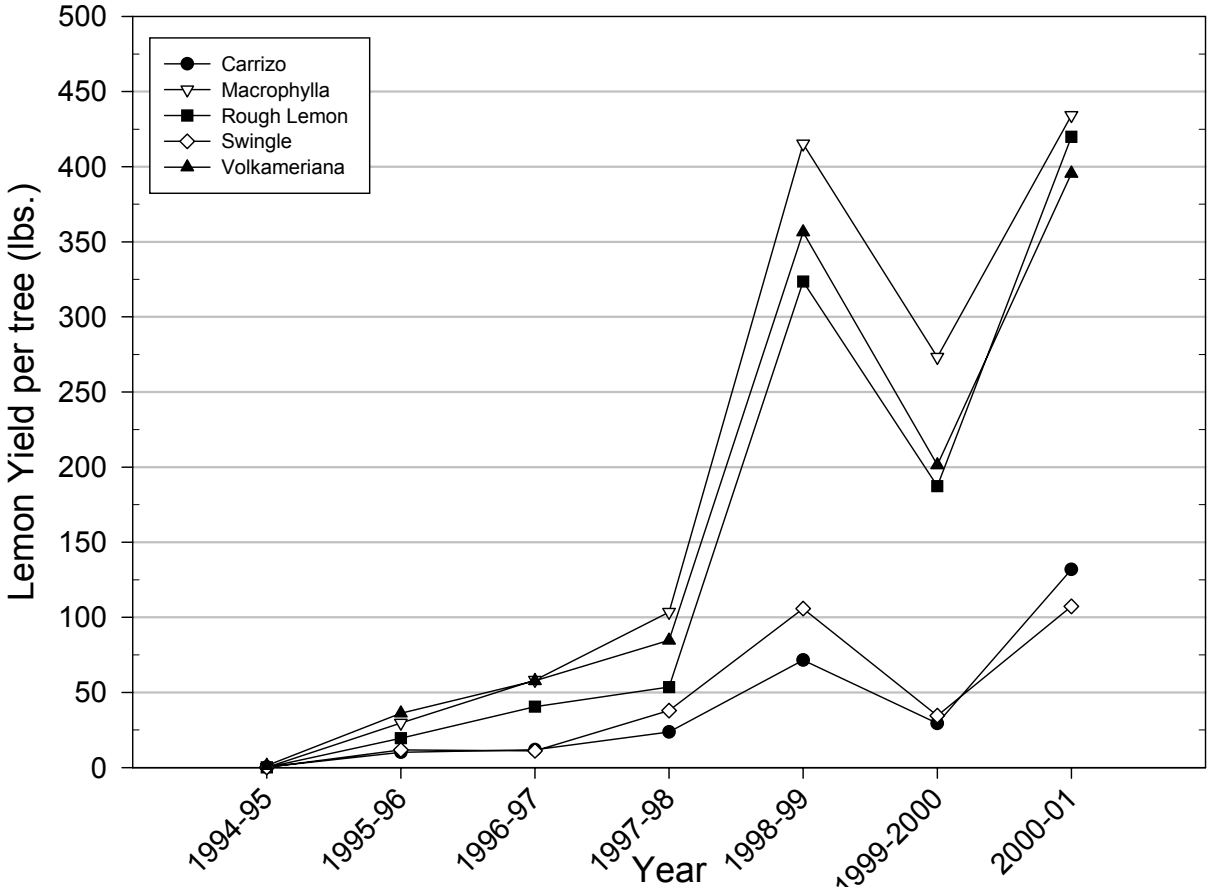

**Figure 2. Effect of rootstock on packout of 'Limoneira 8A Lisbon' lemons.**

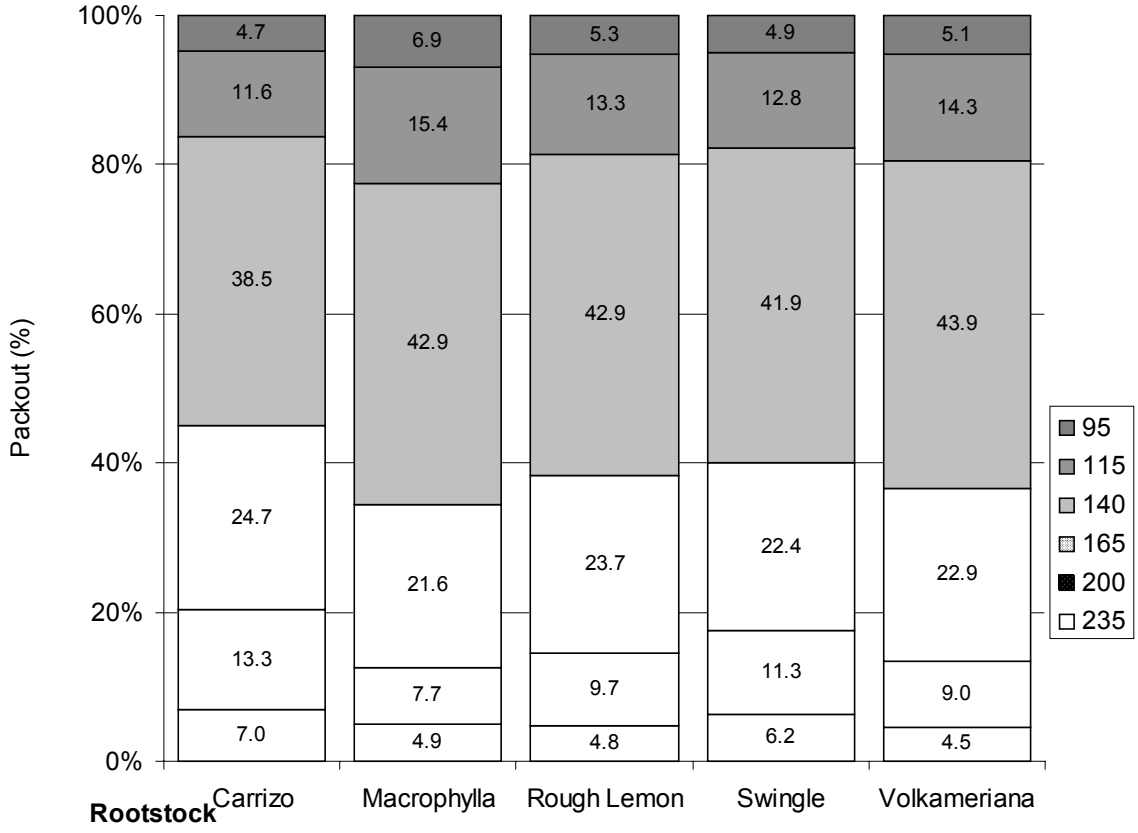

Table 4. 1994-98 yields of four 'Lisbon' lemon cultivars budded to *C. volkameriana* rootstock.

| | Yield per tree (lb.). | | | | |
|---|---|---|---|---|---|
| Scion[z] | 1994-95 | 1995-96 | 1996-97 | 1997-98 | 1998-99 |
| 'Corona Foothills Lisbon' | 0.13 a[y] | 4.98 b | 11.33 b | 18.43 b | 281.13 b |
| 'Frost Nucellar Lisbon' | 0.07 a | 3.97 b | 14.48 b | 26.61 b | 204.96 c |
| 'Limoneira 8A Lisbon' | 0.13 a | 10.56 a | 27.71 a | 69.07 a | 343.34 a |
| 'Prior Lisbon' | 0.00 a | 3.90 b | 15.19 b | 34.92 b | 202.10 c |

[z] Values are the means of 12 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 5. 1999-2000 yields of four 'Lisbon' lemon cultivars budded to *C. volkameriana* rootstock.

| | Yield per tree (lb.). | | | |
|---|---|---|---|---|
| Scion[z] | 9/22/99 | 11/18/99 | 2/3/00 | Total Yield |
| 'Corona Foothills Lisbon' | 65.26 a | 76.94 ab | 45.19 a | 187.39 a |
| 'Frost Nucellar Lisbon' | 44.31 b | 68.78 ab | 37.70 ab | 150.79 a |
| 'Limoneira 8A Lisbon' | 52.47 ab | 105.38 a | 33.51 ab | 191.36 a |
| 'Prior Lisbon' | 50.71 b | 57.54 b | 26.23 b | 134.48 a |

[z] Values are the means of 12 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 6. 2000-2001 yields of four 'Lisbon' lemon cultivars budded to *C. volkameriana* rootstock.

| | Yield per tree (lb.). | | |
|---|---|---|---|
| Scion[z] | 9/28/00 | 12/4/00 | Total Yield |
| 'Corona Foothills Lisbon' | 140.21 ab | 228.18 a | 368.39 a |
| 'Frost Nucellar Lisbon' | 113.76 b | 174.38 a | 288.14 a |
| 'Limoneira 8A Lisbon' | 174.60 a | 197.75 a | 372.36 a |
| 'Prior Lisbon' | 153.22 ab | 208.11 a | 361.33 a |

[z] Values are the means of 12 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Figure 3. Yield of four 'Lisbon' lemon scion cultivars on *C. volkameriana* rootstock.

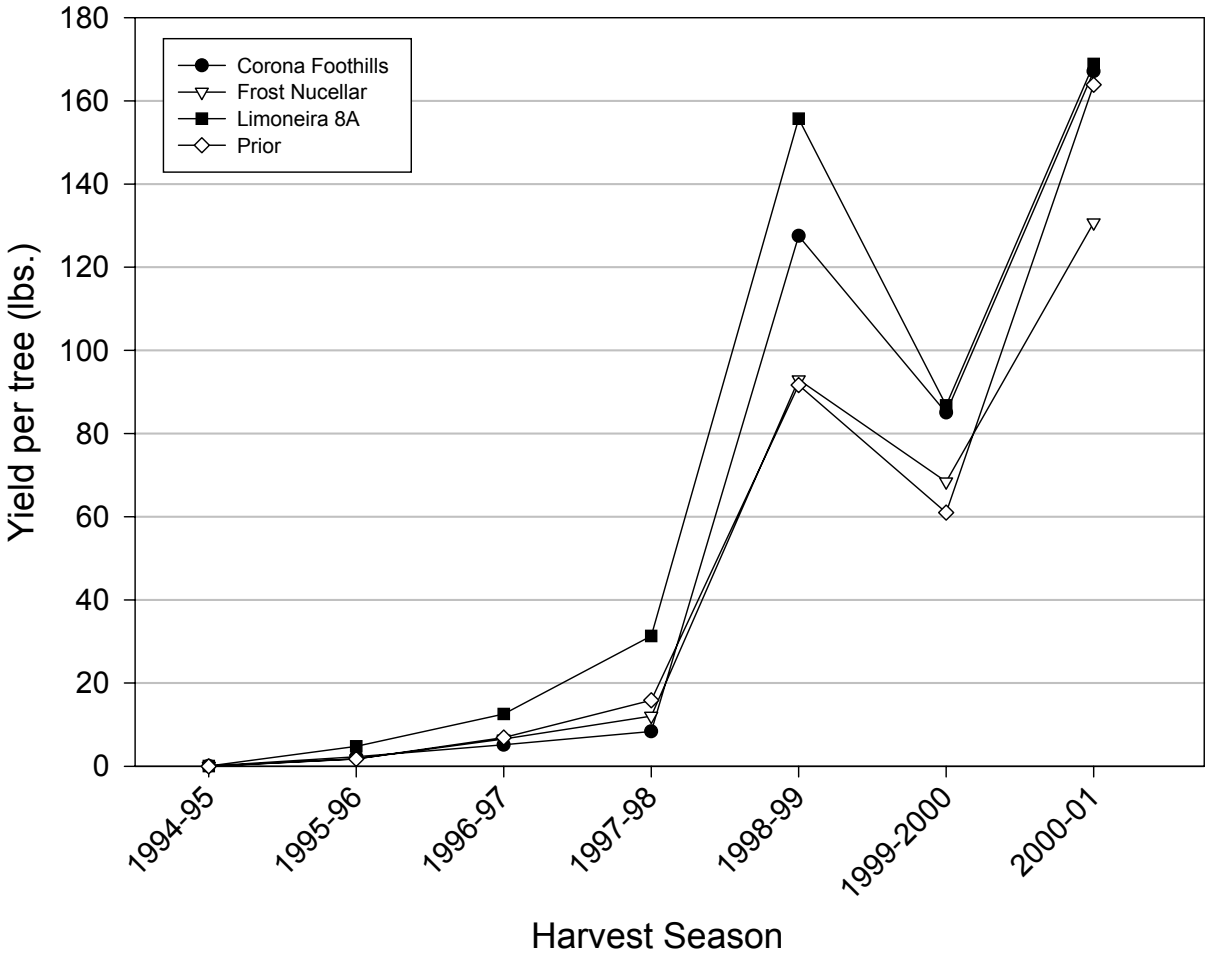

**Figure 4. Packout of four 'Lisbon' lemon cultivars on *C. volkameriana* rootstock.**

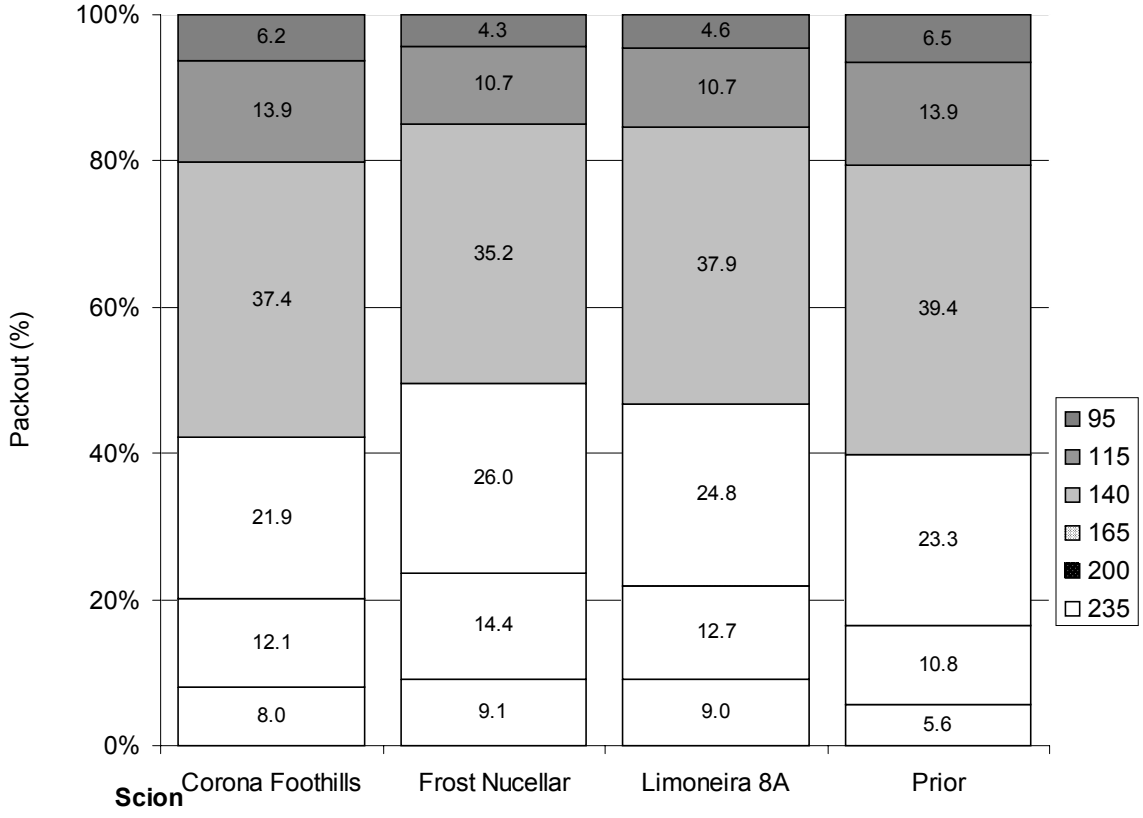

Table 7. Yields from 1998-2001 of 'Limoneira 8A Lisbon' lemon trees on six different rootstocks.

| Rootstock[z] | Yield per tree (lb.). Total 1998-99 Yield (lbs.) | Total 1999-2000 Yield (lbs) | 9/28/00 Yield (lbs.) | 12/4/00 Yield (lbs.) | Total 2000-01 Yield (lbs.) |
|---|---|---|---|---|---|
| *C. volkameriana* | 18.64 a | 121.01 a | 35.20 a | 108.12 a | 143.32 a |
| C-35 Citrange | 7.21 b | 49.15 b | 12.00 a | 56.42 b | 68.42 b |
| Citremon 1449 | 5.14 b | 47.13 b | 26.80 a | 56.81 b | 83.61 b |
| *C. taiwanica* | 4.69 b | 33.13 b | 10.29 a | 43.32 b | 53.61 b |
| African Shaddock x Rubidoux trifoliate. | 2.20 b | 23.38 b | 29.80 a | 28.62 b | 58.42 b |

[z] Values are the means of 9 to 15 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 8. Yields during 1998-2001 of 'Limonero Fino 49' lemon trees on nine different rootstocks.

| Rootstock[z] | Yield per tree (lb.). Total 1998-99 Yield (lbs. per tree) | Total 1999-2000 yield (lbs. per tree) | Total 2000-01 yields (lbs. per tree) |
|---|---|---|---|
| *C. macrophylla* | 21.46 a | 38.75 a | 102.8 a |
| C-35 citrange | 6.26 a | 12.43 bc | 31.2 b |
| Swingle Citrumelo | 8.70 a | 20.57 abc | 40.8 b |
| Carrizo Citrange | 8.49 a | 7.56 bc | 32.0 b |
| Citremon 1449 | 5.69 a | 23.74 abc | 52.8 b |
| *C. volkameriana* | 4.21 a | 28.79 ab | 50.9 b |
| Afr. Shaddock x Rubidoux trifoliate. | 5.65 a | 4.34 bc | 13.1 b |
| *C. taiwanica* | 3.51 a | 2.62 c | 26.4 b |
| Rough Lemon | 2.04 a | 3.44 c | 32.2 b |

[z] Values are the means of 9 to 15 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 9. 1997-1999 Yields and percentage of fruit harvested early of ten lemon cultivars budded to *C. volkameriana* rootstock.

| Scion[z] | 1997-98 | | 1998-99 | |
|---|---|---|---|---|
| | Total Yield (lb.) | Pct. Fruit Harvested Early[y] | Total Yield (lb.) | Pct. Fruit Harvested Early[y] |
| Allen Eureka | 39.7 c[x] | 56.7 cd | 164.5 cd | 41.5 e |
| Cascade Eureka | 44.5 c | 57.4 cd | 93.5 f | 67.0 d |
| Cook Eureka | 41.4 c | 49.5 d | 129.2 def | 42.7 e |
| **Cavers Lisbon** | **101.9 a** | **71.5 ab** | **272.3 a** | **86.8 ab** |
| **Frost Nucellar Lisbon** | **57.1 bc** | **62.4 bc** | **123.9 def** | **85.1 abc** |
| **Limoneira 8A Lisbon** | **95.0 ab** | **63.0 bc** | **152.3 def** | **71.4 cd** |
| **Prior Lisbon** | **95.7 ab** | **66.2 bc** | **104.9 ef** | **82.3 abcd** |
| **Rosenberger Lisbon** | **121.9 a** | **57.5 cd** | **132.5 def** | **67.7 d** |
| *Limonero Fino 49* | *94.4 ab* | *79.7 a* | *233.9 ab* | *92.9 a* |
| *Villafranca* | *124.3 a* | *71.1 ab* | *199.7 bc* | *75.7 bcd* |

[z] Values are the means of 3 to 5 trees.
[y] Fruit harvested on the first harvest date as a percentage of the entire annual yield.
[x] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 10. 1999-2001 Yields and percentage of fruit harvested early of ten lemon cultivars budded to *C. volkameriana* rootstock.

| Scion[z] | 1999-2000 | | 2000-01 | |
|---|---|---|---|---|
| | Total Yield (lb.) | Pct. Fruit Harvested Early[y] | Total Yield (lb.) | Pct. Fruit Harvested Early[y] |
| Allen Eureka | 142.4 bc[x] | 62.0 a | 210.1 cd | 42.9 bc |
| Cascade Eureka | 143.3 bc | 61.7 a | 303.8 bcd | --- |
| Cook Eureka | 103.8 cd | 60.4 a | 177.0 d | 38.9 bcd |
| **Cavers Lisbon** | **279.1 a** | **59.8 a** | **454.4 a** | **62.2 a** |
| **Frost Nucellar Lisbon** | **203.0 ab** | **52.0 a** | **349.0 abc** | **52.2 ab** |
| **Limoneira 8A Lisbon** | **101.0 cd** | **78.2 a** | **304.5 bcd** | **23.0 de** |
| **Prior Lisbon** | **188.5 b** | **60.0 a** | **326.9 abc** | **32.9 cd** |
| **Rosenberger Lisbon** | **45.0 d** | **66.5 a** | **360.2 ab** | **15.1 e** |
| *Limonero Fino 49* | *226.2 ab* | *51.0 a* | *434.3 ab* | *62.6 a* |
| *Villafranca* | *220.2 ab* | *57.7 a* | *313.7 bcd* | *61.8 a* |

[z] Values are the means of 3 to 5 trees.
[y] Fruit harvested on the first harvest date as a percentage of the entire annual yield.
[x] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 11. 2000-2001 Packout of ten lemon cultivars budded to *C. volkameriana* rootstock.

| Scion[z] | Packout (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 75 | 95 | 115 | 140 | 165 | 200 | 235 |
| Allen Eureka | 0.5 d | 2.6 b | 15.8 b | 22.2 abc | 34.5 bc | 12.4 d | 7.4 bcde | 4.8 bcd |
| Cascade Eureka | 5.1 a | 7.8 a | 24.6 a | 19.2 bc | 23.8 d | 9.1 d | 5.1 cde | 5.4 bc |
| Cook Eureka | 0.8 cd | 1.7 bcd | 15.7 b | 19.6 bc | 32.7 c | 13.4 cd | 9.0 bc | 7.0 b |
| Cavers Lisbon | 1.5 cd | 2.2 bc | 16.0 b | 24.3 ab | 38.4 ab | 12.2 d | 3.6 de | 1.9 de |
| Frost Nucellar Lisbon | 2.0 bcd | 0.9 bcd | 10.8 b | 18.7 c | 39.8 ab | 17.7 bc | 7.6 bcd | 2.6 cde |
| Limoneira 8A Lisbon | 1.6 cd | 0.6 cd | 8.6 bc | 16.7 c | 38.1 ab | 18.8 b | 10.4 b | 5.2 bc |
| Prior Lisbon | 2.5 bc | 1.1 bcd | 11.8 b | 20.6 abc | 38.0 ab | 17.5 bc | 6.4 bcde | 2.2 de |
| Rosenberger Lisbon | 3.3 b | 0.3 d | 3.0 c | 7.7 d | 31.5 c | 23.8 a | 17.3 a | 13.2 a |
| Limonero Fino 49 | 1.4 cd | 1.4 bcd | 15.8 b | 25.6 a | 40.5 a | 10.9 d | 3.1 e | 1.5 e |
| Villafranca | 1.6 cd | 1.0 bcd | 11.9 b | 19.7 bc | 38.2 ab | 18.1 bc | 6.6 bcde | 3.1 cde |

[z] Values are the means of 3 to 5 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 12. 2000-2001 Yields and fruit shape of eleven lemon cultivars budded to *C. volkameriana* rootstock.

| Scion[z] | Total Yield (lb.) | Fruit shape Width to Length ratio |
|---|---|---|
| Corpaci | 9.5 b[y] | 0.865 a |
| Cavers Lisbon | 9.7 b | 0.847 abc |
| Femminello Commune | 14.6 b | 0.815 bcd |
| Cook Eureka | 15.4 b | 0.817 bcd |
| Primofiori | 16.5 b | 0.810 cd |
| Cascade Eureka | 17.9 b | 0.793 d |
| Allen Eureka | 18.7 b | 0.820 bcd |
| Femminello Sta. Teresa | 20.9 b | 0.810 cd |
| Villafranca | 22.3 b | 0.857 ab |
| Limonero Fino 49 | 26.5 b | 0.813 cd |
| Limoneira 8A Lisbon | 56.9 a | 0.810 cd |

[z] Values are the means of 15 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 13. 1999 and 2000 Yield of Fallglo mandarin trees on eleven different rootstocks.

| Rootstock[z] | 1999 Yield per tree (lb.) | 2000 Yield per tree (lb.) |
|---|---|---|
| *C. volkameriana* | 9.6 a[y] | 14.6 a |
| Rough Lemon | 8.6 a | 8.2 ab |
| Soh Jalia Lemon | 7.1 a | 13.5 a |
| Citremon 1449 | 6.6 a | 4.3 b |
| Sunki Mandarin x Flying Dragon Trifoliate Orange | 6.0 a | 4.6 b |
| 'Carrizo' Citrange | 4.0 a | 10.1 ab |
| Taiwanica Orange | 1.7 a | 4.0 b |
| C-35 Citrange | 0.4 a | 3.2 b |
| African Shaddock x Rubidoux Trifoliate Orange | 0.2 a | 3.4 b |
| Gou Tou Orange | 0.0 a | 5.3 b |

[z] Values are the means of 2 to 11 trees, harvested on 11-11-99 and 11-15-00.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 14. Yields and granulation of five navel orange cultivars budded to Carrizo rootstock.

| Scion[z] | 1998-99 Yield per tree (lb.). 02/15/99 | 1999-2000 Yield per tree (lb.). 12/17/99 | 1999-2000 Weight per fruit (lb.) | 1999-2000 Granulation[y] (%) | 2000-01 Yield per tree (lb.). 2/19/01 | 2000-01 Weight per fruit (lb.) | 2000-01 Granulation[y] (%) |
|---|---|---|---|---|---|---|---|
| Lane Late | 12.44 b | 12.03 c | 0.65 ab | 2.30 c | 47.08 b | 0.76 a | 4.4 c |
| Atwood | 7.09 b | 12.65 c | 0.64 ab | 3.09 c | 33.22 b | 0.70 a | 12.4 bc |
| Fisher | 9.33 b | 35.09 a | 0.70 a | 30.92 a | 98.67 a | 0.71 a | 27.3 a |
| Parent Washington | 8.39 b | 28.32 b | 0.62 b | 5.16 bc | 37.76 b | 0.73 a | 15 0 b |
| Tulegold | 32.78 a | 24.48 b | 0.69 a | 9.31 b | 45.49 b | 0.60 b | 5.2 c |

[z] Yield values are the means of 12 trees.
[y] Granulation values are the means of 25 fruit per tree in 1998-99 and 15 fruit per tree in the 1999-2000 and 2000-01 seasons.
[x] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 15. 2000-01 Fruit Quality of five navel orange cultivars budded to Carrizo rootstock.

| Scion[z] | Percent Juice | TSS (%) | TA (%) | TSS:TA | Peel Thickness (mm) |
|---|---|---|---|---|---|
| Lane Late | 41.42 a | 12.01 a | 0.46 c | 24.71 a | 6.42 b |
| Atwood | 35.04 b | 10.62 b | 0.53 a | 19.80 c | 6.83 ab |
| Fisher | 31.24 c | 11.57 a | 0.47 bc | 25.68 a | 6.78 b |
| Parent Washington | 34.88 b | 11.34 a | 0.50 b | 22.76 b | 7.37 a |
| Tulegold | 41.37 a | 11.36 a | 0.45 c | 25.17 a | 4.83 c |

[x] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 16. Yields of three 'Valencia' orange cultivars budded to C-35, Carrizo and *C. volkameriana* rootstock.

| Scion or rootstock[z] | 1998-99<br>Yield per tree (lb.).<br>26 March 1999 | 1999-2000<br>Yield per tree (lb.).<br>6 March 2000 | 2000-01<br>Yield per tree (lb.).<br>20 March 2001 |
|---|---|---|---|
| 'Delta' | 0.27 a[y] | 4.65 a | 7.05 a |
| 'Midknight' | 0.23 a | 3.80 a | 1.91 a |
| 'Olinda' | 0.42 a | 2.56 a | 3.94 a |
| | --- | --- | --- |
| *C. volkameriana* | 0.07 a | 4.10 a | 2.60 a |
| C-35 | 0.27 a | 4.56 a | 2.91 a |
| Carrizo | 0.58 a | 3.01 a | 7.39 a |

[z] Yield values are the means of 30 trees.

[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.