Results of Scion and Rootstock Trials for Citrus in Arizona - 1999[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. 1999-2000 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. In a similar trial, Four 'Lisbon' lemon selections, 'Frost Nucellar', 'Corona Foothills', 'Limoneira 8A' and 'Prior' were selected for evaluation on Citrus volkameriana rootstock. 1998-99 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 two other lemon scion trials, a navel orange cultivar trial and a 'Valencia' orange trial, and a 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 is 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 trials includes tree growth, mineral nutrition, fruit quality, fruit size and total yield. Previous results from this trial

[1] The authors wish to thank the Arizona Citrus Research Council for supporting this research. This is a final report for project 99-07 – Citrus rootstock and cultivar breeding and evaluation for the Arizona citrus industry – 1999.

This is a part of publication az1178: "2000 Citrus and Deciduous Fruit and Nut Research Report," College of Agriculture and Life Sciences, the University of Arizona, Tucson, Arizona, 85721.

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.

1999 was the third 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.

1999-2000 was the second 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, 1999-2000 was the first 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. Fruit diameter data was collected semiweekly in 1999. One fruit of a representative size per tree was tagged, and was measured until harvest. Replacement fruits of approximately the same size were selected if a fruit was harvested or if it abscised. Yield data is collected during the fall and winter. Trees were ring or strip-picked as noted below. About 30 lbs of fruit is sampled from each tree, and fruit packout data is collected from the sample. For years prior to 1999-2000, fruits were sized by hand and graded by observation, and reported on a percentage basis. For 1999-2000, the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit. 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. These trials were 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 data is collected during the fall and winter. Trees were ring or strip-picked as noted below. For 1999-2000, the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit.

1995 'Limonero Fino 49' Rootstock Trial. These trials were 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 data is collected during the fall and winter. Trees were ring or strip-picked as noted below. For 1999-2000, the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit.

1995 Lemon Scion Trial. These trials were 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 data is collected during the fall and winter. Trees were ring or strip-picked as noted below. For 1999-2000, the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit.

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 data is collected during the fall and winter. For 1999-2000, the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit.

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. Yield data was first collected during 1998-99. For 1999-2000, the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit. Granulation values are determined by visual inspection of fruit cut longitudinally and calculated as the average of a 15 or 25 fruit sample.

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. Yields are expressed as lbs. fruit per tree. Yield data was first collected in November 1999. Each the fruit was passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit. 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 6.0 for Windows (SPSS Inc., Chicago, Illinois).

Results and Discussion

1993 Lemon Rootstock Trial. Fruit diameter increase from late May 1999 until September 1999 is shown in Figure 1. During 1999, fruit diameter of trees on *Rough lemon* was usually larger than any other scion-rootstock

combination. Fruit diameter of trees on *C. volkameriana, C. macrophylla* and 'Swingle' was slightly less, beginning in middle June, a time that was notable for high temperatures. There was no significant difference in fruit size between any of the four rootstocks mentioned. Trees on 'Carrizo' rootstock had the significantly smaller fruit than the others, and the smallest fruit diameter throughout the season.

Yield of trees on the five rootstocks was quite limited during the 1994-95 season. Nonetheless, significant yield differences appeared (Table 1), where 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 1997-98 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 1998-99, when trees on *C. macrophylla* had 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). This continues the trend first noted in 1997-98. 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. Neither 'Swingle' nor 'Carrizo' is suitable as a rootstock for lemons on the Yuma Mesa.

There was no effect of rootstocks on fruit grade (Table 3). Trees on *C. volkameriana,* and *C. macrophylla* had the greatest numbers of fruit of size 75 or more. Fruit size of trees on 'Swingle' and 'Carrizo' was smaller, while that of trees on Rough lemon was intermediate.

1993 Lemon Scion Trial. For 1999, fruit of the 'Frost Nucellar Lisbon trees were smaller than the others (Figure 2). This contrasts with 1998-99 when fruit of 'Corona Foothills Lisbon' and 'Prior Lisbon' were larger than fruit on the other two scions tested, and with 1997-98 when fruit of 'Prior Lisbon' was smaller than the fruit of the other three scions beginning in July.

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 8A' 'Frost Nucellar' in particular has performed poorly as far as early fruit sizing. This is surprising because this cultivar was originally planted in Arizona because of its early sizing capabilities.

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 scions tested, there was no effect of scion on fruit grade or quality (Data not shown).

1995 'Limoneira 8A' Rootstock Trial. Second year yields of 'Limoneira 8A Lisbon' on the six rootstock cultivars are shown in Table 6. Yields of trees on *C. volkameriana* were 2 ½ to 6 times greater than yields on any of the other rootstocks. Trees on the 'African' Shaddock x Rubidoux trifoliate hybrid rootstock and the 'C-35' citrange had the smallest percentage of early fruit. These results are similar to those of last year.

1995 Lemon Scion Trial. Yields of the ten cultivars tested are shown in Table 7. 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.

1995 Limonero Fino 49' Rootstock Trial. Second year yields of 'Limonero Fino 49' scions on the nine rootstock cultivars are shown in Table 8. Unlike 1998-99, when yields of trees on *C. macrophylla* were 2 ½ to 8 times greater than yields on any of the other rootstocks, trees on *C. volkameriana* and 'Citremon 1449' rootstock were statistically the equal of *C. macrophylla*. Since the trees are so young, it is difficult to draw any conclusions from these data.

1995 Navel Orange Trial. Yields of the five orange cultivars are shown in table 9. 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 a much higher granulation content than the other cultivars (Table 10), although if the fruit from this had been harvested earlier, it is possible that this granulation would have been less. 'Lane Late' had the greatest juice content, because of its low granulation. 'Tulegold' had the highest TSS:TA level, because of its low acid content.

1996 Valencia Orange Trial. As in 1998-99, in 1999-2000 there was no significant effect of either rootstock or scion upon yields of 'Valencia' oranges in 1998-99 (Table 11), although yields were much greater than in the previous year.

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 12). It was difficult to spot any clear differences in fruit size or fruit grade between the rootstocks. There were no differences in fruit quality due to rootstock (Table 13).

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*, *C. macrophylla* are becoming clear; trees on *C. macrophylla* have outperformed all others for the second year in a row in 1999-2000. Whether this represents a long-term phenomenon is still in question. It still appears as if trees on rough lemon may not be as vigorous as those trees on the other two lemon rootstocks. 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, 'Limoneira 8A' still appears to be superior to the others at this point, because of its consistency for the last five years. Whether it will remain superior will not be known for several years. Given this year's data, it is likely that 'Corona Foothills' is a superior cultivar as well. 'Frost Nucellar Lisbon' continues to be only average, as does 'Prior'.

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. In particular, 'Fallglo' appears to be particularly interesting because of its large size and early maturity.

Literature Cited

Wright, G.C. 1999. Results of scion and rootstock trials for citrus in Arizona – 1998. 1999 Citrus Research Report. College of Agriculture Series P-117. Tucson, AZ.

Wright, G.C. 1998. Results of scion and rootstock trials for citrus in Arizona – 1997. 1998 Citrus Research Report. College of Agriculture Series P-113. Tucson, AZ.

Wright, G.C. 1997. Early results for scion and rootstock trials in Arizona. 1997 Citrus Research Report. College of Agriculture Series P-109. Tucson, AZ.

Wright, G.C. 1996. Cultivar and rootstock research for the Arizona citrus industry. 1996 Citrus Research Report. College of Agriculture Series P-105. Tucson, AZ.

Wright, G.C. 1995. Cultivar and rootstock research for the Arizona citrus industry. 1995 Citrus Research Report. College of Agriculture Series P-101. Tucson, AZ.

Table 1. Yields and percentage of fruit harvested early of 'Limoneira 8A Lisbon' lemon trees on five different rootstocks.

	Yield per tree (lb.).				
Rootstock[z]	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.

	Yield per tree (lb.).				
Rootstock[z]	9-22-99	11-18-99	2-3-00	Total Yield	Pct. Fruit Harvested Early[x]
'Carrizo' Citrange	3.41 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	3.77 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. November 18th, 1999 harvest fruit grade and fruit size, expressed as a percentage, of 'Limoneira 8A Lisbon' lemon trees on five different rootstocks.

Rootstock[z]	Fruit Grade (%)			Fruit Size (%)				
	Fancy	Choice	Juice	165	140	115	95	75
'Carrizo' Citrange	47.8 a	20.4 a	31.7 a	7.9 ab	32.5 a	34.4 c	11.0 b	0.5 c
C. macrophylla	60.3 a	17.1 a	22.6 a	4.4 c	19.9 c	45.6 a	21.2 a	2.5 ab
Rough Lemon	44.7 a	19.4 a	35.8 a	6.6 bc	25.3 bc	43.0 ab	15.7 ab	1.6 bc
'Swingle' Citrumelo	43.4 a	18.2 a	38.4 a	8.8 a	31.3 ab	37.5 bc	11.2 b	0.7 c
C. volkameriana	50.3 a	19.9 a	29.8 a	5.5 bc	21.1 c	42.3 ab	21.0 a	3.4 a

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

Table 4. Yields and percentage of fruit harvested early of four 'Lisbon' lemon cultivars budded to *C. volkameriana* rootstock.

Scion[z]	Yield per tree (lb.).				
	1994-95	1995-96	1996-97	1997-98	1998-99
'Corona Foothills Lisbon'	0.13 a[y]	4.98 b	11.33 b	18.42 b	281.15 b
'Frost Nucellar Lisbon'	0.07 a	3.97 b	14.48 b	26.62 b	204.96 c
'Limoneira 8A Lisbon'	0.13 a	10.56 a	27.71 a	69.04 a	343.35 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.

Scion[z]	Yield per tree (lb.).			
	9/22/99	11/18/99	2/3/00	Total Yield
'Corona Foothills Lisbon'	65.3 a	76.9 ab	45.3 a	187.5 a
'Frost Nucellar Lisbon'	44.3 b	68.8 ab	37.8 ab	150.8 a
'Limoneira 8A Lisbon'	52.4 ab	105.3 a	33.5 ab	183.6 a
'Prior Lisbon'	50.8 b	57.6 b	26.3 b	134.8 a

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

Table 6. Yields and percentage of fruit harvested early during 1998-2000 of 'Limoneira 8A Lisbon' lemon trees on six different rootstocks.

Rootstock[z]	Yield per tree (lb.).					
	Total 1998-99 Yield (lbs.)	9-22-99 Harvest	11-18-99 Harvest	2-3-00 Harvest	Total 1999-2000 Yield (lbs)	Fruit Harvested Early (%)
C. volkameriana	18.64 a	76.88 a	19.72 a	24.40 a	121.01 a	65 a
C-35 Citrange	7.21 b	10.13 b	16.87 a	14.78 ab	49.15 b	33 b
Citremon 1449	5.14 b	27.00 b	4.81 a	15.30 ab	47.13 b	54 ab
Yuma Citrange	2.00 b	17.50 b	4.60 a	5.65 b	20.35 b	65 a
C. taiwanica	4.69 b	17.44 b	4.80 a	10.89 b	33.13 b	53 ab
African Shaddock x Rubidoux trifoliate.	2.20 b	9.38 b	2.78 a	11.20 b	23.38 b	30 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 7. Yields and percentage of fruit harvested early of ten lemon cultivars budded to *C. volkameriana* rootstock.

Scion[z]	1997-98		1998-99		1999-2000	
	Total Yield (lb.)	Pct. Fruit Harvested Early[y]	Total Yield (lb.)	Pct. Fruit Harvested Early[y]	Total Yield (lb.)	Pct. Fruit Harvested Early[y]
Allen Eureka	39.60 c	56.67 cd	164.55 cd	41.51 e	142.5 bc	62.0 a
Cascade Eureka	44.50 c	57.40 cd	93.40 f	67.00 d	143.33 bc	61.7 a
Cook Eureka	41.36 c	49.53 d	129.21 def	42.66 e	103.90 cd	60.4 a
Cavers Lisbon	**101.80 a**	**71.52 ab**	**272.32 a**	**86.78 ab**	**279.06 a**	**59.8 a**
Frost Nucellar Lisbon	**57.05 bc**	**62.35 bc**	**123.79 def**	**85.14 abc**	**203.12 ab**	**52.0 a**
Limoneira 8A Lisbon	**95.04 ab**	**63.04 bc**	**152.28 def**	**71.41 cd**	**101.00 cd**	**78.2 a**
Prior Lisbon	**95.75 ab**	**66.15 bc**	**105.04 ef**	**82.28 abcd**	**188.43 b**	**60.0 a**
Rosenberger Lisbon	**121.97 a**	**57.52 cd**	**132.43 def**	**67.65 d**	**45.00 d**	**66.5 a**
Limonero Fino 49	*94.42 ab*	*79.72 a*	*233.88 ab*	*92.94 a*	*226.25 ab*	*51.0 a*
Villafranca	*124.27 a*	*71.05 ab*	*199.79 bc*	*75.69 bcd*	*220.31 ab*	*57.7 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 8. Yields during 1998-2000 of 'Limonero Fino 49 lemon trees on nine different rootstocks.

Rootstock[z]	Yield per tree (lb.). Total 1998-99 Yield (lbs.)	Total 1999-00 Yield (lbs.)
C. macrophylla	21.46 a	38.75 a
C-35 citrange	6.26 a	12.43 bc
Swingle Citrumelo	8.70 a	20.57 abc
Carrizo Citrange	8.49 a	7.56 bc
Citremon 1449	5.69 a	23.74 abc
C. volkameriana	4.21 a	28.79 ab
Afr. Shaddock x Rubidoux trifoliate.	5.65 a	4.34 bc
C. taiwanica	3.51 a	2.62 c
Rough Lemon	2.04 a	3.44 c

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

Scion[z]	1997-98	1998-99			1999-2000		
	Yield per tree (lb.). 01/13/98	Yield per tree (lb.). 02/15/99	Weight per fruit (lb.)	Granulation [y] (%)	Yield per tree (lb.). 12/17/99	Weight per fruit (lb.)	Granulation [y] (%)
Lane Late	4.40 b	12.44 b	0.58 a	0.00 c	12.03 c	0.65 a	2.30 c
Atwood	5.14 b	7.09 b	0.52 ab	2.17 c	12.65 c	0.64 a	3.09 c
Fisher	6.51 b	9.33 b	0.49 b	11.47 a	35.09 a	0.70 a	30.92 a
Parent Washington	7.05 b	8.39 b	0.50 ab	5.17 b	28.32 b	0.62 b	5.16 bc
Tulegold	11.84 a	32.78 a	0.47 b	1.17 c	24.48 b	0.69 a	9.31 b

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

Table 10. 1999-2000 Fruit Quality of five navel orange cultivars budded to Carrizo rootstock.

Scion[z]	Percent Juice	TSS (%)	TA (%)	TSS:TA	Peel Thickness (mm)
Lane Late	46.5 a	10.06 d	0.59 a	17.18 d	4.95 bc
Atwood	44.2 ab	11.00 ab	0.59 a	18.50 c	5.86 a
Fisher	30.2 c	10.70 c	0.54 b	20.08 b	5.19 b
Parent Washington	45.2 ab	11.04 a	0.59 a	18.59 c	4.52 bc
Tulegold	41.1 b	10.78 bc	0.49 c	22.03 a	5.21 b

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

Table 11. Yields of three 'Valencia' orange cultivars budded to C-35, Carrizo and *C. volkameriana* rootstock.

	1998-99	1999-2000
Scion or rootstock[z]	Yield per tree (lb.). 26 March 1999	Yield per tree (lb.). 6 March 2000
'Delta'	0.27 a[y]	4.65 a
'Midknight'	0.23 a	3.80 a
'Olinda'	0.42 a	2.56 a
C. volkameriana	0.07 a	4.10 a
C-35	0.27 a	4.56 a
Carrizo	0.58 a	3.01 a

[z] Yield values are the means of 30 trees.
[y] Means separation in columns by Duncan's Multiple Range Test, 5% level.

Table 12. 1999 Yield and packout of Fallglo mandarin trees on eleven different rootstocks.

Rootstock[z]	Yield per tree (lb.)	Fruit Size (%)							Fruit Grade (%)		
		Small	Medium	Large	Jumbo	Mammoth	Colossal	Super-Colossal	Fancy	Choice	Juice
C. volkameriana	9.6 a[y]	0.0 a	0.0 a	0.0 a	9.9 b	26.8 ab	32.6 b	30.3 a	81.8 a	17.1 b	1.1 a
Rough Lemon	8.6 a	0.0 a	0.0 a	3.0 a	10.1 b	42.9 ab	42.5 ab	1.5 a	81.8 a	16.6 b	1.6 a
Soh Jalia Lemon	7.1 a	--	--	--	--	--	--	--	--	--	--
Citremon 1449	6.6 a	0.0 a	0.0 a	2.9 a	7.1 b	51.3 a	34.9 b	3.9 a	82.9 a	17.0 b	0.0 a
Sunki Mandarin x Flying Dragon Trifoliate Orange	6.0 a	0.0 a	0.1 a	1.5 a	21.3 ab	51.2 a	21.3 b	4.7 a	82.3 a	17.7 b	0.0 a
'Carrizo' Citrange	4.0 a	0.0 a	0.0 a	0.0 a	12.0 b	41.8 ab	46.3 ab	0.0 a	77.6 a	20.5 b	1.9 a
Taiwanica Orange	1.7 a	0.7 a	0.0 a	2.8 a	39.5 a	50.9 a	6.2 b	0.0 a	62.9 a	33.8 b	3.3 a
C-35 Citrange	0.4 a	0.0 a	0.0 a	0.0 a	12.2 b	67.0 a	20.8 b	0.0 a	17.0 b	83.0 a	0.0 a
African Shaddock x Rubidoux Trifoliate Orange	0.2 a	0.0 a	0.0 a	0.0 a	22.1 ab	0.0 b	77.9 a	0.0 a	50.0 ab	50.0 ab	0.0 a
Smooth Flat Seville Orange	0.0 a	--	--	--	--	--	--	--	--	--	--
Gou Tou Orange	0.0 a	--	--	--	--	--	--	--	--	--	--

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

Table 13. 1999-2000 Fruit Quality of Fallglo mandarin trees on six different rootstocks..

Rootstock[z]	Percent Juice	TSS (%)	TA (%)	TSS:TA	Peel Thickness (mm)
C. volkameriana	49.1 bc[z]	10.7 b	0.87 a	12.25 a	1.84 a
Rough Lemon	48.9 bc	11.03 ab	0.95 a	11.57 a	1.98 a
Citremon 1449	52.4 ab	11.73 a	1.01 a	11.59 a	2.01 a
Sunki Mandarin x Flying Dragon Trifoliate Orange	55.1 a	11.51 ab	0.99 a	11.67 a	1.82 a
'Carrizo' Citrange	46.7 c	10.6 b	0.88 a	11.99 a	2.42 a
Taiwanica Orange	54.2 a	10.8 ab	0.99 a	10.95 a	1.66 a

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

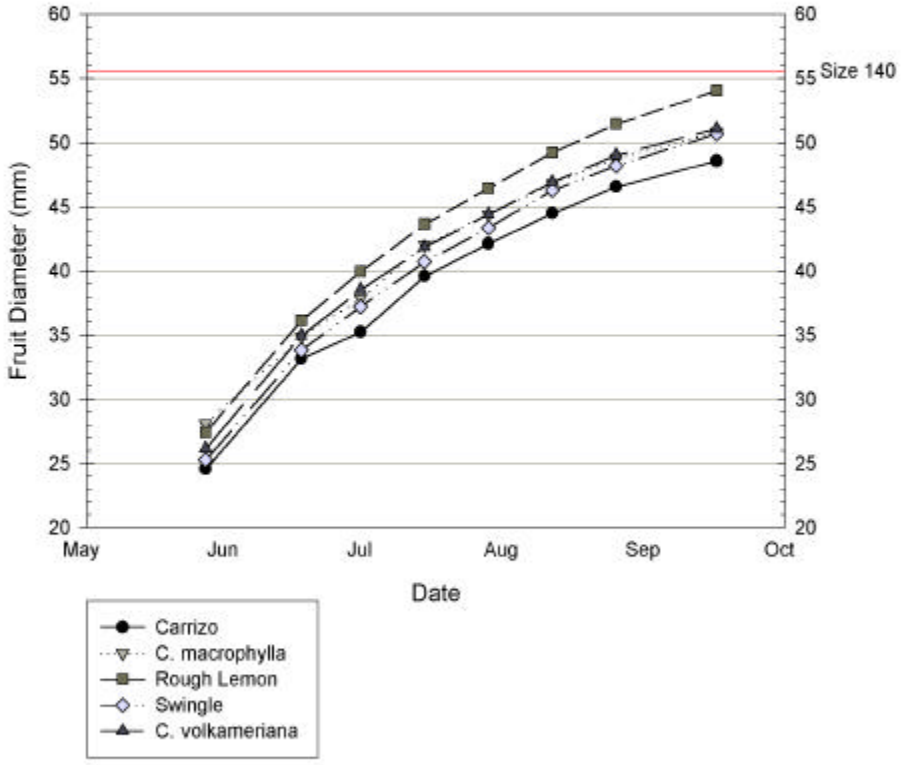

Figure 1. Fruit diameter of 'Limoneira 8A Lisbon' lemon on five rootstocks.

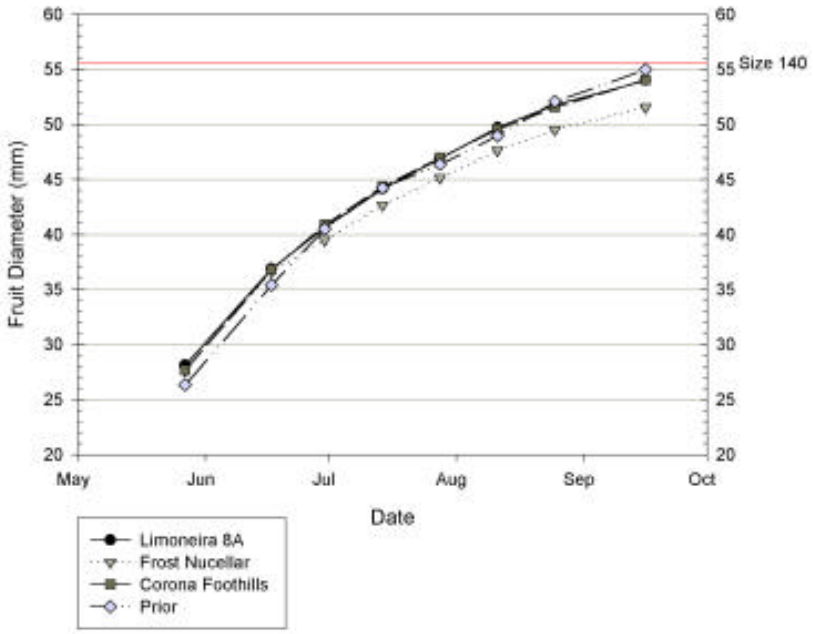

Figure 2. Fruit diameter of four lemon scions on '*Citrus volkameriana*' rootstock.