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Effect of Different Thinning Techniques on Fruit Set, Leaf Area, Yield and Fruit Quality Parameters of *Prunus persica*, L. Batsch cv. Floridaprince

M.S. El-Boray, A.M. Shalan and Z.M. Khouri
Department of Pomology, Faculty of Agriculture, Mansoura University, El-Mansoura, 35516, Egypt

Corresponding Author: M.S. El-Boray, Department of Pomology, Faculty of Agriculture, Mansoura University, El-Mansoura, 35516, Egypt

ABSTRACT

This research was carried out during 2011 and 2012 seasons at commercial orchard on twelve years old peach cv. Floridaprince trees which budded on Nemaguard rootstock, grown in sandy soil under drip irrigation system and spaced at 4 m within rows and 5 m between rows to determine the effectiveness of three thinning techniques {pre-bloom thinning with Soybean Oil (SO) at 6 and 9%, chemical blossom-thinning with Ammonium Thio-Sulphate (ATS) at 1.5 and 3% and commoner thinning by Hand Blossom Thinning (HBT) at different distances 10, 15 and 20 cm} on fruit set, leaf area, yield and fruit quality. In both years, parameters of fruit set, firmness and number of fruits and titratable acidity were reduced; on the contrary, leaf area, fruit weight, size, height and diameter, SSC, SSC/acid ratio and fruit content of anthocyanin and total soluble sugar were increased significantly among the treatments. Results suggest SO at 9% or ATS at 1.5% in peach could reduce the need for hand thinning significantly for peach growers. However, data concludes that ATS at 1.5% is the most promising bloom thinner for peach trees where it reduced the fruit set percentage (55.05 and 58.07% during both seasons, respectively) without harming the yield per feddan (5.91 and 5.56 tones during both seasons, respectively). Finally, hand blossom thinning was the best technique in this study especially at 15 cm for yield per feddan (6.08 tons for both seasons) but 20 cm introduced the highest fruit quality.

Key words: *Prunus persica*, thinning techniques, fruit quality, Floridaprince

INTRODUCTION

Peach (*Prunus persica*, L. Batsch) is revered as delicious and healthy summer fruit in most temperate regions of the world. It is considered one of the most important deciduous fruit in the world and in Egypt (Kandil *et al*., 2010). It ranks second to the apple among temperate zone deciduous fruit trees from the view point of production (Childres, 1978). Egypt occupies the twelfth position globally in peaches and nectarines production, where the total area harvested in Egypt reached about 33017 ha (81588.31 feddan) producing about 273256 tons (FAO, 2010).

Most peach trees produce thousands of flowers and if conditions are favorable, may set several thousand fruits per tree. If all these fruits are allowed to develops, the weight of the fruit will break branches and the fruits will be small and have low sugar concentrations which reduce marketability of the fruits. To avoid over cropping, the number of fruits per tree must be regulated. So, fruit thinning is now a standard commercial practice in peach orchard (Layne and Bassi, 2008).

In addition, early competition for carbohydrates due to heavy flowering can limit fruit size even when the crop load is adjusted later to recommended levels adequately (Stover *et al.*, 2001).

Hand blossom thinning is the most secure technique for most peach cultivars but most costly than the others. Furthermore, hand thinning is a labor intensive practice when applied with the degree of detail and concentration required to do good job. It can account for as much as 20% of the total costs of production (Jackson and Looney, 1999).

Chemical thinning of peach did not use widely in commercial orchards because of the greatest risk of this technique which lead to over thinning. Nevertheless, we feel the cost savings of chemical thinning may justify the effort if the risk of over-thinning can be minimized. Chemical thinning enhanced fruit quality by reduced potentially excessive crop load on trees by preventing fruit set on proportion of flowers. Chemical thinning reduced crop load by magnifying natural fruitlet drop expressed at the moment of application (Bangerth, 2004). A Several chemicals were found to interfere with peach pollination like Ammonium Thio-Sulphate (ATS) which was among the most effective flower thinners for peach (Green *et al.*, 2001; Balkhoven-Baart and Wertheim, 1997).

Soybean oil is edible oil and it had not any side effect on fruits and trees. Moreover, it has been used on a limited scale as a pre-bloom thinning technique at dormant stage which leads to thin flower bud of peach trees (Reighard *et al.*, 2010).

Therefore, this work was carried out to (1) compare the effects of several thinning techniques {pre-bloom thinning with Soybean Oil (SO), chemical blossom-thinning with Ammonium Thio-Sulphate (ATS) and commoner hand blossom thinning at different distances} to find out the best technique which affect positively on fruit set, leaf area, yield and fruit quality of peach, (2) provide peach growers with low risk options for safe concentrations of chemical blossom and pre-bloom thinning.

MATERIALS AND METHODS

The present study was carried out during the two successive seasons of 2010-2011 and 2011-2012 on Floridaprince peach trees to evaluate the effect of different thinning techniques {pre-bloom thinning with Soybean Oil (SO), chemical blossom-thinning with Ammonium Thio-Sulphate (ATS) and commoner hand blossom thinning at different distances} on fruit set, leaf area, yield and fruit quality.

Peach trees were about twelve years old, budded on Nemaguard rootstock grown in sandy soil under drip irrigation system and spaced at 4 m within rows and 5 m between rows (210 trees per feddan) in EL-Egeizy orchard at Sadat city in Monofia governorate.

Forty eight trees almost uniform in growth and vigor and in good physical conditions were selected for this study and treated rows were separated by 2 un-treated guard tree rows. Treatments were replicated three times each replicate represented by two trees in a complete randomized block design to represent the treatments as follows:

- Soybean oil (SO) at 6%
- Soybean oil (SO) at 9%
- Ammonium thio-sulphate (ATS) at 1.5%
- Ammonium thio-sulphate (ATS) at 3%
- Hand blossom thinning (HBT) at 10 cm
- Hand blossom thinning (HBT) at 15 cm
- Hand blossom thinning (HBT) at 20 cm
- Control (un-thinned trees)

First and second treatments were applied to dormant peach trees on 25th December at both seasons but the other treatments were applied at full bloom (70-80% blossom) on 5th and 15th February at the first and second seasons, respectively.

Fruit set percentage: In each growing season, four main branches as uniform as possible were chosen at the four cardinal points of each experimented tree, tagged and the number of flowers on these branches were counted before treatments, except the branches of soybean oil treatments were counted after the application. Then persisting fruit were counted on 5th and 15th March at the first and second seasons, respectively. Fruit set was expressed as percentage of flowers, which developed into fruits.

Leaf area: In both growing seasons, at the harvest time samples of 20 leaves from each replicate were taken from the middle of the growing shoots to measure the average leaf area using the following equation:

$$LA = \frac{-0.5+0.23\times L}{W+0.67\times L\times W}$$

where, LA is leaf area, W is leaf width and L is leaf length according to Demirsoy *et al.* (2004) and the average was expressed as cm^2.

Yield: Average yield per each treatment was recorded as kg fruits per tree by counting number of fruits per tree multiplied by average fruit weight. Average yield per feddan was estimated by using yield per tree and the number of trees per feddan in tones at harvesting date (5th and 15th April at the first and second seasons, respectively).

Characteristics of fruits: About 30 FloridaPrince peach fruits from each replicate in each treatment were harvested when the skin ground color is yellow about 98% of external surface of fruits covering with red blushes and firmness reaches 14.0-16.0 lb $inch^{-2}$ according to Shaltout (1995) and transported to the Laboratory of the Pomology Department, Faculty of Agriculture, Mansoura University to determine the following parameters:

Fruit size: Fruit size was measured by using the volume of water as cm^3 after dipping fruit in water.

Fruit height and diameter: Fruit height and diameter were measured by using vernier calipers as cm. Fruit diameter was measured from the middle of the fruit.

Fruit firmness: It was measured on 10 fruits for each replicate by using a hand Effegi-Penetrometer supplemented with a plunger 9 mm tip by removing a small exocarp segment on the two opposite sides to expose the average flesh firmness of each fruit. The average was estimated as lb $inch^{-2}$ (Southwick *et al.*, 1995).

Soluble solids concentration (SSC): Soluble solids concentration in fruit juice was measured by using a Carl-Zeiss hand refractometer.

Total titratable acidity (%): Five mililiter of fruit juice were titrated with 0.1 N sodium hydroxide solution using phenolphthalein as an indicator. Total acidity was expressed as g malic acid/100 mL juice (AOAC, 1980).

Soluble solids concentration (SSC)/acid ratio: This ratio was calculated from the results recorded for fruit juice SSC and titratable acidity.

Total anthocyanin content: Total anthocyanin content in fruit skin was determined according to the method of Mazumdar and Majumder (2003) by extracting half gram of fresh fruit skin in 10 mL of ethanolic-hydrochloride acid mixture which prepared by mixing 85 parts of ethanol 95% and 15 parts of hydrochloric acid 1.5 N. It is allowed to stand overnight at a temperature of about 4°C, centrifuged for 3 min. and then filtered through filter paper (Whatman No. 1). The filtered aliquot was maintained in darkness for about 2 h with cover of the container. The Optical Density (OD) value of the solution was then measured through 535 nm wave length in a spectrophotometer against blank. The amount of total anthocyanin in fruit skin was calculated using the following equations:

$$\text{Total absorbance value for the skin (per 100 g)} = \frac{e \times b \times c}{d \times a}$$

where, a is weight of sample, b is volume made for color measurement, c is total volume made, d is volume of aliquot taken for estimation, e is specific OD value at 535 nm wavelength.

The 1 mg mL^{-1} of the solution is equivalent to the absorbance of 98.2. Therefore, the amount of total anthocyanin present in the sample (mg/100 g) = Total absorbance for the sample/98.2.

Total sugars: Total sugars were determined on crude fruit dried from each treatment by using phenol 18% and sulphoricacid 96% and the absorbance was recorded with spectrophotometer at 490 nm, according to the method described by Sadasivam and Manickam (1996). A standard curve was prepared by plotting the known concentrations of glucose solution (100 μg mL^{-1} of glucose) against respective Optical Density (OD) value of each. From the standard curve, the amount of total sugars actually present in the sample is determined.

Statistical analysis: The obtained data were subjected to an ordinary analysis of variance according to the procedure outlined by Snedecor and Cochran (1980). Differences among treatment means were compared by using the Newly Least Significant Differences Test (NLSD) at 5% level of probability as mentioned by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Fruit set percentage and average leaf area: It is clear from Table 1 that all treatments used significantly reduced the percent of fruit set than the control; specifically, HBT treatment at 20 cm and the high rate of ATS (3%) which presented the lowest significant effect in this respect during the both seasons, respectively; hence, the values attributed due to these treatments were 41.96 and 52.41, 43.00 and 54.97% in the two seasons of study, respectively. These results confirm the result obtained by Osborne and Robinson (2008) who found that ATS at 3.5% reduced fruit set in peach compared to control; furthermore, Coneva and Cline (2006) reported that ATS at earlier stages of bloom may be prevent a greater percentage of flower to set by preventing pollination or pollen tube growth. Similarly, Whiting *et al.* (2006) in sweet cherries and Meland (2009) in apple trees found that hand thinning gave a lower final percentage of fruit set compared to the control.

In addition, the high rate of SO (9%) reduced fruit set percentage than the low rate at 6%; it resulted in 57.43 and 60.47% during both seasons, respectively. These data are in harmony with results of Reighard *et al.* (2010) who found that SO at 10% in peach trees reduced fruit set compared to control.

Table 1: Effect of different thinning techniques on fruit set and average leaf area of Floridaprince peach fruits during 2011 and 2012 seasons

Treatment	Fruit set (%) 2011	Fruit set (%) 2012	Average leaf area (cm^2) 2011	Average leaf area (cm^2) 2012
SO (6%)	61.090	65.820	32.320	29.080
SO (9%)	57.430	60.470	36.410	35.960
ATS (1.5%)	55.050	58.070	39.660	40.970
ATS (3%)	43.000	54.970	43.080	41.440
HBT (10 cm)	69.380	71.500	29.930	25.810
HBT (15 cm)	59.690	62.310	35.380	32.760
HBT (20 cm)	41.960	52.410	38.360	37.870
Control	71.650	74.370	27.500	23.960
N-LSD at 5%	2.789	1.492	2.174	2.326

SO: Soybean oil, ATS: Ammonium thio-sulphate, HBT: Hand blossom thinning

The highest leaf area detected at the ATS treatments especially at the high rate (ATS 3%) followed by the low rate (ATS 1.5%). The value of leaf area due to these treatments was 43.08 and 41.44 cm^2 for ATS at 3% and 39.66 and 40.97 cm^2 for ATS at 1.5% in the two seasons, respectively. Also, the high rate of Soybean Oil (SO 9%) enhanced leaf area than the low rate (SO 6%); it resulted in 36.41 and 35.96 cm^2 in the two seasons, respectively. These results are in agreement with those of Coneva and Cline (2006) who found that ATS (30 and 15 ml L^{-1}) spraying after flowering, leaf size of "Harrow Diamond" peach trees had already expanded to about 6 cm in length. Also, Schroder and Link (2000) reported that ATS treatment increased leaf area on apple trees; furthermore, Palmer *et al.* (1997) found that leaf area on apple trees had increased with lighter crop load.

Furthermore, hand blossom thinning had a great effect in this respect. As soon as, the Hand Blossom Thinning (HBT) distance increased the leaf area increased; therefore, HBT at 20 cm presented the highest value in this respect compared to other HBT distances. The value of leaf area due to this treatment was 38.36 and 37.87 cm^2 during both seasons, respectively.

However, all treatments improved the leaf area of Floridaprince peach trees significantly except the control which presented the lowest value in this respect; it recorded 27.5 and 23.96 cm^2 in the two seasons, respectively. That is may be due to the thinning effect of these treatments which decreased fruit number per tree. In addition, Nii (1997) reported that leaf area in peach at the fruit-maturation stage decreased with increasing numbers of peaches per tree.

Fruit number, fruit weight, yield per tree and yield per feddan: All thinning treatments decreased fruit number per tree significantly compared to the untreated control during both seasons (Table 2). The treatment that most significantly reduced fruit number per tree was HBT at 20 cm producing 216.67 and 228.33 fruit per tree during first and second season, respectively. In contrast, the untreated control had the highest fruit number per tree of 388.33 and 405.00 during first and second season, respectively followed by HBT at 10 cm treatment which presented so closely results in this respect to the control. These results go in line with those reported by Mohsen (2010) who mentioned that the best result were dedicated to thinning Floridaprince and Desert Red peach with 20 cm apart that decreased fruit number compared to the control; moreover, Njoroge and Reighard (2008) found that number of fruit harvested per peach trees decreased with increased fruit spacing from 10, 15, 25 cm along the shoot on trees.

The high rate of SO (9%) or ATS (3%) decreased the number of fruit per tree compared to the low rate of them during both seasons but ATS rates presented lower number of fruit per tree than SO rates during both seasons (Table 2). That is may be due to high concentration of ATS reduced pollen viability and germination on pollinated stigmas and on germination medium and reduced number of fruit on trees (Myra *et al.*, 2007). In the same direction, Reighard *et al.* (2006) found that SO 9% reduced the number of surviving flower bud in peach so may be number of fruit was reduced by effect of soybean thinning.

Table 2: Effect of different thinning techniques on fruit number, fruit weight, yield/tree and yield/feddan of Floridaprince peach during 2011 and 2012 seasons

	Fruit number		Fruit weight (g)		Yield/tree (kg)		Yield/feddan (tons)	
Treatment	2011	2012	2011	2012	2011	2012	2011	2012
SO (6%)	296.670	300.000	86.490	85.510	25.650	25.650	5.390	5.390
SO (9%)	263.330	271.670	109.170	98.070	28.750	26.640	6.040	5.590
ATS (1.5%)	258.330	260.330	109.280	101.830	28.23	26.510	5.93	5.560
ATS (3%)	236.670	250.000	109.570	107.010	25.930	26.75	5.450	5.62
HBT (10 cm)	325.000	340.000	83.620	82.500	27.170	28.050	5.700	5.890
HBT (15 cm)	290.000	295.330	99.930	97.990	28.98	28.940	6.080	6.080
HBT (20 cm)	216.670	228.330	111.420	108.670	24.140	24.810	5.070	5.210
Control	388.330	405.000	63.340	61.590	24.590	24.94	5.160	5.240
N-LSD at 5%	14.467	16.783	1.635	0.872	1.171	2.000	0.257	0.419

SO: Soybean oil, ATS: Ammonium thio-sulphate, HBT: Hand blossom thinning

The concerned results from Table 2 indicated that all treatments used significantly increased fruit weight than the control. In addition, HBT at 20 cm treatment presented the superior effect in this respect, for it gave the lowest number of fruit per tree compared to other treatment under this study (Table 2). Conversely, the un-thinned trees decreased fruit weight significantly compared to other treatments; it resulted in 63.34 and 61.59 g during first and second season, respectively. These results are in agreement with those recorded by Mohsen (2010) who indicated that hand thinning 20 cm on Floridaprince peach increased fruit weight compared to control. Also, Son (2004) found that hand thinning 70% increased fruit weight compare control on apricot.

Moreover, the high rate of ammonium thio-sulfate and soybean oil gave a better effect in this respect than the low rate of them. However, it is obvious from Table 2 that the treatments which increased fruit number per tree decreased average fruit weight. Also, Meland (2007) found that ATS 1-1.5% increased fruit weight on plum. Moreover, (Moran *et al.*, 2000) found that mean fruit weight on peach increased with increasing soybean oil concentration; in addition, Stopar (2008) reported that soybean oil enhanced mean fruit weight compared to control on apple.

Yield per tree and per feddan of Floridaprince peach was affected by using different thinning treatments significantly except HBT at 20 cm treatment which indicated so closely results in this respect to the control but it was lower. Thus, it recorded 24.14 and 24.81 kg for yield per tree and

5.07 and 5.21 tones per feddan while the control treatment recorded 24.59 and 24.95 kg for yield per tree and 5.16 and 5.24 tones per feddan in the two seasons, respectively (Table 2) but HBT at 20 cm treatment produced the best quality of Floridaprince peach fruit compared to other treatments. Alternatively, the highest yield per tree and per feddan was found on trees thinned by HBT at 15 cm. Hence, it resulted in 28.80 and 28.96 kg for yield per tree and 6.08 tons per feddan in the two seasons, respectively.

These data go in line with results recorded by Mohsen (2010) who reported that hand thinning 20 cm treatment on peach Floridaprince cultivar decreased the yield compared to control and the yield was decreased with increasing thinning space. Also, Njoroge and Reighard (2008) found that fruit weight increased with increased fruit space but yield per tree decreased compared to control and hand thinning 25 cm between fruit give the lower yield than 10 and 15 cm on peach. That may be due to the relationship between the crop densities, fruit weight and yield (Treder, 2008). Furthermore, Osborne and Robinson (2008) reported that ATS thinning on peach at 5 and 4% at 85% full bloom reduced yield and fruit set compared to control. The same result in sweet cherries found by Whiting *et al.* (2006).

Fruit firmness, size, height and diameter: Concerning the effect of different thinning techniques on fruit firmness, data in Table 3 showed that all treatments used significantly decreased fruit firmness than the control during the both season under this study. It is obvious that there is a positive relationship between number of fruit per tree and fruit firmness; hence, the untreated control presented the highest significant effect of fruit firmness compared to the other treatments; it recorded 15.43 and 15.32 lb inch^{-2} under this study during first and second season, respectively. On the contrary, HBT at 20 cm gave the lowest significant effect of fruit firmness; thus, the result due to this treatment was 11.8 and 10.93 lb inch^{-2} during first and second season, respectively. Last of all, the other HTB distances at 10 or 15 cm, SO rates at 6 or 9% and ATS at 1.5 or 3% enhanced fruit firmness, respectively compared to HBT at 20 cm. That is may be due to high crop load reduced fruit quality and delayed maturity (Davarynejad *et al.*, 2008). And that was confirmed by Reighard *et al.* (2006) who reported that soybean oil at 9% advanced fruit maturity. Also, Mohsen (2010) found that hand thinning at 20 cm reduced fruit firmness compared to 10, 15 cm and control due to thinning advanced the maturity.

Table 3: Effect of different thinning techniques on fruit firmness and size, height and diameter of Floridaprince peach fruits during 2011 and 2012 seasons

	Fruit firmness (lb inch^{-2})		Fruit size(cm^3)		Fruit height (cm)		Fruit diameter (cm)	
Treatment	2011	2012	2011	2012	2011	2012	2011	2012
SO (6%)	14.950	14.400	89.060	86.000	5.200	5.170	5.420	5.270
SO (9%)	14.170	13.730	106.670	104.260	5.750	5.550	5.800	5.670
ATS (1.5%)	13.550	12.770	107.330	104.780	5.750	5.820	5.880	5.850
ATS (3%)	13.370	12.570	109.330	107.430	6.000	5.980	6.030	5.980
HBT (10 cm)	15.100	14.470	84.900	82.380	5.180	5.140	5.230	5.170
HBT (15 cm)	14.370	14.070	101.390	98.330	5.730	5.240	5.680	5.250
HBT (20 cm)	11.800	10.930	126.330	110.740	6.230	5.990	6.380	5.990
Control	15.430	15.320	63.000	61.390	4.500	4.810	4.570	4.480
N-LSD at 5%	0.312	0.771	4.574	2.354	0.203	0.383	0.248	0.169

SO: Soybean oil, ATS: Ammonium thio-sulphate, HBT: Hand blossom thinning

High rate of ATS or SO yielded larger fruit size, height and diameter than the low rate of them; meanwhile, ATS concentrations were better than SO concentrations in this respect and that coincides with results obtained by Osborne and Robinson (2008) who reported that ATS thinning on peach at 5% thinned increased fruit size compared to control. Similar results found by Osborne *et al.* (2006), Christen *et al.* (2010) on Apricot and Schoedl *et al.* (2009) on sweet cherry. Also, Green *et al.* (2001) found that ATS increased fruit diameter compared to control on "Red Haven" peach. Furthermore, the increasing in fruit diameter classes to ATS thinning effect due to lowered fruit number thus reducing competition for metabolites among the remaining fruit (Ouma, 2007). Finally, it was found by Osborne and Robinson (2008) and Reighard *et al.* (2010) that soybean oil on peach increased fruit size compared control.

Fruit size, height and diameter for all the treatments were very large due to the low fruit number per tree compared to the control. Fruit size, height and diameter were smallest with the hand thinning of flowers at 10 cm treatment and the untreated control which had fruit size, height and diameter of 84.90 and 82.38 cm^3, 5.18, 5.14, 5.23 and 5.17 cm, respectively and 63.00 and 61.39 cm^3, 4.5, 4.81, 4.57 and 4.48 for the control, respectively (Table 3). HBT at 20 cm yielded the largest fruit size, height and diameter at 126.33 and 110.74 cm^3, 6.23 and 5.99 cm and 6.38 and 5.99 cm, respectively. That coincides with results obtained by, Mohsen (2010) found that peach hand thinning 20 cm increased fruit diameter and fruit quality on Floridaprince; also, Njoroge and Reighard (2008) reported that fruit diameter increased linearly with increasing fruit spacing on peach. That is may be due to early competition for carbohydrates due to heavy flowering can compromise fruit size even when the crop load is later adjusted to recommended levels (Stover *et al.*, 2001); in addition Davarynejad *et al.* (2008) found that when a cherry tree's blossoms are thinned, less fruit is left on the tree so that the tree can devote more nutrients to develop each cherry into that the larger fruits.

Soluble solids content (SSC%), titratable acidity and SSC/acid ratio: Data in Table 4 revealed that different thinning techniques increased SSC% and SSC/acid ratio but they reduced titratable acidity% of Floridaprince peach fruit juice compared to the control during the two seasons of study. Furthermore, it is clear that ATS at 3% presented the highest value of SSC%; it resulted in 12.07 and 10.74% but presented the lowest value of titratable acidity%; it resulted in 0.71 and 0.69%; therefore, it presented the highest value of SSC/acid ratio; it resulted in 17.00 and 15.17 during the two seasons of study, respectively. That may be due to this treatment gave the highest value of leaf area (Table 1) and decreased the number of fruit per tree compared to the other treatments. These results go in the same line with those reported by Schoedl *et al.* (2007) who reported that ATS on "Samba" cherry trees increased SSC% content may be due to the reducing of crop load and better support of fruit with water. Also, Schoedl *et al.* (2009) found that ATS affected SSC% content in "Techlovan" cherry trees but content of titratable acids were not improved by ATS thinning. Conversely, the control presented the lowest value of SSC%; it resulted in 8.70 and 8.04% but presented the highest value of titratable acidity%; it resulted in 0.99 and 0.97%; therefore, it presented the lowest value of SSC/acid ratio; it resulted in 8.79 and 8.29 during the two seasons of study, respectively.

Table 4: Effect of different thinning techniques on SSC, titratable acidity and SSC/acid ratio of Floridaprince peach fruit juice during 2011 and 2012 seasons

	Soluble solids concentration (SSC%)		Titratable acidity (%)		SSC/acid ratio	
Treatment	2011	2012	2011	2012	2011	2012
SO (6%)	9.700	9.470	0.940	0.830	10.320	11.410
SO (9%)	10.470	9.700	0.910	0.800	11.510	12.130
ATS (1.5%)	10.690	10.100	0.790	0.750	13.530	13.470
ATS (3%)	12.070	10.740	0.710	0.690	17.000	15.170
HBT (10 cm)	9.230	9.170	0.950	0.940	9.720	9.750
HBT (15 cm)	10.330	9.600	0.920	0.820	11.230	11.710
HBT (20 cm)	10.530	9.900	0.830	0.780	12.670	12.690
Control	8.700	8.040	0.990	0.970	8.790	8.290
N-LSD at 5%	0.881	0.787	0.026	0.019	1.600	1.518

SO: Soybean oil, ATS: Ammonium thio-sulphate, HBT: Hand blossom thinning

Concerning to the effect of HBT in this respect, it is obvious that HBT at 20 cm gave the highest value of SSC% and the lowest value of titratable acidity%; hence, it presented the highest value of SSC/acid ratio compared to the other HBT distances. Finally, the high rate of SO was better than the low rate. In this respect, Mohsen (2010) cleared that Floridaprince peach hand thinning at 20 cm increased SSC/acid while reduced titratable acidity%. Also Kerry *et al.* (2007) demonstrated that hand thinning increased SSC% in peach. The similarly result in plum found by Kvaale (1985) and in Apricot by Son (2004).

However, it is obvious that there is a positive relationship between leaf area and SSC%. In other words, treatments which enhanced leaf area due to decreasing fruit number per tree; they enhanced SSC% but reduced titratable acidity% which lead to increasing SSC/acid ratio compared to the control.

Fruit content of anthocyanin and total sugar: Concerning to the effect on total sugars on peach fruits, it is obvious from Table 5 that all treatments under this study enhanced total sugars on peach fruits significantly compared to the control during the both seasons which presented 5.99 and 5.98 $\mu g\ mL^{-1}$ in the two seasons, respectively. On the contrary, ATS at 3% presented the highly significant effect in this respect; it resulted in 8.37 and 8.33 $\mu g\ mL^{-1}$ in the two seasons of the study, respectively. This data is confirmed by results of Mohsen (2010) who found that hand thinning in peach cv. Floridaprince trees at 20 cm increased total sugar content in fruit. Also, Bound and Wilson (2007) found that total sugar content in apple fruit increased by ATS treatment and a positive relationship between fruit weight and total sugar content. Increasing total sugar in all treatments compared to control may be due to a negative correlation between number of fruit and carbohydrates concentration (Beruter, 1990).

Data in Table 5 also indicated that total anthocyanin content in fruit skin took the same trend as for total soluble sugars; where, ATS treatment at 3% gave the highest significant effect in this respect compared to other treatments; it resulted in 23.23 and 21.15 mg/100 g fresh weight. Conversely, the un-thinned trees diminished total anthocyanin content in fruit skin compared to other treatments; hence, the value of total anthocyanin content in fruit skin due to this treatment was 16.77 and 14.12 mg/100 g fresh weight in the two seasons, respectively (Table 5). These results are in agreement with those reported by Johnson (1995) and Basak (2006) who found that ATS increased color in fruits of apple trees compared to control. Also, Whiting *et al.* (2006) found that hand thinning on apple increased fruit color (% red skin color); moreover, Guidoni *et al.* (2002) found that hand thinning in grape fruit increased anthocyanins and flavonoids in berries of cluster and the same result found with Khalil and Stino (1987) on nectarine.

Table 5: Effect of different thinning techniques on total sugars and anthocyanin of Floridaprince peach fruits during 2011 and 2012 seasons

	Total Sugars (100 µg mL^{-1} of glucose)		Anthocyanin (mg/100 g fresh weight)	
Treatment	2011	2012	2011	2012
SO (6%)	6.640	6.590	18.030	16.290
SO (9%)	7.380	7.320	19.770	17.730
ATS (1.5%)	7.990	7.950	22.530	19.830
ATS (3%)	8.370	8.330	23.230	21.150
HBT (10 cm)	6.530	6.380	17.330	15.400
HBT (15 cm)	6.830	6.820	18.730	16.890
HBT (20 cm)	7.690	7.650	20.870	19.400
Control	5.990	5.980	16.770	14.120
N-LSD at 5%	0.031	0.051	0.804	1.561

SO: Soybean oil, ATS: Ammonium thio-sulphate, HBT: Hand blossom thinning

However, it is clear that there is a positive relationship between average leaf area, total sugars and anthocyanin. Where leaf area average increased; the rate of photosynthesis increased because leaves are the main source of photosynthesis in plants (Fleancu, 2007); In addition, Palmer (1992) found that light interception photosynthetic active was linearly related to leaf area which leads to increase total sugar resulting in improving total anthocyanin content in fruit skin. And that coincides with results obtained by Pavel and DeJong (1993) who reported that photosynthesis of peach provided 3 to 9% of the weekly carbohydrate (total soluble sugar) requirements early in the season and 8 to 15% mid-season. Also, Du plooy and van Huyssteen (2000) reported that light is essential for anthocyanin synthesis in fruit trees.

CONCLUSION

Results from the current study demonstrate that pre-bloom thinning with SO at 9% or chemical blossom-thinning with ATS at 1.5% can be effective peach technique thinners, but are very environmentally and cultivar dependent. However, growers cannot replace commoner thinning by hand blossom thinning with either pre-bloom thinning or chemical blossom-thinning techniques, but they are important for saving implementation time and costs of hand blossom thinning especially at 15 cm which presented the highest yield per feddan and at 20 cm which introduced the highest fruit quality in this study.

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