

Results of New Cultivar Selection Trials for Lemon in Arizona – 2006-07¹

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Abstract

Three lemon cultivar selection trials are being conducted at the Yuma Mesa Agriculture Center in Somerton, AZ. Data from these trials suggest that 'Limonero Fino 49' and 'Cascade Eureka' selections may be a suitable alternative for the varieties most commonly planted in Southwest Arizona today. 'Femminello' and 'Villafranca' might also be planted on an experimental basis

Introduction

The Arizona lemon industry has historically relied on a small number of lemon cultivar selections. In the 1950's, the industry was established with 'Desert Lisbon', however within a few years, 'Desert Lisbon' was eclipsed in popularity by 'Frost Nucellar Lisbon' the only nucellar clonal selection of the 'Lisbon' cultivar. Other minor selections of 'Lisbon' that were planted in Arizona from the 1960's through the 1980's included 'Monroe', 'Prior', and 'Rosenberger'. Beginning in the late 1980's, new plantings were established using 'Limoneira 8A Lisbon'. More recently, 'Corona Foothills Lisbon' is increasingly popular. 'Allen Eureka' has also been occasionally planted in Arizona.

All of these represent clonal selections of outstanding trees that were then propagated. Typically, they are identified by their originator or place of origin, and are valuable to Arizona growers because of their high vigor, high productivity, precocity (trees bear at an early age), earliness (a high percentage of the fruit can be harvested before 1 November), short thorns and good fruit quality. When a commonly grown lemon cultivar selection is gradually replaced in the industry, the new selection typically is improved in one of these characteristics. Sometimes a cultivar selection may be replaced because of a negative characteristic. Such was the case with 'Frost Nucellar Lisbon' which appears to be susceptible to brown heartwood rot.

From the late 1980's, to the early 1990's, Arizona lemon growers have received their information about new cultivar selections through word of mouth or from nursery sources, since there were no trials planted in the state. With this in mind, we have planted three new lemon cultivar selection trials in 1995, 1997 and 1998, all located at the Yuma Mesa Agricultural Center. These trial results are presented here.

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Materials and Methods

1995 Lemon Cultivar Selection Trial. This trial, at first comprising 10 cultivar selections was established in March 1995 in Block 17 (Foundation Block) of the Yuma Mesa Agricultural Center, near Yuma, Arizona. An additional cultivar selection was planted in 1997. As it exists within the citrus variety collection, it is not a large trial, nor is it replicated. The experimental area 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 cultivar selection were planted. This trial contains the following selections, all on *C. volkameriana* rootstock:

- ‘Allen Eureka’ – The most common and popular ‘Eureka’ selection planted in Arizona. Originated in Santa Paula, CA
- ‘Cavers Lisbon’ – A vigorous ‘Lisbon’ selection originating in Upland, CA.
- ‘Cascade Eureka’ – Another, less-commonly planted, vigorous selection that originated in San Diego County, CA.
- ‘Cook Eureka’ – A selection from Limoneira Del Mar Ranch, Ventura County, California.
- ‘Frost Nucellar Lisbon’ – Vigorous nucellar selection derived by Dr. H.B. Frost of the Citrus Research Station, Riverside, CA
- ‘Limoneira 8A Lisbon’ – A vigorous selection originating from the Limoneira Ranch, Ventura County, CA. The most popular lemon planted in Arizona today.
- ‘Prior Lisbon’ – A selection from California. Originated at the Rancho Sespe, near Fillmore, CA. Has a reputation for lateness.
- ‘Rosenberger Lisbon’ – Although considered a ‘Lisbon’, possibly a hybrid of ‘Lisbon’ and ‘Villafranca’. Vigorous and productive. Originated in Upland, CA.
- ‘Limonero Fino 49’ – The chief winter lemon of Spain. Reportedly vigorous, thorny and highly productive. Early producer with uniform yield. Fruit is spherical to oval, with a smooth rind and a relatively short nipple. Relative high acid and about five seeds per fruit.
- ‘Villafranca’ – Said to be of Sicilian origin, introduced into Florida in 1875. Formerly planted in California, but of little importance there today. Fruit and tree characteristics similar to ‘Eureka’, but produces mainly a winter crop.
- ‘Walker Lisbon’ – A vigorous selection from California, planted in 1997

1997 Lemon Cultivar Selection Trial. This trial, comprising 13 cultivar selections, 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 selection were planted. This trial includes ‘Allen’, ‘Cavers’, ‘Cascade’, ‘Cook’, ‘Limoneira 8A’, ‘Limonero Fino 49’, ‘Villafranca’ as well as the following selections:

- ‘Arancino’ – A minor Italian cultivar, with rounded fruit, a short nipple and thick rind. Fruit is seedy.
- ‘Berna’ (‘Verna’) – The common summer lemon of Spain. Thornless tree produces medium to large fruit with few seeds.
- ‘Corpaci’ – A minor Italian cultivar from Sicily. Vigorous, thorny trees are reportedly productive. Fruit matures early and has few seeds.
- ‘Femminello Comune’ – Italian, everbearing cultivar.
- ‘Primofiori’ – Originated in Spain. Similar to the ‘Limonero Fino 49’ described above.
- ‘Santa Teresa’ (Femminello Santa Teresa) – Similar to ‘Femminello Comune’, but resistant to the Mal Secco disease prevalent in Italy.

1998 Lemon Cultivar Selection Trial. This trial, comprising 7 cultivar selections, was established in late September 1998 in Block 14 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 selection were planted. This trial includes the ‘Limoneira 8A Lisbon’ and ‘Walker Lisbon’ described above as well as the following additional cultivar selections:

- ‘Dr. Strong Lisbon’ – Originated at the Glen Good ranch, Santa Paula, CA. Large fruit and the tree is reportedly precocious.
- ‘Genoa’ – Similar to the ‘Villafranca’, imported from Italy to the U.S. in 1881.
- ‘Lapithotiki’ – Originated in Cyprus. Reportedly harvested from September until March. Fruit is tapered at both ends.
- ‘Monroe Lisbon’ – Vigorous selection. Reportedly bears early, but fruit is small and coarse.
- ‘Taylor Eureka’ – A nucellar selection, originating in Australia. Reportedly produces late.

Yield data is collected during the fall and winter. Trees picked as noted as follows: For 2006-07, trees in the 1995 trial were picked on 10-12-06. Trees of ‘Allen Eureka’, ‘Cavers Lisbon’ and ‘Walker Lisbon’ were not harvested as the trees had been inadvertently irrigated when the pickers arrived. Trees in the 1997 trial were picked on 10-12-06, and for the 1998 trial, trees were picked on 10-11-06. For each harvest date, a portion of the entire quantity of harvested fruit from each tree 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 packout data is reported on a percentage basis. Fruit quality data, including juice %, peel thickness, °brix, %acid, and brix:acid ratio are reported for trees in the 1997 and 1998 trial.

All data was analyzed using SPSS 11.0 for Windows (SPSS Inc., Chicago, Illinois).

Results and Discussion

1995 Lemon Selection Trial. Annual yields of the original ten selections in this trial, since its inception, are found in Figure 1. For 2006-07, yields of all the selections decreased compared with the previous season. It is likely that this was due to the large crop the previous year. ‘Cascade Eureka’ was superior for the second consecutive year.

Yields for the 2006-07 year are shown in Figure 2. There was no significant effect of the selections upon yield for 2006-07. In addition to ‘Cascade’, ‘Limoneira 8A’ performed well. ‘Prior Lisbon’ had the least yield for the year.

Packout for this trial is shown in Figure 3. Fruit size was generally large in 2006-07 since total yield was low. ‘Cascade Eureka’, ‘Cook Eureka’ and ‘Limonero Fino 49’ had the most fruit of size 75 and 95. followed by ‘Villafranca’. ‘Rosenberger Lisbon’ and ‘Prior Lisbon’ had the smallest fruit size for the second consecutive year.

There was a significant effect of selection upon fruit color, shape and exterior quality. ‘Prior’ and ‘Limonero Fino 49’ had the most highly colored fruit, while ‘Cascade’ and ‘Frost Nucellar’ had the greenest fruit. Significant differences in fruit shape were found. ‘Villafranca’ had fruit that was rounder, while ‘Cascade Eureka’ fruit was the most elongated. ‘Cascade’ also had the most fruit in the fancy category, with ‘Cook Eureka’ and ‘Villafranca’ with only slightly less. These three selections also had the least fruit in the choice and juice category. ‘Limoneira 8A’, ‘Rosenberger’ and ‘Limonero Fino 49’ had the least fruit in the fancy category, while ‘Limoneira 8A’ and ‘Rosenberger’ had the most juice fruit.

1997 Lemon Selection Trial. Yields of this trial, since its inception, are found in Figure 4. Because of the large number of selections in this trial, the graph has been split for ease of viewing. Selections that have had superior yields since the beginning, include ‘Cascade Eureka’, ‘Cook’ Eureka, ‘Limoneira 8A Lisbon’, ‘Limonero Fino 49’, ‘Primofiori’ and ‘Villafranca’. All the yields fell precipitously this year, probably in response to the large crop last year; only ‘Cascade Eureka’ stands out.

Yield for the 2006-07 season is shown in Figure 5. Although ‘Cascade Eureka’ had the greatest yield, ‘Cook Eureka’, ‘Femminello’ and ‘Limoneira 8A’ were not statistically different. All the others performed particularly poorly.

Packout for the 10-12-06 harvest is shown in Figure 6. There was no significant effect of selection upon fruit size for 2006-07. There was no significant effect of selection upon juice %, juice pH, peel thickness, °brix, %acid, and brix:acid ratio for 2006-07 (data not shown).

1998 Lemon Cultivar Selection Trial. 2001 to 2006 yields from this trial are found in Figure 7. Although the 'Limoneira 8A' was originally the best performer of this trial; 2006-07 is the third year that any other selection has surpassed it in total yield since 2001-02, although there a great drop in overall yield for 2006-07, probably due to the large crop for the previous year. . 'Lapithiotiki', 'Genoa', and 'Dr. Strong' Lisbon had yields that equaled or surpassed the yield of 'Limoneira 8A Lisbon' (Figure 8). Meanwhile, 'Genoa', 'Taylor Eureka', Walker Lisbon' and 'Monroe Lisbon' had yields less than 'Limoneira 8A', but there was no significant difference among any of the selections. After consistently producing low yields up until 2004-05, we were surprised to see 'Lapithiotiki' vault into the second-highest place in 2005-06 and have the third highest yield in 2006-07.

Fruit size for the 2006-07 harvest of this trial is shown in Figure 9. There was no significant effect of selection upon fruit size for 2006-07. There was no significant effect of selection upon juice %, juice pH, peel thickness, °brix, %acid, and brix:acid ratio for 2006-07 (data not shown).

Conclusions

Two new lemon cultivar selections appear promising for Arizona. One is 'Limonero Fino 49' lemon, because its yields are similar to that of 'Limoneira 8A' and it has larger fruit size. 'Cascade Eureka' is also beginning to stand out, having had equivalent or better yield than 'Limoneira 8A' for the last two years, along with better fruit size. 'Femminello Comune' and 'Villafranca' may also be suitable, but neither consistently equals or surpasses 'Limoneira 8A Lisbon' lemon in terms of overall yield and/or earliness as often as does 'Limonero Fino 49' or 'Cascade'.. Furthermore, 'Femminello' performed poorly in 2005-06. 'Santa Teresa' had excellent yield in 2002-03, but stumbled for the last three years, and is hobbled by its lateness. None of the other selections in the 1995 and 1997 trial have been consistently better than 'Limoneira 8A Lisbon'.

In the 1998 trial, no selection has proved to be consistently better than 'Limoneira 8A', but 'Walker', 'Monroe' and particularly 'Dr. Strong' may be contenders. 'Lapithiotiki' has large fruit, and high yields for the second year in a row. 'Eureka' lemons have typically performed poorly in comparison to the 'Lisbons', and should not yet be considered as a replacement for any of the high-yielding 'Lisbon' selections, with the exception of 'Cascade'.

Table 1. Fruit color, shape and exterior quality of eight lemon selections on *C. volkameriana* rootstock.

Selection	Fruit color ^z	Fruit shape ^y	Exterior Fruit Quality (%)		
			Fancy	Choice	Juice
Cascade Eureka	1.87 c	0.72 e	98.30 a	0.98 d	0.72 d
Cook Eureka	2.05 abc	0.75 cd	94.55 ab	5.00 d	0.55 d
Villafranca	1.93 bc	0.82 a	94.30 ab	4.44 d	1.26 d
Prior Lisbon	2.12 a	0.79 b	88.85 bc	7.78 cd	3.37 bc
Frost Nucellar Lisbon	1.89 c	0.78 bc	88.74 bc	8.16 bcd	3.10 bc
Limonero Fino 49	2.19 a	0.74 de	81.79 cd	14.46 abc	3.75 bc
Rosenberger Lisbon	2.22 a	0.76 bcd	79.98 cd	15.03 ab	4.99 ab
Limoneira 8A Lisbon	2.11 ab	0.77 bc	75.89 d	17.12 a	6.99 a

^z Value represents the red to green color ratio of the peel. A larger number indicates a more yellow or orange fruit, while a smaller number indicates a greener fruit.

^y Shape indicates width to length ratio. A perfectly round fruit would have a value of 1.0.

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

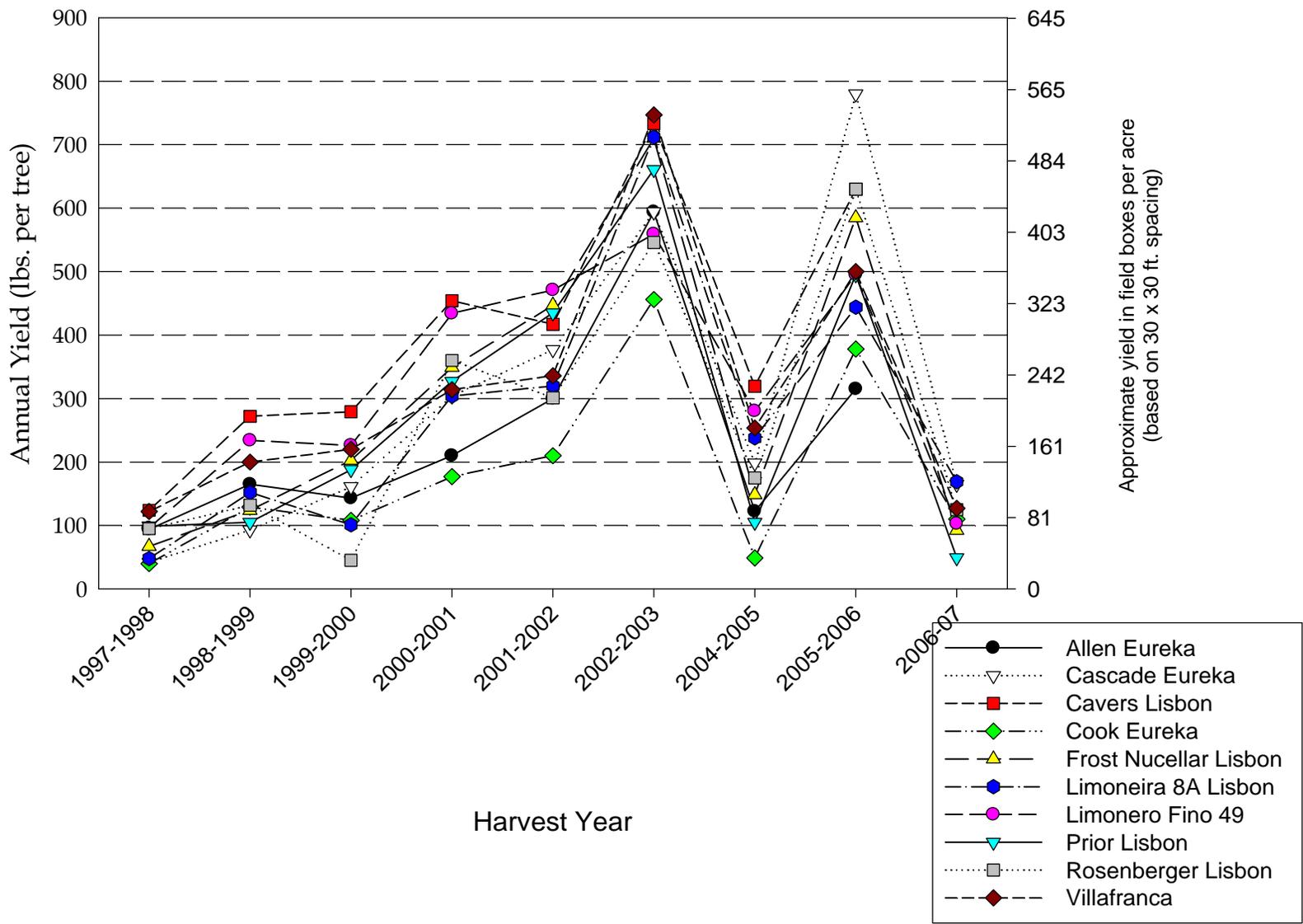


Figure 1. 1997-2006 yield of ten lemon selections budded to *C. volkameriana* rootstock.

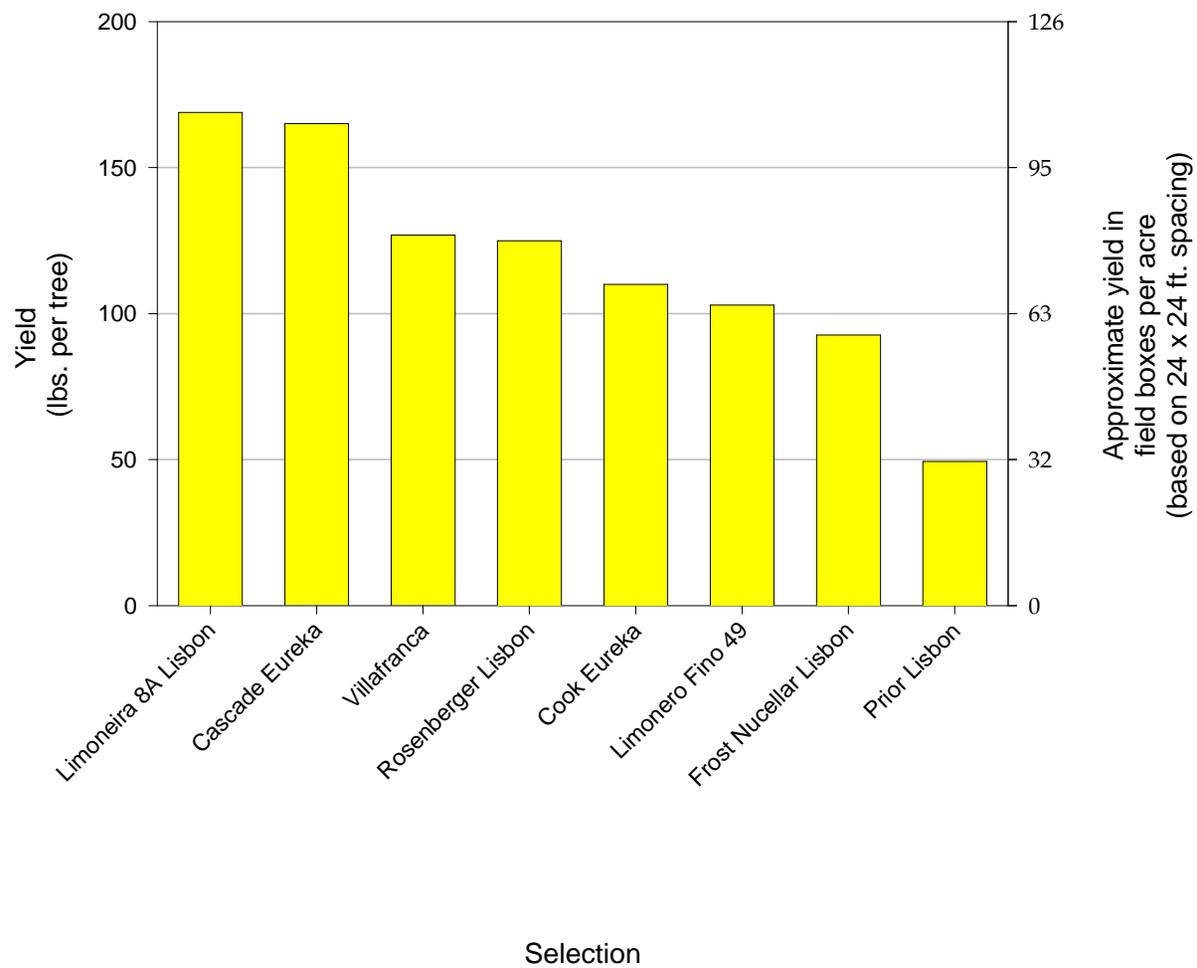
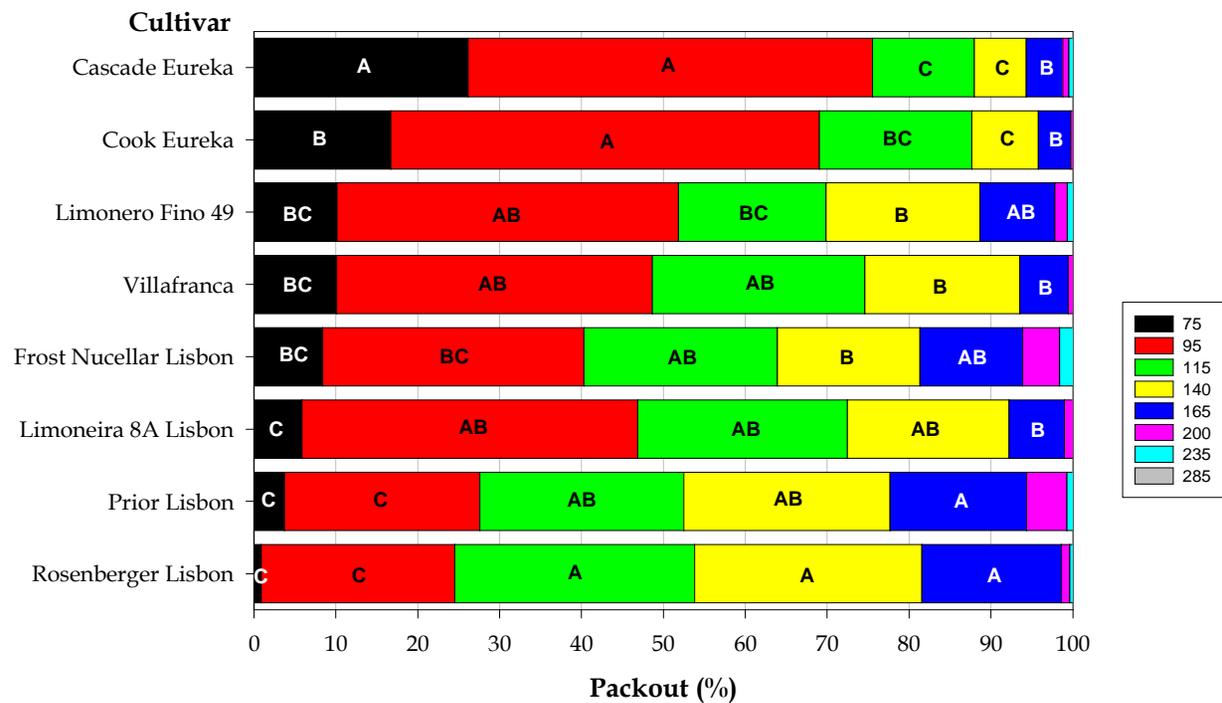


Figure 2. 2006-07 yield of eight lemon selections budded to *C. volkameriana* rootstock. There were no differences in yield among the selections for 2006-07.



Letters indicate significant differences, within fruit sizes, between cultivars tested.

Figure 3. Packout of 8 lemon selections on *C volkameriana* rootstock for the 10-12-06 harvest. Bars of the same shade are significantly different if the lowercase letters within them are different. Letters within bars of different shades cannot be compared.

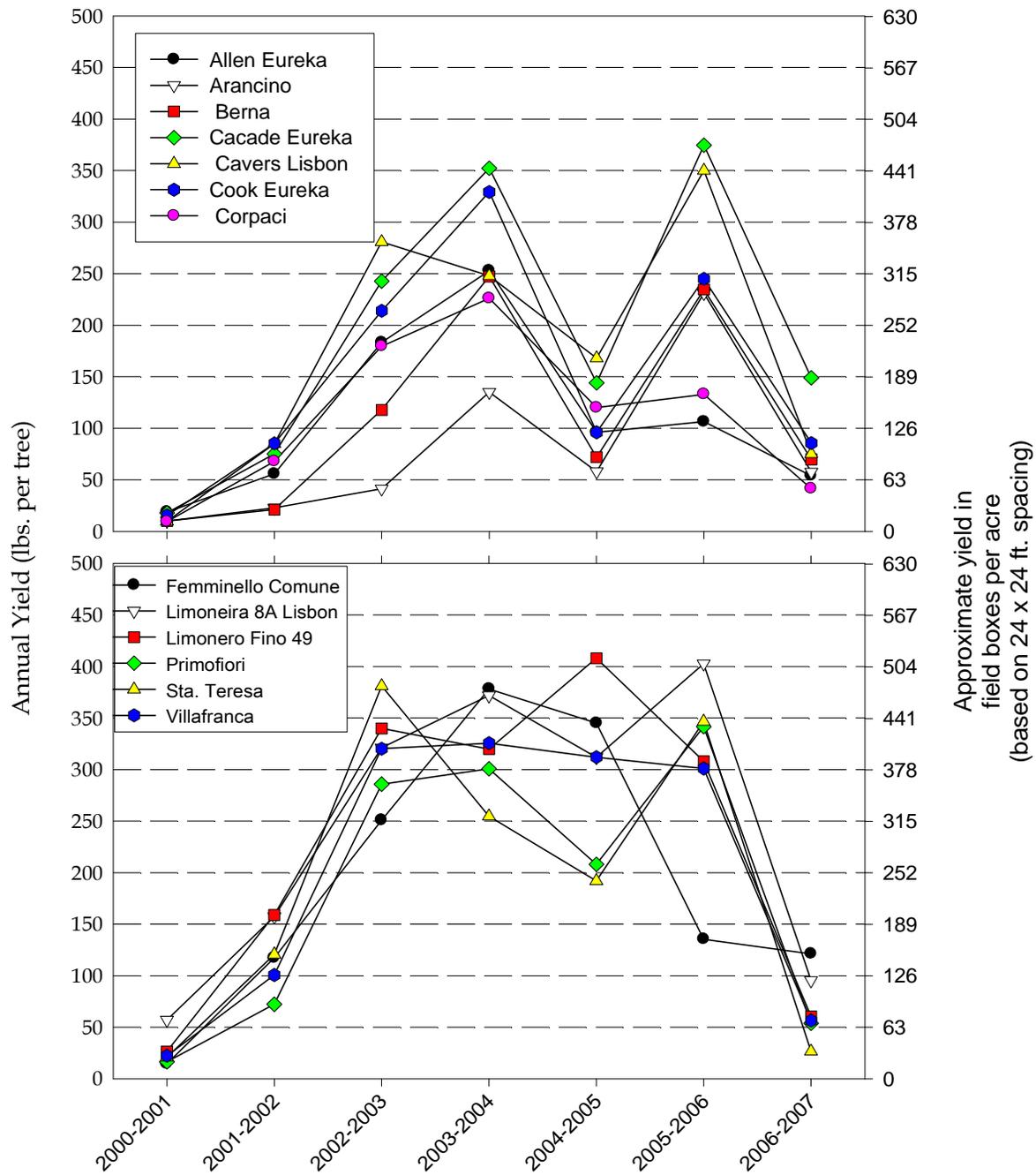


Figure 4. 2000-2006 yield of thirteen lemon selections budded to *C. macrophylla* rootstock.

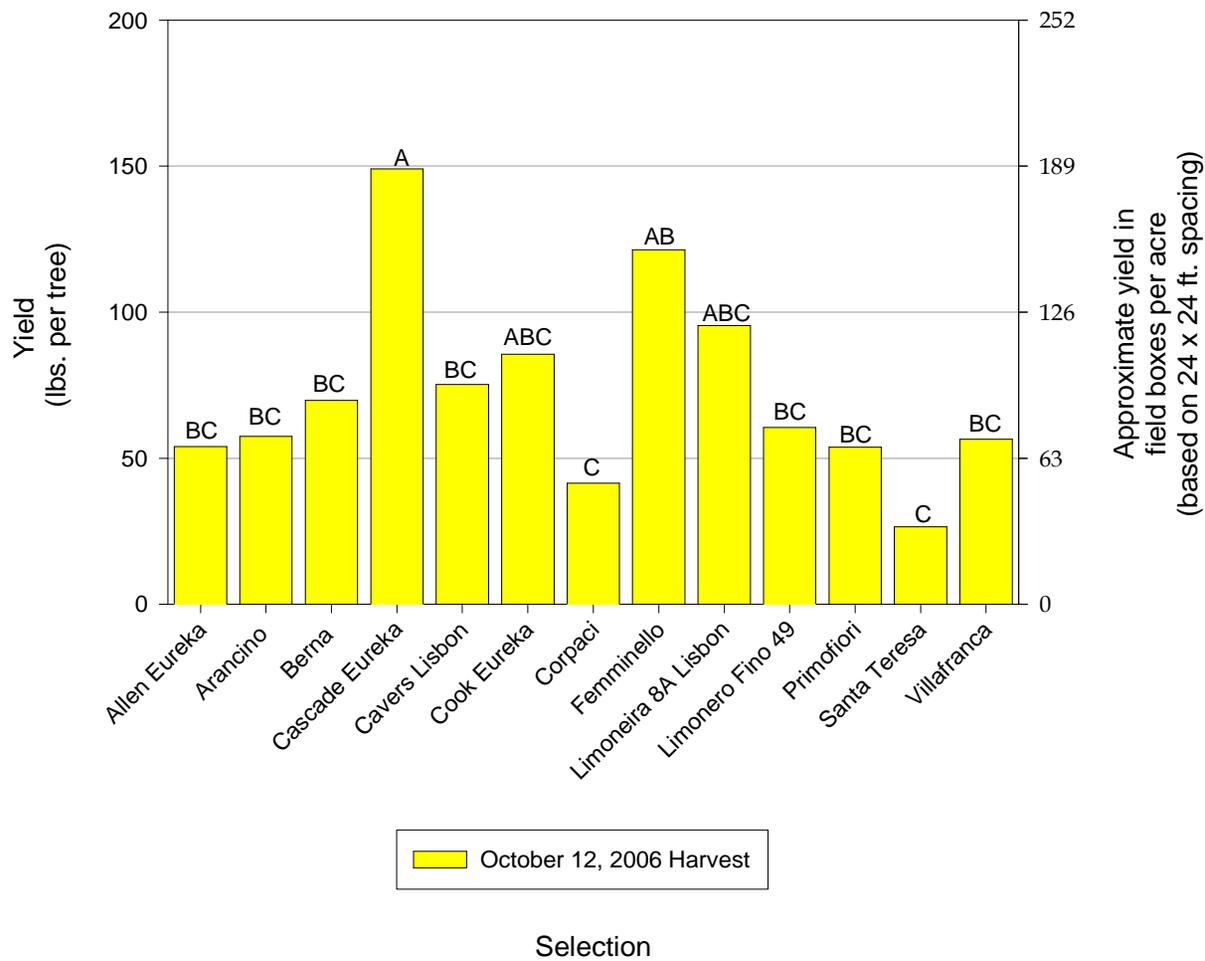


Figure 5. 2006-07 yield of thirteen lemon selections budded to *C. macrophylla* rootstock. Yields are significantly different if the letters above the bars are different.

Cultivar

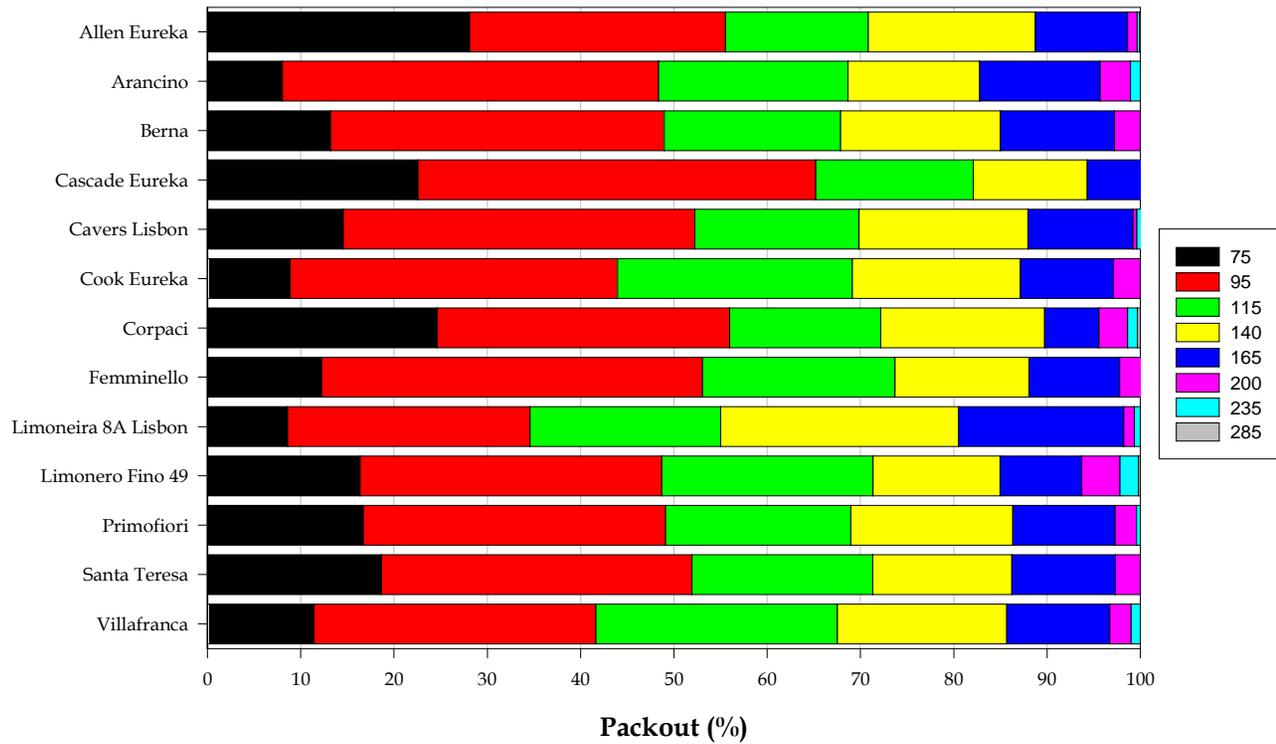


Figure 6. 2006-07 packout of 13 lemon selections on *C. macrophylla* rootstock for the 10-12-06 harvest. There was no effect of the selection on packout for the season.

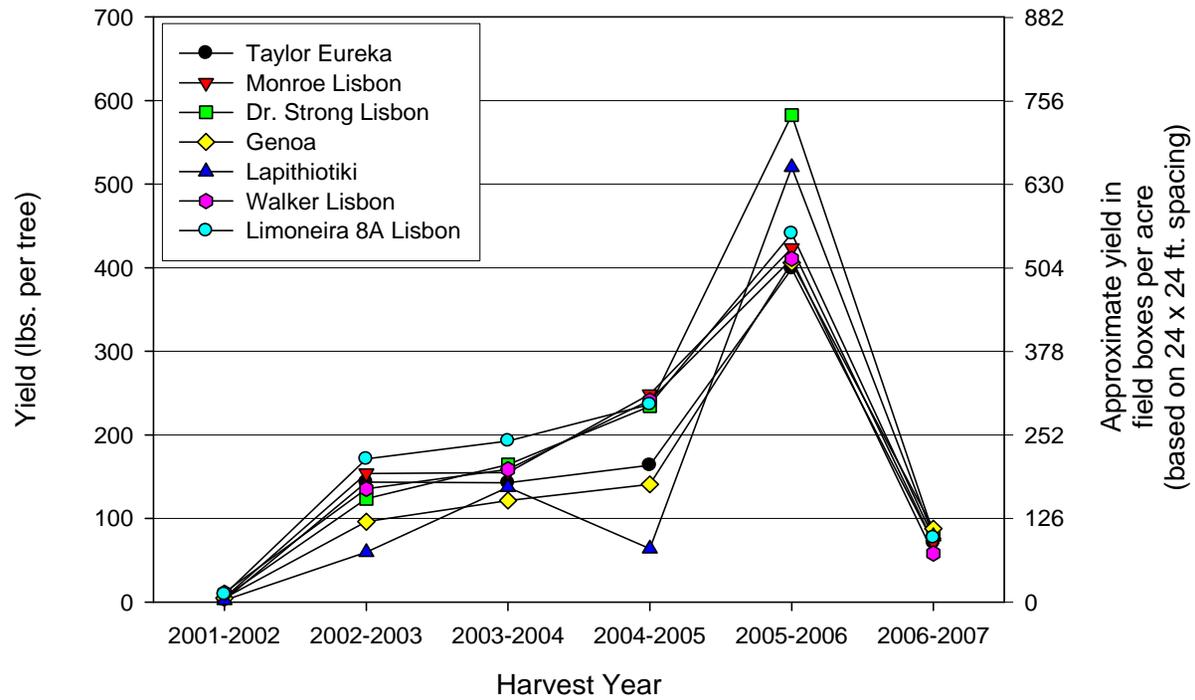


Figure 7. 2001-2006 yield of seven lemon selections budded to *C. macrophylla* rootstock.

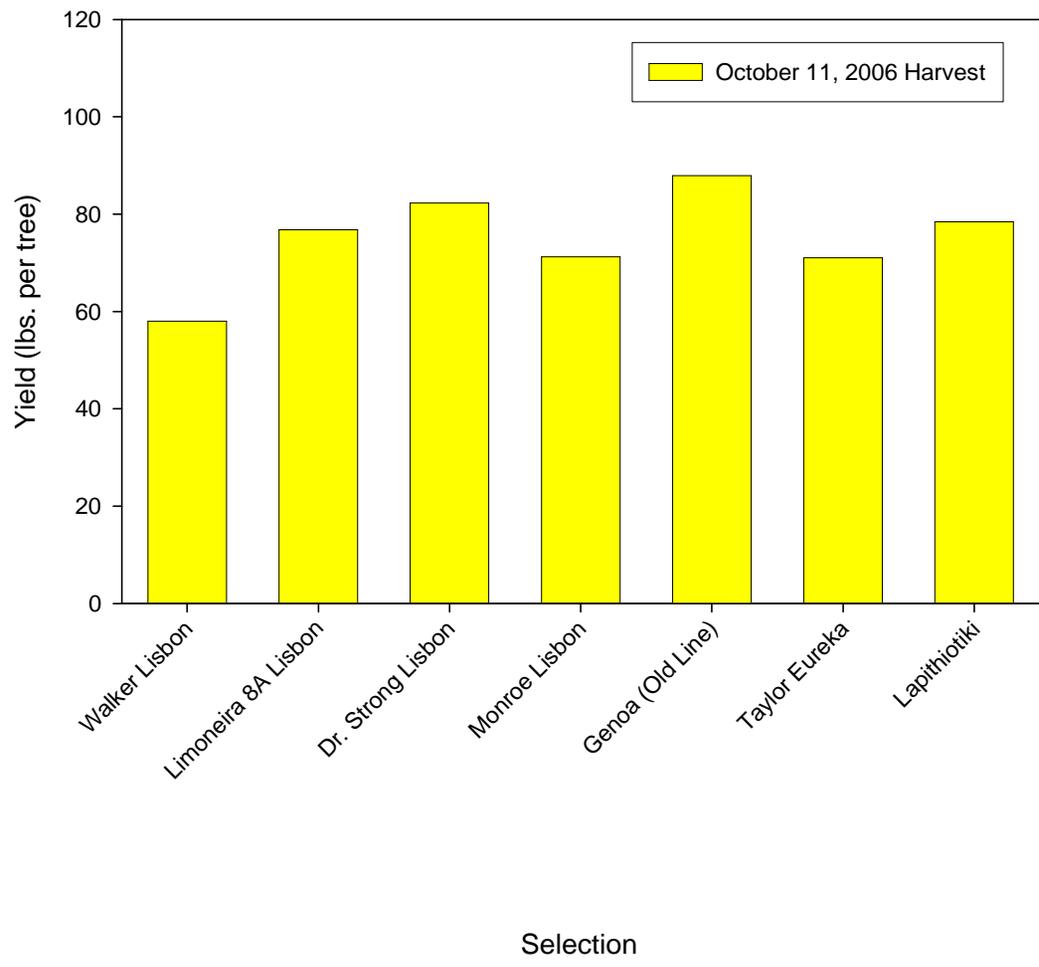


Figure 8. 2006-07 yield of seven lemon selections budded to *C. macrophylla* rootstock.

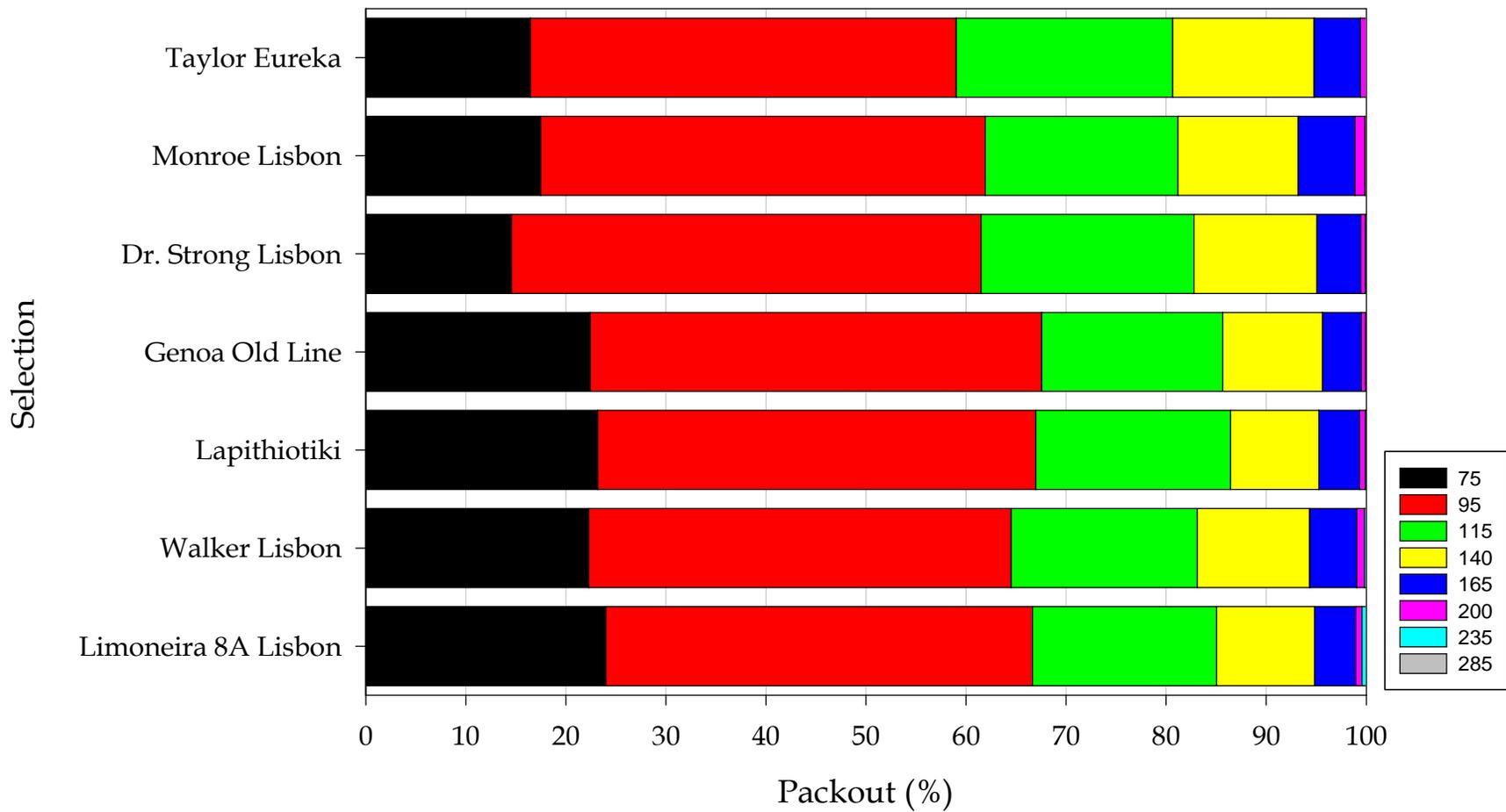


Figure 9. Packout of seven lemon selections on *C. macrophylla* rootstock for the 10-11-06 harvest. Bars of the same shade are significantly different if the lowercase letters within them are different. Bars of different shades cannot be compared.

