International Journal of Horticultural Science and Technology
Vol. 1, No. 1;June 2014, pp 21-29

Phenological Characteristics, Yield, and Fruit Quality of Yellow-Fleshed Nectarines under High Desert Conditions of the Northwestern United States over Five Years

Esmaeil Fallahi [1*], Bahar Fallahi [2], Kourosh Vahdati [3], Michael J. Kiester [4]

1. Professor and Director of Pomology and Viticulture Program, University of Idaho, Parma Research and Extension Center, 29603 U of I Lane, Parma, ID 83660, USA.
2. Research Pomologist, University of Idaho, Parma, ID 83660, USA.
3. Professor of Pomology, Department of Horticulture, Aburaihan Campus, University of Tehran, Tehran, Iran.
4. Pomology Research Assistant, University of Idaho, Parma, ID 83660, USA.

(Received: February 16, 2014, Accepted: May 17, 2014)

Abstract
An increasing world population and the competitive nature of the stone fruit market, particularly nectarines [(*Prunus persica* var. *nectarine)*], demand the selection of fruit with high quality attributes, flavor, and a wide range of maturity. Information on this subject is limited at the present time. In search of superior nectarines, a trial was conducted to study growing degree days (GDD), full bloom and harvest dates, fruit quality attributes, and yield of 11 yellow-fleshed nectarines under the high desert conditions of southwest Idaho in the northwestern region of the United States; these factors were studied over a span of 5 years. The average response analyses results over these years revealed that 'Fantasia' and 'Honey Kist' bloomed earlier, while A28.082 and 'Summer Fire' bloomed later than other cultivars. 'Diamond June' and 'Honey Kist' were the earliest cultivars to harvest and needed 110 and 114 days between full bloom and harvest, respectively. On average, 'Sparkling Red' and A28.082 were harvested after the second half of September, and the periods between bloom and harvest for these cultivars were 161 and 166 days, respectively. The difference between the earliest and latest cultivars for full bloom dates was only 4 days or 26.7^{o}C GDD, while the range for harvest dates was 57 days or 943.7^{o}C GDD. Considering all factors evaluated in this project, 'Honey Kist' is suitable as an early cultivar. 'Summer Grand' would be a good choice as a yellow-fleshed cultivar with moderately high soluble solids concentration (SSC), while 'Fantasia' would be an excellent choice for a yellow-fleshed cultivar if fruit appearance, large size, and high yield are the main objectives of nectarine production during the period of late-August to early-September. A28.082 was a good choice for planting as a very-late maturing yellow-fleshed cultivar. It had attractive fruit color, high fruit SSC, a high number of fruit per tree and large fruit size, and hence high yield.

Keywords*:* Cultivar performance, fruit flavor, nectarine selection, stone fruit adaptability.

Abbreviations: DGDD, daily growing degree days; DY, day of the year; GDD, cumulative growing degree days; K, potassium; KCl, potassium chloride; N, nitrogen; P, phosphorous; SSC, soluble solids concentration.

[*] Corresponding author: E-mail: efallahi@uidaho.edu

Introduction

There are more options for choosing nectarine and peach cultivars than for other deciduous fruit, because there are needs for cultivars with 1) different ranges of chilling requirements; 2) various maturity and harvest dates to fulfill the market demand; 3) a range of flavors and tastes for diverse consumers. According to the Fruit Tree Census (United States Department of Agriculture, 2007), peaches constituted 21% and nectarines constituted 2% of Idaho's total tree fruit production in 2006, which was a considerable increase compared to 1999. After several decades, peach cultivars such as 'Early Red Haven', 'Late Red Haven', 'Red Globe', 'Early Hale', 'J.H. Hale', and 'Improved Elberta' have been included among the popular cultivars in many areas (Yost and d'Easum, 1980). In the northwestern United States, new nectarine and peach orchards are often planted in old 'Delicious' apple orchard sites. The increasing production of nectarines and peaches in the high desert conditions of this region stems from a market demand for the high quality stone fruit that can be produced in this area. The climate and soil conditions of this region are similar to those in many fruit-producing areas, particularly those in the Alborz Province, Azarbaeijan, and Khorasan regions of Iran (E. Fallahi and K. Vahdati, personal knowledge). Warm dry days and cool nights during the growing season and at fruit maturity create suitable conditions for growing high quality nectarines and peaches in these regions.

Similar to the situation in other nectarine-producing states (Frecon *et al.*, 2002), many suitable orchard sites are utilized for development and urbanization in Idaho, Colorado, and Washington. The pressure for urbanization and the competitive nature of world markets mandate the production of new cultivars with high quality attributes that mature over a span of time for a wide market window. In reports by Huang *et al.* (2008) and the California Tree Fruit Agreement (CTFA, 2003), peaches and nectarines are classified into five categories according to the length of the period between full bloom and harvest:

1."Very early cultivars", which have less than 65 days from full bloom to harvest,

2."Early cultivars", which have 66-90 days from full bloom to harvest,

3."mid-season cultivars", which have 91-120 days from full bloom to harvest,

4."late-season cultivars", which have 121-150 days from full bloom to harvest, and

5."very late cultivars", which have more than 151 days from full bloom to maturity.

Based on the California Tree Fruit Agreement (2003), of the total production of 186,660 metric tons of leading nectarines in California during 2002-03, 14.2%, 35.3%, 25.0%, 19.2%, and 6.3% were produced in May, June, July, August, and September, respectively. Cultivars in each group have their advantages and disadvantages, and they are planted according to the marketing outlet and strategy of each grower.

A majority of consumers accept yellow-fleshed nectarines, but sub-acid white-fleshed nectarines are popular among consumers of Asian ethnic background (Bruhn *et al.*, 1991). Yellow-fleshed nectarines are less susceptible to bruising (Brooks and Olmo, 1972; Brooks and Olmo, 1997; Crisosto *et al.*, 2001; Okie, 1998; Robertson *et al.*, 1990; Whealy and Demuth, 1993). Frecon *et al.* (2002) compared the peach and nectarines developed in New Jersey with some white-fleshed cultivars from other locations and found that 'Carolina Belle', 'Klondlike', 'Blushing Star', 'Sugar Giant', 'Snow Giant', and 'Arctic Jay' showed promise for planting. Performance of nectarines and/or peaches in the southeast (Okie, 1998) and other regions of the United States (Fallahi *et al.*, 2009; Okie *et al.*, 2008; Shane and Iezzoni, 2007) were also reported, and some of these new cultivars were found to be superior to previously planted ones.

In spite of the increasing commercial nectarine production, there is no comprehensive or comparative information on the bloom and harvest dates, yield, or quality of this fruit. The goal of this long-term

project was to investigate the growing degree days, bloom and harvest dates, yield, and fruit quality of 11 yellow-fleshed nectarines under the high desert conditions of southwest Idaho in the northwestern United States in order to identify the most promising cultivars for commercial use and export markets.

Materials and Methods

Orchard description and cultural practices

The experimental orchard was established at the University of Idaho Parma Research and Extension Center, near Parma in southwestern Idaho, which is a representative area of high desert fruit-producing orchards in the northwestern region of the United States. This region has an annual precipitation of about 274 mm, lat. 43°48' 00"N, long.116°56'00", an average minimum daily temperature of -27.6°C in January and an average maximum daily temperature of 34.3°C in July, and an elevation of 702.6 m.

Uniform certified nectarine trees on 'Nemaguard' rootstock with a 1.27 cm trunk diameter (at planting) were obtained from different nurseries in California. Eleven yellow-fleshed nectarine cultivars were planted with 2.4×5.0 m spacing in April 2000. The list of cultivars is presented in Tables 1-4 and Fig. 1.

Fig. 1. Cultivars used in this study

Trees were trained into a 4-leader vase shape. The soil was sandy loam with a pH of 7.1 to 7.3. Urea nitrogen ($CO(NH_2)_2$ mixed with potassium chloride (KCl) and P were applied annually in the month of May to provide actual amounts of N, P, and K at rates of 123.2, 61.6, and 67.2 kg ha^{-1} per year, respectively. This mixed fertilizer was broadcast in an approximately 1-m band on either side of tree rows.

Trees were irrigated weekly with a sprinkler system to match the evapotranspiration requirements for nectarine (ETc). Information from the Agrimet Weather Station at the University of Idaho, Parma, Idaho was used to calculate ETc. Annual pruning, spraying, and other cultural practices in this experiment were similar to those of commercial orchards in the region (Washington State University, 2014). Fruit was thinned by hand just before the pit hardening stage (about 6 weeks after full bloom) to maintain a 12 to 15 cm spacing between fruit.

Bloom and harvest dates, growing degree dates, yield, and quality

Dates of full bloom (about 80% blooms open) and commercial harvest (when most of the fruit was ready to be harvested as judged visually by flesh and skin color) for each tree were recorded every year from 2003 to 2007. In addition to the actual dates, 'day of the year' (DY) for full bloom and harvest dates was also recorded. Daily growing degree days (DGDD) from 1 Jan. to full bloom and harvest dates were calculated as:[(daily maximum plus minimum temperatures in Centigrade/2) – (4.4^{o}C)]. Cumulative growing degree days (GDD) were calculated as the sum DGDD to the full bloom or harvest dates for each cultivar in each year. 4.4^{o}C was chosen as the base temperature in DGDD calculations, because even at these low temperatures, blooms will develop, although the rate of development is slower (E. Fallahi, personal observation, unpublished data).

Fruit color and total yield (kg per tree) were measured at harvest time every year between 2003 and 2006. Ten fruit were randomly sampled from each tree in the middle of commercial harvest time. Average fruit weight from 2003 to 2005 and soluble solids concentration (SSC) in 2004 and 2005 were measured with a hand-held temperature-compensated refractometer (Atago N1, Tokyo, Japan). Fruit skin and flesh color were inspected visually and described based on shades of color ranging from green, white, yellow, to deep red.

Experimental design

The experiment was arranged as a complete randomized design with six one-tree replications per cultivar. Data was analyzed using general linear model (GLM) procedures. Fisher's protected LSD ($P \leq 0.05$) was used to separate treatment means. Statistical analyses were carried out using SAS (version 9.2; SAS Institute, Cary, NC).

Results and Discussion

Bloom dates and growing degree days for bloom

Nectarine cultivars in Table 1 are listed in ascending order of long-term average full bloom dates and DY for full bloom. Considering all cultivars over the period 2003 to 2007, dates of full bloom ranged from 1 to 25 April (total of 24 days). Averaging values for either actual full bloom dates or DY over 2003-07 revealed a 4-day or 26.7^{o}C GDD difference between the earliest and latest blooming cultivars. On average, 'Fantasia' and 'Honey Kist' bloomed earlier (7 April), while A28. 082 and 'Summer Fire' bloomed later than other cultivars (between 9-11 April). In this experiment, the variation for full bloom time was greater between years than among cultivars within a given year. Trees within each cultivar and each year had very small variations in their full-bloom dates due to the uniformity of tree and soil. This knowledge will facilitate cultural practices such as blossom thinning that would otherwise be difficult (i.e., if wide tree-to-tree or year-to-year variation occurred).

During warmer seasons, differences in bloom dates still existed between cultivars, but the differences were less than those in cooler seasons. For example, GDD for the period between 30 March and 25 April was 204°C in 2004 and 144°C in 2005 (data not shown). However, the difference between the earliest- and latest-blooming cultivars was 2 days in 2004 and 8 days in 2005 (Table 1). Historically, the chance of spring frost diminishes for late-blooming cultivars in southwest Idaho, although differences in bloom dates were not great. Therefore, the very late-blooming cultivars such as 'Summer Fire' may have a slightly lower chance of experiencing frost damage.

Table 1. Full bloom date (FB), growing degree-day (GDD) and average day of the year to full bloom in different cultivars of nectarines grown under southwest Idaho conditions, listed in ascending order of their FB dates [zy]

Cultivar	Full bloom (FB) dates							Avg. GDD [x] (2003-07)	Avg. day the year for FB (2003-07)
	Type of flower	2003	2004	2005	2006	2007	Avg. FB day 2003-07		
Fantasia	Showy	1 Apr.	5 Apr.	7 Apr.	18 Apr.	4 Apr.	7 Apr.	209.4	97
Honey Kist	Showy	1 Apr.	3 Apr.	10 Apr.	18 Apr.	5 Apr.	7 Apr.	209.4	97
Summer Beaut	Non-Showy	1 Apr.	5 Apr.	10 Apr.	19 Apr.	4 Apr.	8 Apr.	217.2	98
Sparkling Red	Showy	2 Apr.	5 Apr.	11 Apr.	20 Apr.	6 Apr.	8 Apr.	217.2	98
Diamond Ray	Showy	1 Apr.	5 Apr.	10 Apr.	19 Apr.	6 Apr.	8 Apr.	217.2	98
Red Diamond	Non-Showy	1 Apr.	5 Apr.	10 Apr.	20 Apr.	5 Apr.	8 Apr.	217.2	98
Summer Grand	Showy	1 Apr.	5 Apr.	10 Apr.	19 Apr.	6 Apr.	8 Apr.	217.2	98
Supreme Red#1	Showy	1 Apr.	4 Apr.	10 Apr.	18 Apr.	6 Apr.	8 Apr.	217.2	98
Diamond June	Showy	1 Apr.	4 Apr.	10 Apr.	20 Apr.	5 Apr.	8 Apr.	217.2	98
A28.082	Showy	5 Apr.	5 Apr.	10 Apr.	19 Apr.	5 Apr.	9 Apr.	223.3	99
Summer Fire	Non-Showy	5 Apr.	5 Apr.	15 Apr.	25 Apr.	6 Apr.	11 Apr.	236.1	101
LSD							1	5.17	1

[z]Abbrevitions: Apr.=April.
[y] Mean separation within columns using LSD at 5% significant level.
[x] GDD=cumulative Growing Degree-days from 1 Jan., °C= ∑[(daily maximum plus minimum temperatures in Centigrade/2) –(4.4 °C)].

Commercial harvest date and growing degree days for harvest

Cultivars presented in Tables 2-4 are arranged in ascending order of their 2003-07 average harvest dates and DY for these dates. Significant differences ($p \leq 0.05$) existed in commercial harvest dates and GDD to harvest among cultivars (Table 2). The harvest date for each cultivar varied from year to year, but the order of harvest among cultivars generally stayed the same in each season, and no significant interaction existed between cultivars and years. The range among cultivars was more spread for their harvest dates than their bloom dates. For example, averaging values over 2003-07 revealed that the difference between the earliest and latest cultivars for full bloom dates was only 4 days and 26.7°C GDD, while for harvest dates it was 57 days and 943.7 GDD°C (difference between 27 July and 22 September). The earliest cultivar in our evaluation was 'Diamond June' with 110 days between full bloom and harvest and, on average, it was harvested on 27 July. Thus, the earliest cultivar in our evaluation fits in the mid-season category of Huang *et al.* (2008). 'Honey Kist' was also early and was harvested on 30 July. On average, it needed 114 days from full bloom to harvest (Table 2). 'Sparkling Red' and A28.082 were harvested after the second

half of September, and the period between bloom and harvest for these cultivars was 161 and 166 days, respectively. Thus, these nectarines are considered to be "very late" cultivars according to the California Tree Fruit Agreement (2003) and Huang *et al.* (2008) categorization.

With the competitiveness of the nectarine market, in addition to the favorable climatic conditions, time of harvest (early, mid, or late season), quality attributes, and yield should be considered before planting a cultivar. According to the California Tree Fruit Agreement (2003), of the total nectarines produced in California during 2002-2003, 14.2%, 35.3%, 25.1%, 19.2%, and 6.2% were harvested in May, June, July, August, and September, respectively. A comparison of results from selected cultivars used in both the California Tree Fruit Agreement (2003) and our experiment revealed that nectarines were harvested several weeks later in southwest Idaho than in California. It is noteworthy that differences in the harvest dates between California and Idaho were greater for the early-maturing cultivars than for the late-maturing cultivars (Table 2). For example, these differences were 48, 46, and 51 days for the earlier-maturing cultivars of 'Honey Kist', 'Red Diamond', and 'Diamond Ray', respectively, while they were 30 and 34 days for the late-ripening cultivars of 'Arctic Mist' and 'Arctic Snow', respectively (data not shown). Comparison of these harvest days underscores the importance of knowing the harvest dates of various nectarines in southwest Idaho. Our early-season nectarines were harvested at a time that many mid-season nectarines from California were in the market. Thus, our early cultivars would be suitable for local and farmers' markets. However, mid- and late-season nectarines (Table 2) were harvested at a time when the California market for those cultivars had either slowed down or was over, thus providing an excellent market window for growers in southwest Idaho and other similar regions in the northwestern United States.

Table 2. Harvest date (HD), growing degree-days (GDD) and day of the year (DY) for HD in various nectarine cultivars under high desert conditions of Northwestern United States, listed in ascending order of their average harvest dates[z]

Cultivars	Harvest Date (HD)						Calif.HD[y]	GDD[x] for harvest	Avg. DY for harvest	Full bloom to harvest (days)
	2003	2004	2005	2006	2007	Avg. HD 2003-07				
Diamond June	30 Jul.	20 Jul.	28 Jul.	31 Jul.	27 Jul.	27 Jul.	-	1746.4	208	110
Honey Kist	4 Aug.	23 Jul.	1 Aug.	31 Jul.	31 Jul.	30 Jul.	12 June	1811.6	211	114
Summer Beaut	12 Aug.	24 Jul.	5 Aug.	15 Aug.	7 Aug.	7 Aug.	-	1972.4	216	118
Red Diamond	30 Jul.	3 Aug.	10 Aug.	19 Aug.	17 Aug.	10 Aug.	25 June	2030.8	219	121
Diamond Ray	21 Aug.	15 Aug.	22 Aug.	24 Aug.	17 Aug.	20 Aug.	30 June	2216.9	232	134
Supreme Red#1	30 Aug.	15 Aug.	18 Aug.	24 Aug.	24 Aug.	22 Aug.	-	2253.7	234	136
Summer Grand	1 Sept.	22 Aug.	26 Aug.	29 Aug.	31 Aug.	28 Aug.	-	2351.6	240	142
Fantasia	4 Sept.	2 Sept.	9 Sept.	30 Aug.	31 Aug.	3 Sept.	-	2450.5	246	149
Summer Fire	14 Sept.	30 Aug.	19 Sept.	18 Sept.	5 Sept.	11 Sept.	-	2570.6	254	153
Sparkling Red	18 Sept.	14 Sept.	20 Sept.	18 Sept.	12 Sept.	16 Sept.	-	2639.9	259	161
A28.082	22 Sept.	21 Sept.	20 Sept.	25 Sept.	20 Sept.	22 Sept.	-	2690.1	265	166
LSD								92.8	9	10

Fruit Quality Attributes and Yield

Fruit color. Descriptions for fruit skin and flesh color are presented in Table 3, and other quality attributes and yield are shown in Table 4. Although fruit skin colors are generally categorized as yellow and red, a range of colors was observed in these cultivars. All cultivars developed attractive yellow flesh and skin color due to the warm days and cool nights in the area.

A28.082 and all yellow-fleshed cultivars had distinctively attractive skin and flesh color. A28.082 had an orange-red background color with large irregular red blotches.

Fruit weight. 'Diamond June' and 'Honey Kist' (both early-maturing cultivars) had smaller fruit than other cultivars, and their long-term average fruit weight (AFW) was less than 142 g (Table 4). 'Supreme Red #1', 'Fantasia', and A28.082 had consistently larger fruit than many other cultivars, and their average fruit weights exceeded 214 g over three growing seasons (Table 4). All trees in this experiment were pruned and thinned uniformly; nevertheless, the fruit size differences in some of these cultivars could be due to their lower yield or genetic characteristics.

Soluble solids concentration (SSC). With the exception of 'Diamond June', fruit of the late-maturing cultivars that on average were harvested after 10 September (Table 2) had greater than 14.9^{o}Brix SSC (Table 4). This finding is in general agreement with those of Frecon *et al*. (2002), who worked with a different set of nectarine cultivars and reported that early-maturing cultivars had lower SSC. Averaging values over 2004-05, 'Summer Fire' had higher SSC than all other cultivars. Among all cultivars, 'Honey Kist', 'Supreme Red #1', and 'Fantasia' had, on average, less than 13^{o}Brix SSC.

Fruit weight did not always correlate strongly with SSC. For example, 'Diamond June' with an AFW of 141.3 g and 'Diamond Ray' with an AFW of 173.1 had average SSCs of 13.5 or higher (Table 4).

Yield per tree and fruit number. Several cultivars had lower yield in 2003 compared to other years, because the trees were young (Table 4). There was no strong correlation between yield and time of harvest in these cultivars. 'Honey Kist', which was among the earliest cultivars to harvest (Table 2), had the highest yield, in spite of its small fruit size (Table 4). This is because this cultivar had a higher number of fruit per tree (Table 4). 'Fantasia' had the highest average yield, because it was among the cultivars having high fruit number and large fruit size. These factors make this cultivar an excellent choice for planting under conditions similar to those in our experiment. 'Supreme Red #1' and 'Summer Fire' had lower yield and fewer fruit. The relatively larger fruit size in these cultivars could not compensate for their lower yield, and thus they may not be suitable cultivars for commercial use.

Overall performance. Considering all factors evaluated in this project, we believe that 'Honey Kist' is suitable as an early cultivar for harvest near the end of July (Table 2). Although its fruit is small, the trees are productive (Table 4). This cultivar can be planted on a limited scale for early market. However, it should be noted that, similar to many other cultivars, the 'Honey Kist' nectarine is susceptible to russeting.

Based on this research, we suggest planting 'Summer Grand' and 'Fantasia' for the harvest period of 21August to 3 September. 'Summer Grand' would be a good choice if a sweeter yellow-fleshed cultivar is in demand, while 'Fantasia' would be an excellent choice if fruit appearance (Table 3), large size and number of fruit, and high yield (Table 4) are the main objectives for harvest in late-August to early-September.

Among those that matured between 20 and 22 September, A28.082 was an outstanding cultivar, not only compared to late-maturing cultivars, but also among all cultivars in our experiment. Trees of A28.082 had a relatively high number of fruit per tree and large size fruit, and hence high yield. Fruit of this cultivar also had distinctively attractive and appealing skin and flesh color (Table 3). We therefore recommend planting this cultivar as a very late cultivar (166 days from bloom to harvest) for the region.

Acknowledgments

Authors wish to thank the Idaho Stone Fruit Committee and the Idaho Agricultural Experiment Station for their financial support of this project. Authors are also thankful to PipeCo, Fruitland, USA, for providing the irrigation materials.

Table 3. Fruit skin and flesh color of nectarine cultivars grown under high desert conditions of Northwestern Unites States, listed in ascending order of their average harvest dates

Cultivar	Fruit skin color	Flesh color	Comments
Diamond June	Light to dark maroon with cream color blotches	Yellow with bleeding red	Early
Honey Kist	Red to dark maroon with cream blotches	Yellow with red spot near skin	Excellent but small
Summer Beaut	Orange to dark maroon with cream blotches	Yellow with red stain near skin	
Red Diamond	Dark orange to maroon with some blotches	Yellow with red stain	
Diamond Ray	Light to deep dark maroon with some blotches	Orange with red stripes and big red stain on the calyx end.	
Supreme Red#1	Medium red to maroon	Yellow with red blush	
Summer Grand	Medium to dark red with some orange stain	Yellow with red stain around the pit	
Fantasia	Yellow to dark red	Yellow with pink stain near the pit	Good production

Table 4. Yield and fruit quality attributes of various yellow-fleshed nectarines grown under high desert conditions of Northwestern United States

	Fruit weight (g)				Yield (kg/tree)					Avg. fruit No./tree 2003-06	Soluble solids concentration (^{o}Brix)		
	22003	2004	2005	Avg. 2003-05	2003	2004	2005	2006	Avg. 2003-06		2004	2005	Avg. 2004-05
Diamond June	136.9	136.3	150.7	141.3	5.98	10.8	18	13.1	11.98	85	12.7	14.3	13.5
Honey Kist	.	122.6	159.5	141.1	8.8	10	15.6	31.4	16.4	117	13.2	12.4	12.8
Summer Beaut	132.5	166.1	177.9	158.8	9.2	11	16.8	15.9	13.2	83	12.8	13.2	13.0
Red Diamond	.	146.7	151.4	149.1	12.1	8.1	5.6	11.4	9.3	63	13.9	12.5	13.2
Diamond Ray	134.2	190.4	194.7	173.1	7.0	4.3	15.8	29.4	14.1	82	15.4	11.8	13.6
Supreme Red#1	191.9	.	237.9	214.9	0.6	.	9.3	10.4	6.8	32	.	11.6	11.6
Summer Grand	174.5	178.9	198.9	184.1	6.31	7.5	18.8	15.5	12.0	65	14.8	13.4	14.1
Fantasia	192.4	225.1	249.7	222.4	14.1	15.4	19.4	24.7	18.4	83	13.0	12.8	12.9
Summer Fire	158.9	179.1	167.9	168.6	5.8	8.4	3.8	15.3	8.3	49	13.1	19.6	16.4
Sparkling Red	152.4	160.9	188.8	167.4	4.9	12.5	11	12.2	10.1	61	13.6	16.2	14.9
A28.082	184.8	210.6	253.9	216.4	17.0	11.6	14.4	24.1	16.8	77	15.4	14.8	15.1
LSD	15.2	16.2	16.5	12.2	2.2	4.0	5.0	5.5	4.2	5	1	1.3	1

[z] Mean separation within columns using LSD at 5% significant level

References

1. Brooks. R.M. and H.P. Olmo. 1972. *Register of new fruit and nut cultivars*: 2nd ed. ASHS Press, Alexandria, Virginia, USA.
2. Brooks, R.M. and H.P. Olmo. 1997. *Register of new fruit and nut cultivars*: 3rd ed.. ASHS Press, Alexandria, Virginia, , USA
3. Bruhn, C.M., N. Feldman, C. Garlitz, J. Hardwood, E. Ivan, M. Marshall, A. Riley, D. Thurber, and E. Williamson. 1991. Consumer perceptions of quality: apricots, cantaloupes, peaches, pears, strawberries, and tomatoes. *J. Food Quality* 14:187-195.
4. California Tree Fruit Agreement. 2003. California Tree Fruit Agreement 2002 annual report. *California Tree Fruit Agreement*, Sacramento, California, USA.
5. Crisosto, C.H., K.R. Day, G.M. Crisosto, and D. Garner. 2001. Quality attributes of white flesh peaches and nectarines grown under California conditions. *J. Amer. Pomol. Soc. 55:45-51*.
6. Fallahi, E., B. Fallahi, B. Shafii, and M.E. Amiri. 2009. Bloom and harvest dates, fruit quality attributes and yield of modern peach cultivars in the Intermountain Western United States. *HortTechnology.* 19:823-830.
7. Frecon, J.L., R. Belding, and G. Lokaji. 2002. Evaluation of white-fleshed peach and nectarine cultivars in New Jersey. Acta Hort.592: 467-477.
8. Huang, H., Z. Cheng, Z. Zhang, and Y. Wang. 2008. History of cultivation and trend in China, p. 37-60. In: D.R. Layne. and D. Bassi, (eds.) *The Peach, botany, production and uses.* CABI, Wallingford, UK.
9. Okie, W.R. 1998. Handbook of peach and nectarine cultivars: Performance in the southeastern United States and index of names. *U.S. Dept. of Agr.-Agr. Res. Serv. Hdbk. No. 714.* Washington D.C.
10. Okie, W.R., T. Bacon, and D. Bassi. 2008. Fresh market cultivar development, p. 139-174. In: D.R. Layne. and D. Bassi, (eds.) *The Peach, botany, production and uses*. CABI, Wallingford, UK.
11. Robertson, J.A., A.J. Horvat, B.G. Lyon, F.I. Meredith, S.D. Senter, and W.R. Okie. 1990. Comparison of quality characteristics of selected yellow- and white-fleshed peach cultivar. *J. Food Sci. 55:*1308-1311.
12. Shane, W. and A. Iezzoni. 2007. Peach breeding program. 2007. *Annual Report for 2007.* Tree Fruits. Michigan State University, Southwest Michigan Research and Extension, East Lansing, Michigan, USA.
13. Washington State University. 2014. Washington State University Tree Fruit Research & Extension Center. 4 Feb. 2014. <*http://www.tfrec.wsu.edu/*>.
14. U.S. Department of Agriculture. 2007. Idaho tree fruit census 2006. *U.S. Dept. Agr. Idaho Field Office*, Boise, Idaho, USA.
15. Whealy, K. and S. Demuth. 1993. Fruit, berry and nut inventory. *2nd ed. Seed Savers Publications*, Decorah, Iowa, USA.
16. Yost, G. and D. d'Easum. 1980. Idaho, *The fruitful land. Syms-York Company*, Boise, Idaho