

Cultivar Selection Trials of Navel Orange in Arizona for 2005-06¹

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Abstract

Two orange cultivar trials have been established in Arizona, one at the Yuma Mesa Agricultural Center, Yuma, AZ and one at the Citrus Agriculture Center, Waddell, AZ. For the navel orange trial in Yuma, all the selections had improved yields in 2005-06. 'Fisher' navel continues to have the greatest yield, but is quite granulated. Of the rest in the Yuma trial, 'Lane Late' had the best quality and yield. For the Waddell trial, the fourth year data has been collected, and suggests that 'Fisher', 'Beck-Earli', 'Chislett' and 'Lane Late' are outperforming the other cultivars tested to date.

Introduction

There is no disputing the importance of orange cultivars to desert citrus production. Oranges have been grown in Arizona since citrus was introduced into the state by the Spanish missionaries in the 1700's. Historically, the most commonly planted orange cultivar in Arizona was the 'Valencia'. Recently, navel oranges have become more important to the Arizona industry than 'Valencia' and other round oranges, because juicing fresh oranges in the household is becoming less common, and the American consumer prefers the convenience of eating fresh oranges. Consequently, prices received by the grower for navel oranges are consistently higher than those for 'Valencia' oranges.

Whether navel, 'Valencia' or other cultivar, a successful orange for Arizona 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.

From the late 1980's, to the early 1990's, Arizona orange growers have received their information about new navel through word of mouth or from nursery sources, since there were no trials planted in the state. With this in mind, we have planted two new navel orange cultivar selection trials in the 1990's, one located at the Yuma Mesa Agricultural Center, and one located at the Citrus Agriculture Center in Waddell, AZ, just west of Phoenix.

Materials and Methods

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1995 Yuma Navel Orange Trial. This trial was established in March 1995 in Block 18 of the Yuma Mesa Agricultural Center, near Yuma, Arizona. This trial contains the following navel orange selections on ‘Carrizo’ rootstock:

- ‘Washington’ – the ‘Bahia’ navel imported from Brazil. Produces round, slightly oval fruit with segments that separate easily. Excellent flavor. Tends to granulate if planted on a vigorous rootstock, or harvested late. The Arizona industry standard.
- ‘Lane Late’ – Discovered in the 1950’s in Australia. Fruit is round, with a small navel. Matures up to four to six weeks later than ‘Washington’. Susceptible to fruit drop. Fruit has typical low acid levels.
- ‘Atwood’ - An early maturing navel selection from California. Discovered in 1935, as a limb sport on a ‘Washington’ navel tree. Stores well on the tree.
- ‘Fisher’ – Another early maturing navel selection from California. Rind coloration lags behind legal maturity. Reportedly a heavy producer.
- ‘Tule Gold’ - Another early maturing navel selection from California. Reported in some publications to be “early ripening and heavy bearing”, but other sources report poor fruit quality.

Trees are planted on a 10-m x 10-m spacing. Twelve trees of each of five scions are planted, for a total of 60 trees. Yields are expressed as lbs. fruit per tree. As the field was harvested commercially, yield data was collected from December 7, 2005 through January 19, 2006. Trees are strip-picked for the harvest. Harvested fruit for each tree is collected in wooden or plastic boxes and weighed. For 2004-05, the entire harvest 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. We found no differences in exterior fruit quality, other than shape and color between the selections. Ten fruit were harvested on 12-07 from each tree as a sample from each tree for juice quality analysis.

1999 Waddell Navel Orange Trial. This trial was established in March 1999 in Field 19 of the Citrus Agricultural Center, near Waddell, Arizona. This trial contains the following navel orange selections on ‘Carrizo’ rootstock:

- ‘Beck-Earli’ (‘Beck’) – a limb sport of ‘Washington’, discovered in Delano, CA. Smaller trees are reported to be precocious and produce early maturing fruit.
- ‘Cara Cara’ – Red-fleshed selection from Venezuela. Very similar to ‘Washington’ in all other respects.
- ‘Chislett’ – Australian “ultra-late” selection. Reportedly can be harvested up to 3 weeks later than ‘Lane Late’.
- ‘Fisher’ - Early maturing navel selection from California. Rind coloration lags behind legal maturity.
- ‘Fukumoto’ – Early maturing selection from Japan.
- ‘Lane Late’ – Discovered in the 1950’s in Australia. Fruit is round, with a small navel. Matures up to four to six weeks later than ‘Washington’. Susceptible to fruit drop. Fruit has typical low acid levels.
- ‘Powell’ – Another Australian “ultra-late” selection. Reportedly can be harvested up to 3 weeks later than ‘Lane Late’.
- ‘Spring’ – Another late navel selection.
- ‘Washington’ - the ‘Bahia’ navel imported from Brazil. Produces round, slightly oval fruit with segments that separate easily. Excellent flavor. Tends to granulate if planted on a vigorous rootstock, or harvested late. The Arizona industry standard
- ‘Zimmerman’ (Thomson Improved Zimmerman) – An improved selection of the ‘Thomson’, said to be 2 weeks earlier than ‘Washington’.

Trees are planted on an 8-m x 8-m spacing. There are ten complete blocks of each of the ten selections. Early and mid-season selections were harvested on 12/12/05. This includes ‘Beck-Earli’, ‘Cara Cara’, ‘Fisher’, ‘Fukumoto’, ‘Washington’ and ‘Zimmerman’. Late season selections (‘Chislett’, ‘Lane Late’, ‘Powell’, and ‘Spring’) were harvested on 2/9/2006. Yields are expressed as lbs. fruit per tree. Trees were strip-picked for the harvest. Harvested fruit for each tree is collected in wooden or plastic boxes and weighed. 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 grade data is not reported, as there were no significant differences between the selections. Fruit quality data for all the

selections was collected on their respective harvest dates. Ten fruit were harvested as a sample from each tree for juice quality analysis. We had a large amount of woodpecker damage to the fruit in 2005-06.

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

Results and Discussion

1995 Yuma Navel Orange Trial. (See Figures 1, 2 and 3 as well as Table 1.)

Atwood: Yields of 'Atwood' have historically been lower or 'within the pack', compared to the other selections tested in this trial, and 2005-06 was no exception, and the promise of higher yields that appeared in 2003-04 was not repeated. Nonetheless, yield was about 80% greater than the previous year. Fruit size for this season was typical of the other selections, peaking on size 40. Fruit shape was neither as oblong as 'Fisher', nor as round as 'Lane Late' and 'Washington', and color was superior.

Fisher: Yields of 'Fisher' have been equal to or higher than the other selections tested in this trial, and 2005-06 was no exception. Yields for 2005-06 were 75% better than the previous year, and this is the first year that any of the selections has surpassed 400 lbs per tree. Fruit size for this season is comparable to the other selections, except 'Tulegold', peaking on sizes 40 and 48. Fruit shape was rather oblong, compared to the other selections tested. Color was comparable to the other tested selections.

Lane Late: Yields of 'Lane Late' have typically been similar to yields of the other selections tested in this trial, except for 'Fisher', and 2005-06 was no exception. Yield for 2005-06 was 90% more than the previous year. Fruit size for this season was typical compared to the other selections, peaking on sizes 40 and 48. Fruit shape is round, and color was not as good as the other selections under trial. Because of its greenness, this selection might be harvested later in the season.

Tule Gold: Yields of 'Tule Gold' have typically been lower than the other selections under test, although after 111 years in the ground, these trees are about 50% of the size of the other selections, thus if planting density were increased, yields per acre for this selection might equal the yields of the others. Yields of 'Tulegold' were only about 2/3 of 'Atwood', the next lowest yielding selection, but yields were still just over 50% greater than the previous year. Fruit size was a much smaller than the other selections, peaking on sizes 88 and 113. Fruit was round. Color was surprisingly green in 2005-06.

Washington: Yields of 'Washington' have typically been similar to yields of the other selections tested in this trial, except for 'Fisher', and 2005-06 was no exception. Nonetheless, yield of 'Washington' was 120% greater than the previous year. Fruit size for 2003-04 was larger than most of the other selections, except 'Tulegold', peaking on sizes 40 and 48. Fruit was round, and fruit color was good.

1999 Waddell Navel Orange Trial. (See Figures 4, 5 and 6 as well as Table 2.)

Selections harvested on 12-16-05

Beck-Earli: The 2005-06 yield for 'Beck-Earli' was slightly less than the 2004-05 yields. Still, yield only was 75% of that of 'Fisher'. Fruit size, however, was again the largest of all the early selections tested. 'Beck-Earli' peaked on size 40, 48 and 56, but had appreciable numbers of fruit size 72, and had significantly more of size 36 fruit, than the two other early selections. Percent juice was low, but total soluble solids and TSS:TA was high. Fruit peel was the thickest and fruit was the most oblong of all the selections tested. Fruit was not as orange as 'Fukumoto' but not as green as 'Fisher' in mid-December.

Fisher: Yields of 'Fisher' were the highest for any of the selections tested in this trial, at about 170 lbs. per tree. This represented a 5 lb per tree decrease from the previous year. For these early-maturing navels, fruit size was smaller than 'Beck-Earli' and 'Fukumoto', peaking on size 72 and 88. Fruit quality measurements suggest that percent juice of 'Fisher' is greater than 'Fukumoto', but solids and TSS:TA were not different than the other three selections tested. Peels of 'Fisher' were the thinnest of all the early

selections tested. 'Fisher' also had the roundest fruit, but had the least coloration of all the early-picked selections.

Fukumoto: 'Fukumoto' yields decreased from about 120 lbs. per tree in 2004-05 to 100 lbs. per tree in 2005-06 only about 60% of the yields of 'Fisher'. Fruit size was neither the smallest nor the largest of the three selections harvested early, but still peaking on size 72. There were fewer 'Fukumoto' fruit of size, 40, 48 and 56 than 'Beck-Earli' fruit in the same categories. Fruit quality measurements suggest that 'Fukumoto' had a higher juice content than the other two early selections, and a thinner peel than 'Beck-Earli'. 'Fukumoto' had a good round shape and the most coloration of all the early-picked selections.

Cara Cara: Cara Cara yields for the three years of this study have neither been exceptionally high nor low, but increased from about 90 lb. per tree for 2004-05 to 145 lbs. per tree for 2005-06. 'Cara Cara' and 'Washington' had the greatest yields of the mid-season group. Fruit size of this selection was the largest of the three mid-season selections, peaking on size 72. Fruit quality for 'Cara Cara' was similar to most of the other selections, except this selection had thin peel.

Washington: 'Washington' finally did distinguish itself from the other selections, having a yield of about 150 lbs. per tree, the second highest in the entire trial. Fruit size was larger than 'Zimmerman', and about the same as 'Cara Cara', peaking on size 72. Fruit quality measurements of 'Washington' showed that it had the highest juice content of all the selections tested, but a fairly low TSS level. Fruit of 'Washington' was rather green at harvest.

Zimmerman: 'Zimmerman' had drastically lower yield compared to the other mid-season navel selections, at about 76 lbs. per tree, about 50% less than 'Washington', but about 35% more than its own output for the 2004-05 season. Furthermore, fruit size was smaller than any of the other selections tested. Fruit size peaked on sizes 88. Juice content was low, peel thickness was high, and exterior color was good.

Selections harvested on 2-9-06

Chislett: For 2004-05, 'Chislett' yields, about 97 lbs. per tree, were second only to 'Lane Late' among the late-harvested orange selections. This yield is about 12% less than the 2004-05 season yield. Fruit size for 'Chislett' was the largest for all the selections harvested late, peaking on size 72. Fruit quality of 'Chislett' was not particularly distinguishable from the other late selections tested, but fruit was round, and the exterior coloration was rather green.

Lane Late: Yields of 'Lane Late' were the greatest of any of the late-harvested cultivars, at about 16 lbs. per tree, about 12% higher than the 'Chislett'. Fruit size peaked on sizes 72. Most fruit quality parameters were similar to other selections harvested late.

Powell: Yields for 'Powell' for 2005-06 were similar to those of 2004-05, with yields of just less than 100 lbs. per tree, placing it in the middle of the selections. Fruit size was similar to 'Lane Late' peaking on size 72. 'Powell' had the most juice of any of the late navel orange selections, but was indistinguishable from the other selections in every other way. Yields must improve before this cultivar can be recommended for the desert.

Spring: 'Spring' navel orange yields, at about 88 lbs. fruit per tree, were just lower than those of 'Powell'. Fruit size was just smaller than that of 'Powell', peaking on size 72. Quality of 'Spring' fruit was poorer than the other late selections tested, in that the peels were rather thick, and juice content was low. Fruit coloration was the highest of all the selections under test.

Conclusions

Our results have not yet conclusively demonstrated that navel orange selections other than 'Washington' can be grown successfully on the Yuma Mesa. Low yields are still a problem, except for 'Fisher', but its higher yields are offset by the poor coloration problem. 'Tule Gold' is of interest because of its small tree and fruit size, and may achieve suitable yields per acre if planted closer together. We have not seen the fruit quality problems for this cultivar mentioned by others, but it will be interesting to see if the fruit grade problem persists.

In Waddell, we can begin to draw some conclusions; yet several more years of data are needed to characterize navel orange performance in these trials. The performance of 'Fisher' is noteworthy, yet it is again accompanied by poor coloration (yet much less than in Yuma). 'Beck-Earli' may be improving its yields, and may be worth further notice. 'Cara Cara' improved dramatically. 'Lane 'Late' and 'Chislett' bear watching as this experiment continues.

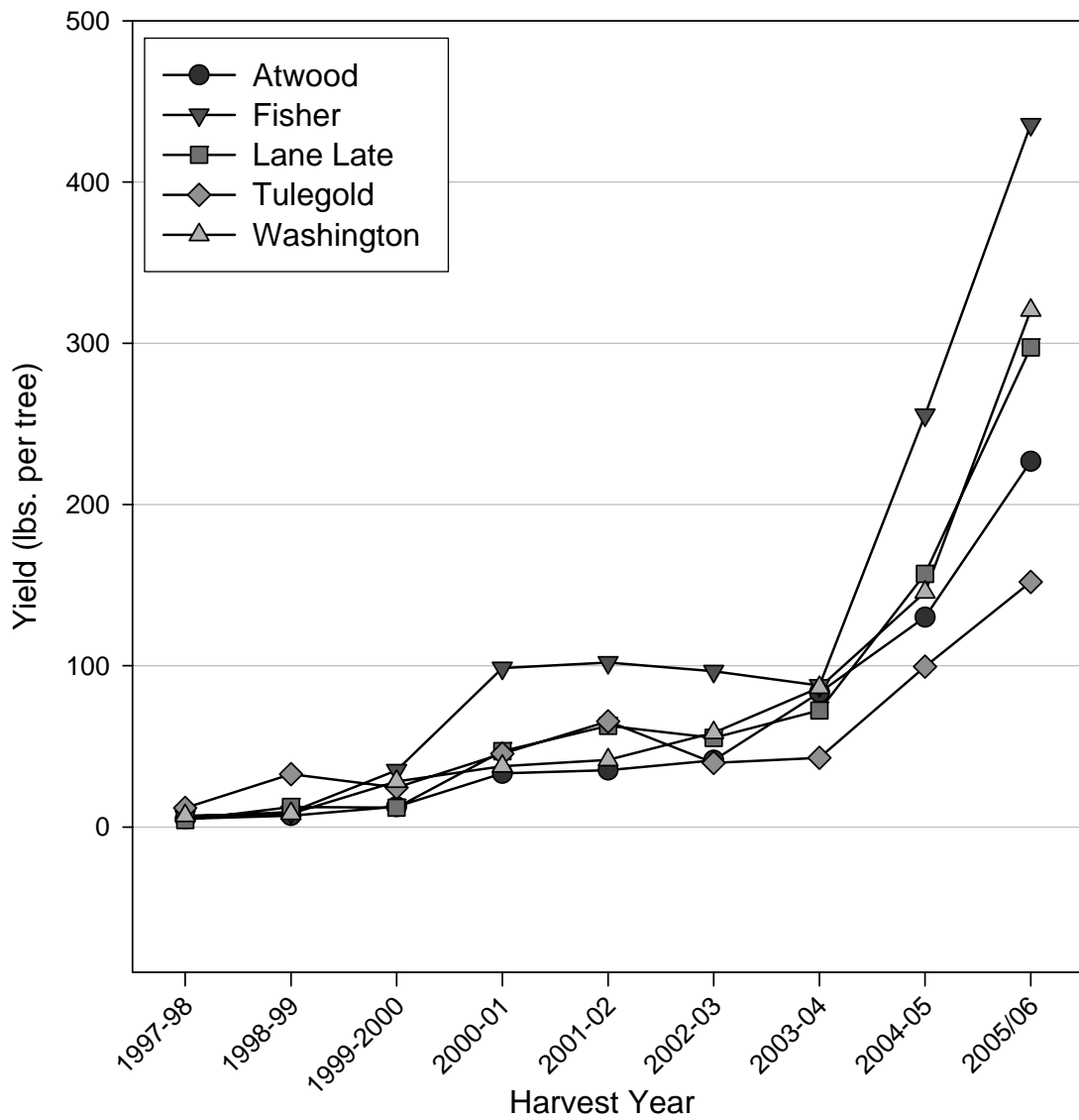


Figure 1. 1997-98 through 2005-06 yields of five navel orange cultivars budded to Carrizo rootstock.

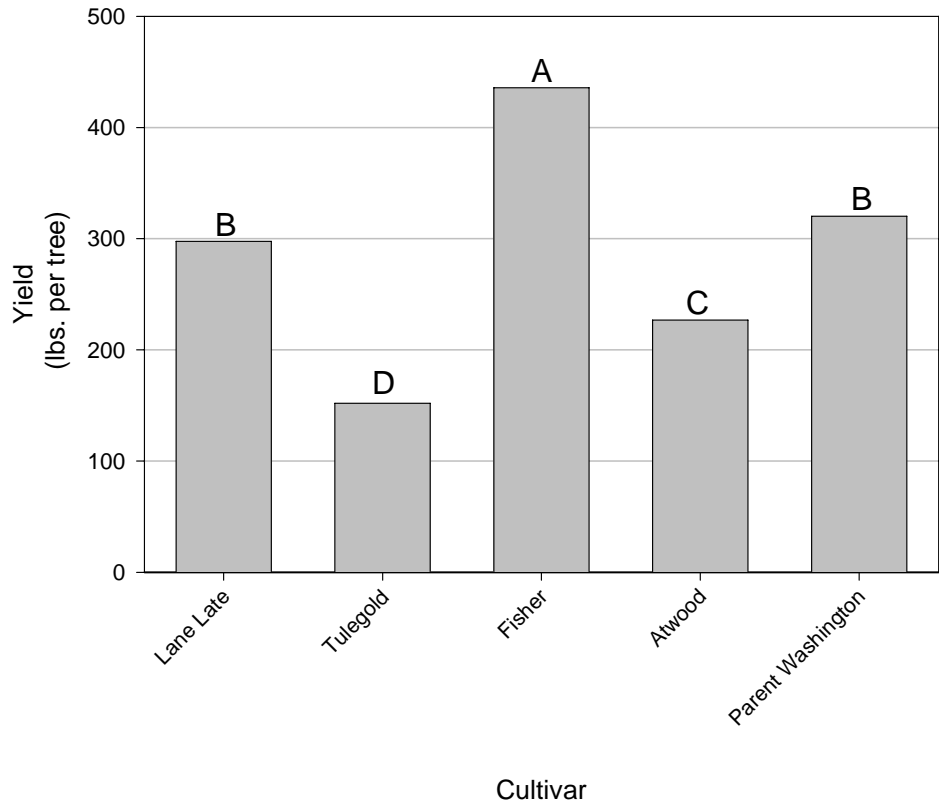


Figure 2. 2005-06 yield of five navel orange cultivars. Letters indicate significant differences between selections, at a 5% level.

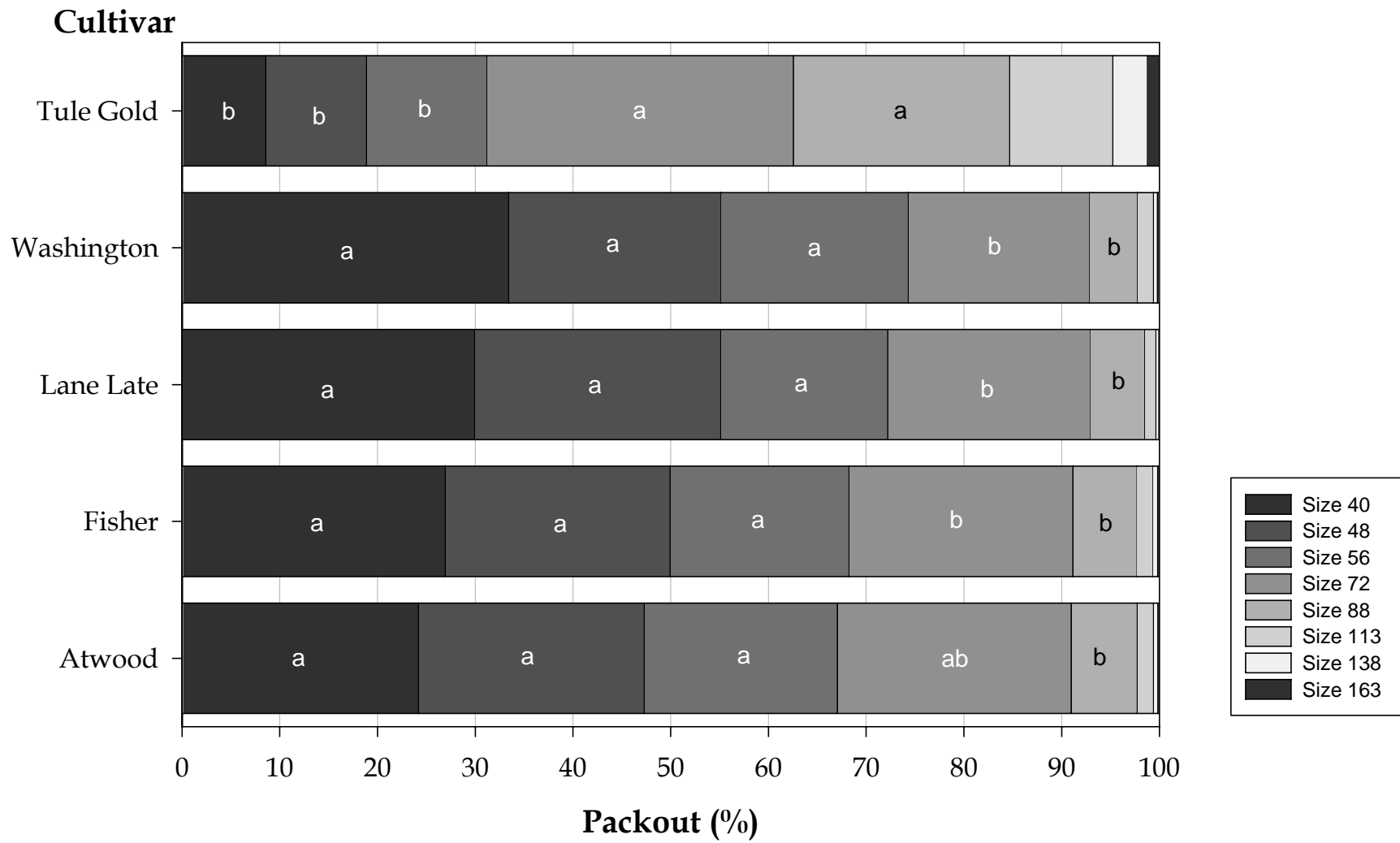


Figure 3. 2005-06 packout of five navel orange cultivars. Letters indicate significant differences between selections, for the same fruit size, at a 5% level.

Table 1. 2004-05 Fruit shape and color of five navel orange cultivars budded to Carrizo rootstock. All fruit was sampled on 12-07-05

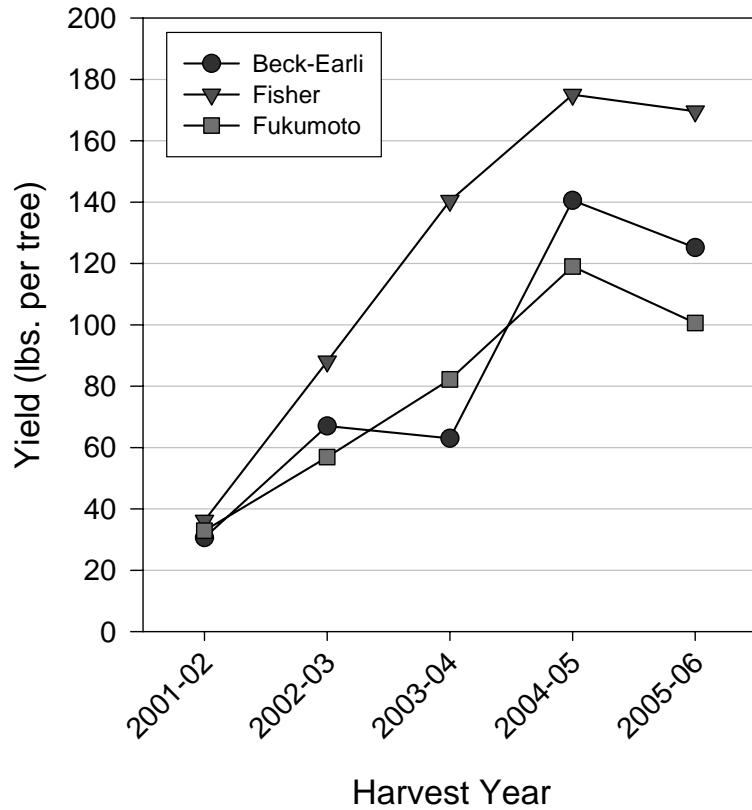
Scion	Fruit Shape ^y	R/G ^x
Atwood	0.87 b	1.78 b
Fisher	0.85 c	1.48 c
Lane Late	0.93 a	1.73 b
Tule Gold	0.89 b	1.39 d
Washington	0.91 a	1.87 a

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

^y A value of 1.00 signifies a completely round fruit.

^x Signifies the red to green intensity ratio of the fruit. A greater value signifies more orange or red color.

Early Season Oranges



Mid and Late Season Oranges

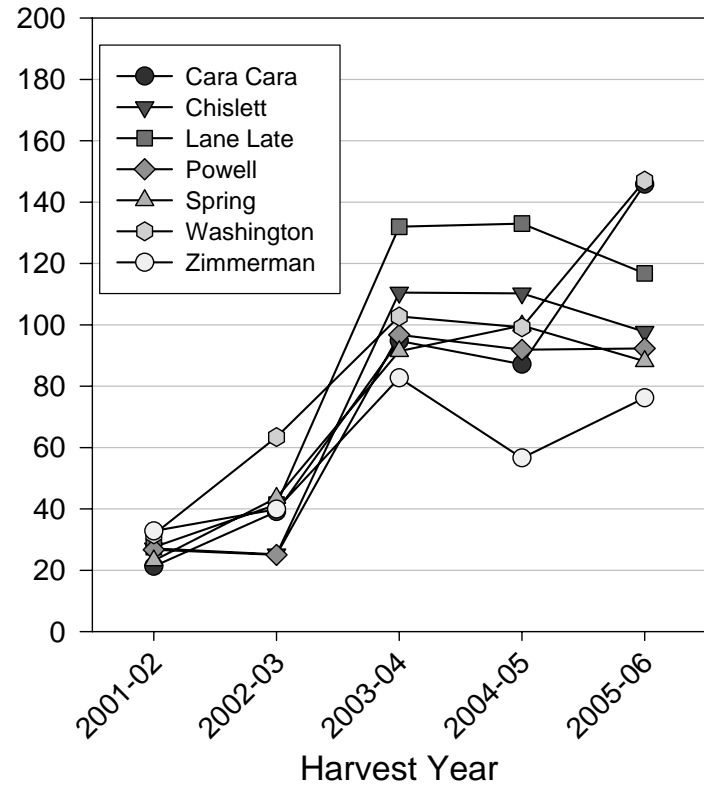


Figure 4. 2001-02 through 2005-06 yields of ten navel orange cultivars budded to Carrizo rootstock.

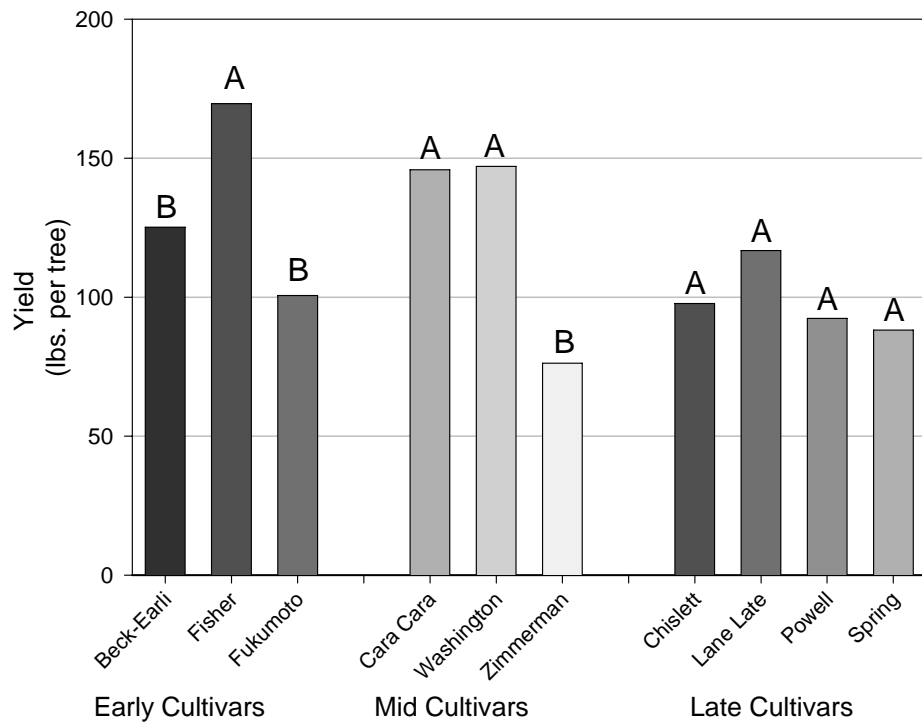


Figure 5. 2005-06 yield of ten navel orange cultivars budded to Carrizo rootstock. Letters indicate significant differences between selections, at a 5% level.

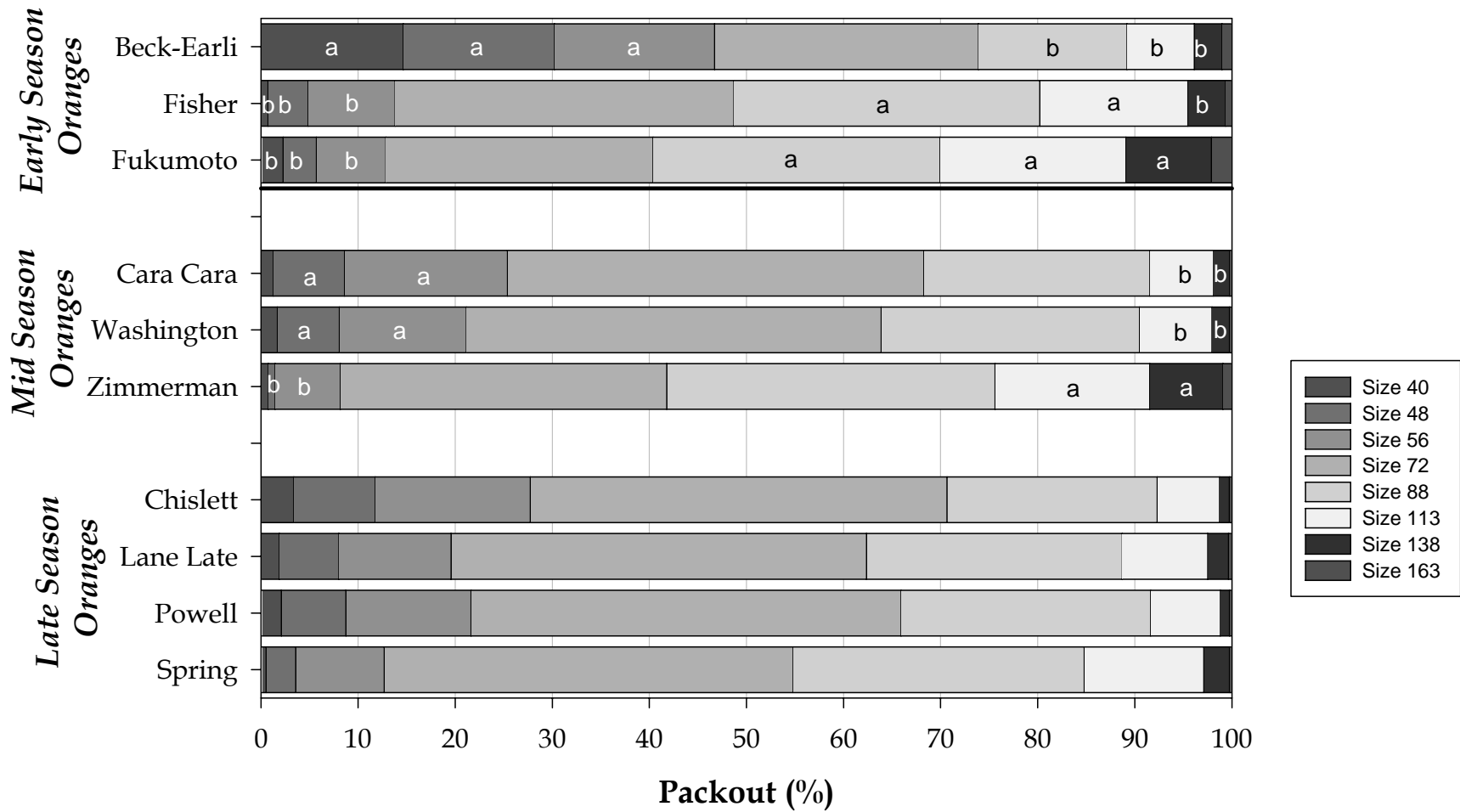


Figure 6. Packout of ten navel orange cultivars harvested in the 2004-05 season. Letters indicate significant differences between selections, for the same fruit size, at a 5% level.

Table 2. 2005-06 Fruit Quality of ten navel orange cultivars budded to Carrizo rootstock.

Scion	Juice Content (%)	TSS (%)	TSS:TA	Peel Thickness (mm)	Fruit Shape ^y	R/G ^x
Beck-Earli	43.8 cd	14.64 ab	26.79 a	3.69 a	0.86 a	1.64 b
Fisher	49.8 ab	14.68 ab	24.67 abc	2.58 b	0.86 a	1.45 c
Fukumoto	44.1 bcd	14.89 a	26.68 a	2.83 b	0.85 a	1.73 a

Cara Cara	44.7 abc	13.80 abc	23.10 bc	2.48 b	0.88 b	1.52 b
Washington	50.2 a	13.34 c	22.45 bc	2.74 b	0.86 b	1.44 c
Zimmerman	38.8 d	14.20 abc	24.49 abc	4.39 a	0.94 a	2.10 a

Chislett	46.9 abc	13.52 bc	24.00 abc	4.09 a	0.90 a	1.75 c
Lane Late	47.6 abc	13.81 abc	22.03 c	4.01 a	0.89 a	1.94 b
Powell	49.8 abc	13.64 bc	23.32 bc	3.92 a	0.89 a	1.78 c
Spring	42.2 cd	13.85 abc	25.85 ab	4.37 a	0.91 a	2.24 a

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

^y A value of 1.00 signifies a completely round fruit.

^x Signifies the red to green intensity ratio of the fruit. A greater value signifies more orange or red color.