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Growing Degree Days, Bloom and Harvest Dates, Fruit Quality and Yield of New Yellow and White Nectarines

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Abstract

A long-term trial was conducted to investigate growing degree-days (GDD; base temperature of 4.4°C), full bloom and harvest dates, fruit quality, and yield of various yellow-and white-fleshed nectarines [(*Prunus persica* var. *nectarine*)] under conditions of southwest Idaho during 2003-07. The average response analyses over these years indicated that 'Arctic Jay', 'Fantasia', 'Honey Kist', and 'Arctic Pride' bloomed earlier, while 'Arctic Mist', A28.082 (a selection from Burchell Nursery, California), 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', 'Arctic Pride', A28.082, 'Arctic Snow' were harvested after the second half of September, and the periods between bloom and harvest for these cultivars were 161, 166, 166 , 180, and 181 days, respectively. The difference between the earliest and latest cultivars for full bloom dates was only 4 days or 26.7°C GDD, while the range for harvest dates was 68 days or 1097.1°C GDD. Considering all factors evaluated in this project, 'Honey Kist' is suitable as an early cultivar. 'Arctic Jay' had an excellent fruit quality and, on average, was harvested on 21 August, and thus recommended as the white-flesh cultivar of choice for that harvest time. '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 of 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. 'Arctic Pride' and A28.082 are good choices for planting as very-late maturing white-fleshed and yellow-fleshed cultivars, respectively. 'Arctic Pride' had moderately large fruit size and high SSC and extremely attractive skin and flesh color, but moderately low yield. A 28.082 had attractive fruit color, high fruit SSC, a high number of fruits per tree with large size, and hence high yield.

Commercial peach (*Prunus persica* L.) and nectarine production in Idaho dates back to 1870. Peach cultivars such as 'Early Red Haven', 'Late Red Haven', 'Red Globe', 'Early Hale', 'J.H. Hale', and 'Improved Elberta' are among the popular cultivars of peaches that are still in production many decades after their initial planting in Idaho (16 and personal knowledge). According to the Idaho Fruit Tree Census (14), peaches constituted 21% and nectarines constituted 2% of the total tree fruit production in Idaho in 2006, which is a considerable increase as compared to 1999. Similar to the situation in other nectarine- and peach-producing states (7), the best orchard sites are taken for development and urbanization in Idaho. New nectarine and peach orchards are often planted in old 'Delicious' apple orchard sites. This production increase is due to the national and international market demand for the high quality nectarines and peaches that can be produced under the high desert conditions of southwest Idaho and central Washington. Warm dry days and cool nights during the

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growing season and at fruit maturity create suitable conditions for growing high quality nectarines and peaches in these regions.

The pressure for urbanization and the competitive nature of world markets mandate production of new cultivars with high quality that mature in a span of time for a wide market window. In reports by Huang et al. (8) and the California Tree Fruit Agreement (CTFA, 4), 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 CTFA (4), 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.

Consumer desire for white-fleshed nectarines and peaches cultivars may vary with individual consumer preference and ethnic background, while yellow-fleshed peaches and nectarines are generally accepted by most consumers. In general, sub-acid white-fleshed peaches and nectarines are popular among consumers of Asian ethnic background, but these cultivars are not well known by other American consumers (3). White-fleshed peaches and nectarines are highly susceptible to bruising (1, 2, 5, 9, 15). Crisosto et al. (5) reported high variability in titratable acidity (TA), SSC, bruising and flesh browning susceptibility and market life among several white-fleshed peach and nectarine cultivars in the San Joaquin Valley, of California. Following harvest, SSC did not increase nor did TA decrease; thus, the SSC/TA remained the same in these stone fruits (5). Due to these characteristics, white-fleshed stone fruits are tasty even when they are firm because of their high SSC/TA balance, while the high acid types have to soften so that the acidity is low enough to have a good SSC/TA. Frecon et al. (7) 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 (9) and other regions of the United States (6, 10, 12) were also reported.

In spite of the increasing commercial importance of nectarine production, there is no comprehensive information on the bloom and harvest dates, yield, or quality of this fruit in Idaho. The goal of this long-term project was to investigate the growing degree-days, bloom and harvest dates, yield, and fruit quality of various yellow- and white-fleshed nectarines under conditions of southwest Idaho, in order to identify the most promising cultivars for commercial use in the region.

Materials and Methods

Orchard description and cultural practices. The experimental orchard was located at the University of Idaho Parma Research and Extension Center, near Parma in southwestern Idaho, which is a representative area of fruit-producing orchards in the Intermountain Western United States region with annual precipitation of about 274 mm, lat. 43°48'N, long.116°56', an average minimum daily temperature of -27.6°C in January and an average maximum daily temperature of 34.3°C in July, and elevation of 702.6 m.

Uniform certified nectarine trees on 'Nemaguard' rootstock with 1.27 cm trunk diameter (at planting) were obtained from various fruit tree nurseries in California and Washington. Sixteen nectarine cultivars or selections were planted at 2.4 x 5.0 m in April 2000. The list of cultivars is presented in Tables 1-4. A28.082 is a new selection from the breeding program of Burchell Nursery, California and does not

have a commercial name yet.

Trees were trained into a 4-leader vase shape. The soil was sandy loam and at the depth of 0-59 cm, the soil characteristics were as follow: pH 7.1 to 7.3, nitrate nitrogen (NO_3-N) 2.74 to 3.14 $\mu g \cdot g^{-1}$, ammonium nitrogen (NH_4-N) 1.45 to 1.09 $\mu g \cdot g^{-1}$, phosphorous (P) 8.0 to 12.4 $\mu g \cdot g^{-1}$, potassium (K) 306 to 319 $\mu g \cdot g^{-1}$, cation exchange capacity 0.166 to 0.183 meq/g, and organic matter 0.48% to 1.03%.

Urea nitrogen ($CO(NH_2)_2$ mixed with potassium chloride (KCl) and P were applied during the month of May annually to provide actual amounts of N, P, and K at rates of 123.2, 61.6, and 67.2 $kg \cdot ha^{-1}$ per year, respectively. This mixed fertilizer was broadcasted in an approximately 1 m band on either side of tree rows.

Trees were irrigated weekly with sprinkler system to match the evapotranspiration requirements for peach (ETc). We used information from the Agrimet Weather Station at the University of Idaho, Parma, Idaho, to calculate ETc. Annual pruning, spraying and other cultural practices in this experiment were similar to those of commercial orchard in the region (13). Fruits were thinned by hand just before pit hardening stage (about 6 weeks after full bloom) to maintain a 12- to 15-cm spacing between fruits.

Bloom and harvest dates, growing degree days, yield, and quality. Dates of full bloom (about 80% blooms open) and commercial harvest (when most of the fruits were ready to be harvested as judged visually by flesh and skin color and at a flesh firmness of about 3.5 kg) for each tree were recorded every year in 2003-07. 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 °C/2) –(4.4°C)]. Cumulative degree-days (GDD) were calculated as the sum DGDD to the full bloom or harvest dates for each cultivar in each year. We chose to use 4.4°C as the base temperature in the DGDD calculations because even at this low temperatures bloom will still develop although the rate of development is slower (E. Fallahi, personal observation, unpublished data).

Fruit color and total yield per tree were measured at harvest time every year between 2003 and 2006. Ten fruits were randomly sampled from each tree in the middle of commercial harvest time. Average fruit weight during 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.

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

Results and Discussion

General observations. Although we did not measure trunk cross sectional area or yield efficiency, total yield per tree could be used as a fair (but not exact) estimation of yield efficiency, because trees were maintained at about 3.8-m height in all cultivars. Tree survival and insect and disease susceptibility among all tested cultivars were similar in this experiment (data not shown).

Bloom dates and growing degree-days for bloom. In Table 1, nectarine cultivars are listed according to 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 25 days). Averaging values for either actual full bloom dates or DY over 2003-07 revealed a 4-day or 26.7°C GDD difference between the earliest and latest blooming cultivars. On average, 'Arctic Jay', 'Fantasia', Honey Kist, and 'Arctic Pride' bloomed earlier (7 April), while 'Arctic Mist', 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

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	Type of flower	Full bloom (FB) date 2003	2004	2005	2006	2007	Avg. FB day 03-07	Avg. GDD[x] 03-07	Avg. day of the yr. for FB (2003-07)
Arctic Jay	Showy	1 Apr.	3 Apr.	9 Apr.	17 Apr.	3 Apr.	7 Apr.	209.4	97
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
Arctic Pride	Showy	1 Apr.	3 Apr.	7 Apr.	19 Apr.	3 Apr.	7 Apr.	209.4	97
Arctic Snow	Showy	2 Apr.	5 Apr.	10 Apr.	19 Apr.	5 Apr.	8 Apr.	217.2	98
Arctic Queen	Showy	2 Apr.	5 Apr.	10 Apr.	19 Apr.	6 Apr.	8 Apr.	217.2	98
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
Arctic Mist	Showy	3 Apr.	5 Apr.	10 Apr.	20 Apr.	5 Apr.	9 Apr.	223.3	99
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] abbreviation: Apr.=April.
[y] Mean separation within columns using LSD at 5% level
[x] GDD=cumulative growing degree-days from 1 Jan. °C= ∑[(daily maximum plus minimum temperatures in °C/2) –(4.4 °C)]

cultivar and each year had very small variation in their full-bloom dates due to the tree and soil uniformity (data not shown). There was no significant interaction between years and cultivars for any of the bloom date measurements. This knowledge will facilitate cultural practices such as blossom thinning that would be difficult otherwise (i.e. if wide tree-to-tree or year-to-year variation occurred).

During warmer seasons, differences 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 the latest blooming cultivars was 2 days in 2004 and 8 days in 2005 (Table 1). Historically, starting 1 May, the chance of spring frost diminishes significantly in southwest Idaho. Therefore, the very late-blooming cultivars such as 'Summer Fire' may have a slightly lower chance of frost damage.

Commercial harvest date and growing degree days for harvest. Cultivars 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). 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 compared to 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 was 68 days and 1097.1 GDD°C (difference between 27 July and 6 October). The earliest cultivar in our evaluation was 'Diamond June' with110 days between full bloom and harvest, and on average, was harvested on 27 July. Thus, the earliest cultivar in our evaluation fits in the mid-season category of Huang et al. (8). 'Honey Kist' was also early and harvested on 30 July and on average, needed 114 days from full bloom to harvest (Table 2). 'Sparkling Red', 'Arctic Pride', A28.082, 'Arctic Mist', and 'Arctic Snow' were harvested after the second half of September, and the period between bloom and harvest for these cultivars was 161, 166, 166, 180, and 181 days, respectively. Thus, these nectarines are considered as "very late" cultivars according to CTFA (4) and Huang et al. (8) categorization.

In the highly competitive nectarine market, in addition to the climatic conditions, time of harvest (early, mid or late season), quality attributes, and yield should be considered before planting a cultivar. According to CTFA (4), of the total nectarines produced in California during 2002-2003, 14.2%, 35.3%, 25.1%, 19.2%, and 6.2% were in harvested in May, June, July, August, and September, respectively. A comparison of results of selected cultivars used in both the CTFA report (4) and our experiment revealed that nectarines were harvested several weeks later in southwest Idaho than in California. It is noteworthy that the harvest date differences between California and Idaho were greater for early-maturing than late-maturing cultivars (Table 2). For

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

	Harvest date (HD)									
Cultivar	2003	2004	2005	2006	2007	Avg. HD 03-07	HD in Calif[y]	GDD[x] for harvest	Avg. day of yr. for HD	Full bloom to harv. (days)
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 Jun	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 Jun	2030.8	219	121
Diamond Ray	21 Aug	15 Aug	22 Aug	24 Aug	17 Aug	20 Aug	30 Jun	2216.9	232	134
Arctic Jay	17 Aug	15 Aug	24 Aug	26 Aug	24 Aug	21 Aug	-	2235.3	233	136
Supr 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
Arctic Queen	4 Sept	4 Sept	16 Sept	13 Sept	13 Sept	10 Sept	-	2557.6	253	155
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
Arctic Pride	14 Sept	16 Sept	23 Sept	24 Sept	22 Sept	20 Sept	8 Aug	2669.4	263	166
A28.082	22 Sept	21 Sept	20 Sept	25 Sept	20 Sept	22 Sept	-	2690.1	265	166
Arctic Mist	16 Oct	27 Sept	7 Oct	3 Oct	5 Oct	6 Oct	6 Sept	2843.5	279	180
Arctic Snow	5 Oct	1 Oct	7 Oct	3 Oct	16 Oct	6 Oct	2 Sept	2843.5	279	181
LSD								92.8	9	10

[z] Mean separation within columns using LSD at 5% level
[y] Data in this column is taken from California (CTFA, 2003) for comparison
[x] GDD=cumulative growing degree-days from 1 Jan. °C= ∑[(daily maximum plus minimum temperatures in °C/2) –(4.4°C)]

Table 3. Fruit skin and flesh color of nectarine cultivars grown under southwest Idaho conditions, 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 sin	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 large red stain on the calyx end	
Arctic Jay	Red to very dark maroon with cream stain	White with red in cavity	Excellent flavor
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
Arctic Queen	Pink to dark maroon with cream stain	White with pink stain near the pit	
Summer Fire	Light red to dark maroon	Yellow orange with big red stain near the pit	
Sparkling Red	Dark orange to dark maroon	Yellow	
Arctic Pride	Red to dark red with white spots	White	Great late white-fleshed
A28.082	Orange to dark red	Yellow with big red stain near the pit	Outstanding quality
Arctic Mist	Cream with medium to dark maroon spot	White with narrow pink line around the pit	Excellent but late
Arctic Snow	Cream with medium pink to to dark maroon blotches	White with narrow pink line around the pit	Excellent but late

example, these differences were 48, 43, 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. In New Jersey, 'Arctic Jay', 'Arctic Queen', 'Arctic Pride', and 'Arctic Snow' were harvested on 6 August, 24 August., 2 September, and 8 September, respectively (7). However, in southwest Idaho, these three cultivars were harvested between 15 and 28 days later (Table 2). Comparison of these harvest days underscores the importance of knowing harvest dates of various nectarines in southwest Idaho. Our early-season nectarines were harvested at a time that many mid-season nectarines from California are in the market. Thus, our early cultivars would be suitable for local and farmers' markets. However, middle- and late-season nectarines (Table 2) are harvested at the time that the California market for those cultivars has either slowed down or finished, and thus provide an excellent market window for growers in southwest Idaho and other similar regions in the Intermountain Western USA.

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, red, or white, a range of color was observed in these cultivars. All cultivars developed attractive flesh and skin color due to warm days and the cool nights in the area.

A28.082 and all white-fleshed cultivars had distinctively attractive skin and flesh color. A28.082 had orange-red ground color with large irregular red blotches. 'Arctic Jay', 'Arctic Queen', 'Arctic Pride', 'Arctic Mist', and 'Arctic Snow' had regions of dark red and creamy-white on the skin, while flesh color was uniform creamy white.

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 fruits than many other cultivars, and their AFW exceeded 214 g over three growing seasons (Table 4). 'Arctic Pride' had significantly larger fruits than all other white-fleshed nectarines. In New Jersey, however, fruit size of 'Arctic Pride' was similar to those of 'Arctic Snow' and 'Arctic Queen' (7), perhaps due to location-cultivar interactions between New Jersey and Idaho for these cultivars. Nevertheless, 'Arctic Jay' had a higher AFW than 'Arctic Queen' in both our research (Table 4) and New Jersey (7). 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.

Soluble solids concentration (SSC). With the exception of 'Arctic Jay', fruits of the late-maturing cultivars that on average were harvested after 10 September (Table 2), had greater than 14.3°Brix SSC (Table 4). This finding is in general agreement with Frecon (7) who worked with a different set of nectarine cultivars, and reported that early-maturing cultivars had lower SSC. 'Arctic Queen' had significantly higher SSC (overall average of 18.6°Brix) than all other cultivars ($P \leq 0.05$). Averaging values over 2004-05, 'Arctic Jay', 'Summer Fire', and 'Arctic Snow' had significantly higher SSC than all other cultivars except 'Arctic Queen', A28.82, and 'Arctic Mist'. Frecon et al. (7) also reported that 'Arctic Jay' was among cultivars with high SSC in New Jersey. Among all cultivars, 'Honey Kist', 'Supreme Red#1', and 'Fantasia' had on average less than 13°Brix SSC.

Fruit weight did not correlate strongly with SSC. For example, relatively small-sized 'Arctic Queen' and relatively large-sized A28.082 had more than 15°Brix SSC. Most of the white-fleshed nectarines had higher SSC values than yellow-fleshed nectarines, which is in agreement with results in peaches (6, 11).

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 fruits per tree (Table 4). 'Fantasia' had the highest average yield, because it was among the cultivars with 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 fruits. 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 were 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, fruits of 'Honey Kist' nectarine were susceptible to russeting.

Based on this research, we suggest planting

Table 4. Fruit weight, yield, number of fruit, and soluble solids concentration for various nectarine cultivars under conditions of southwest Idaho, listed in ascending order of their average harvest dates[z].

	Fruit weight (g)				Yield (kg/tree)					Avg. fruit no./tree	Soluble solids (°Brix)		
Cultivars	2003	2004	2005	Avg. 2003-05	2003	2004	2005	2006	Avg. 2003-06	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	16.44	117	13.2	12.4	12.8
Summer Beaut	132.5	166.1	177.9	158.8	9.22	11	16.8	15.9	13.23	83	12.8	13.2	13.0
Red Diamond	.	146.7	151.4	149.1	12.13	8.1	5.6	11.4	9.32	63	13.9	12.5	13.2
Diamond Ray	134.2	190.4	194.7	173.1	7.04	4.3	15.8	29.4	14.12	82	15.4	11.8	13.6
Arctic Jay	134.3	179.3	212.1	175.2	8.89	13.4	14.6	21.1	14.49	83	15.9	16.0	16.0
Supreme Red #1	191.9	.	237.9	214.9	0.61	.	9.3	10.4	6.77	32	.	11.6	11.6
Summer Grand	174.5	178.9	198.9	184.1	6.31	7.5	18.8	15.5	12.02	65	14.8	13.4	14.1
Fantasia	192.4	225.1	249.7	222.4	14.09	15.4	19.4	24.7	18.40	83	13.0	12.8	12.9
Arctic Queen	135.2	141.3	159.3	145.3	6.11	12.1	10.8	24.1	13.27	91	18.1	19.0	18.6
Summer Fire	158.9	179.1	167.9	168.6	5.77	8.4	3.8	15.3	8.32	49	13.1	19.6	16.4
Sparkling Red	152.4	160.9	188.8	167.4	4.85	12.5	11	12.2	10.14	61	13.6	16.2	14.9
Arctic Pride	188.3	181.3	215.9	195.2	2.46	13.6	7.7	19.9	10.91	56	14.0	14.8	14.4
A28.082	184.8	210.6	253.9	216.4	16.98	11.6	14.4	24.1	16.77	77	15.4	14.8	15.1
Arctic Mist	159.1	195.8	178.5	177.8	6.47	5.7	14.1	21.1	11.81	66	15.6	15.0	15.3
Arctic Snow	159.3	165.9	172.3	165.8	9.64	10.8	12.8	30.5	15.94	96	16.3	15.9	16.1
LSD	15.2	16.2	16.5	12.2	2.2	4.0	5.0	5.5	4.20	5	1	1.3	1

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

'Arctic Jay', 'Summer Grand', and 'Fantasia' for the harvest period of 21August to 3 September. 'Arctic Jay' had a satisfactory level of yield and fruit size and was on average, harvested on 21August. This fruit had a very attractive fruit skin and white-fleshed color with an outstanding flavor and aroma. Consumer preference for this nectarine was extremely high during numerous field days and taste-testing that we offered at the University of Idaho. '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 in late-August to early-September.

For the cultivars that matured during the period of 20 to 22 September, 'Arctic Pride' performed relatively well with respect to fruit size (average of 195.2 g), appearance, and SSC, and would be the white-fleshed cultivar of choice for the region in that period. A28.082 was also harvested during this period (22 September) and was an outstanding cultivar, not only as compared to the late-maturing, but also among all cultivars in our experiment. Trees of A2.082 had a relatively high number of fruits per tree with large size, and hence high yield. Fruits of this cultivar also had a distinctively attractive and appealing skin and flesh color (Table 3). We therefore recommend planting this cultivar as a very late cultivar (116 days from bloom to harvest) for the region.

Both 'Arctic Mist' and 'Arctic Snow' had excellent fruit quality, and can be planted if there is a demand for very late cultivars. However, these two cultivars could be too late for Idaho. On average, these cultivars were harvested on 6 October (180 and 181 days after bloom, respectively). However, the harvest dates ranged from 27 September (for 'Arctic Mist' in 2004) to 16 October (for 'Arctic Mist' in 2003 and for 'Arctic Snow' in 2007), which conflicts with the harvest period of several important apple cultivars of the region.

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