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Enhancing the Quality Attributes and Yield of Florida Prince Peaches Via Winter Pruning Times

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Abstract

Winter pruning of peach trees is a cultural practice known that the timing of winter pruning affects the quality, physical and chemical characteristics of peach fruits and the total yield. This study was carried out during two successive seasons of 2021/2022 and 2022/2023 on peach trees 'Florida Prince'cv grafted on Nemagard rootstock. Trees were grown in sandy soil at distances (4×5) under drip irrigation in private orchard in Menoufia Governorate, Egypt. The treatments were applied at five dates during winter pruning as following: the 15th of October (T1), the second was in the 1st of November (T2), the third was in the 15th of November was control trees (T3) the fourth was in the 1st of December(T4), and fifth was in the 15th of December(T5). The results indicated that the 1st of December gave the highest significance to both fruit physical and chemical characteristics and total yield followed by the 15th of December, 15th of November (control), 1st of November then the 15th of October trees in both seasons.

Keywords: Peach, Florida Prince, pruning times, late pruning, winter pruning, yield, fruit quality, dormancy pruning.

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1. Introduction

The peach (*Prunus persica*) is one of Egypt's most important fruit crops. Among fruits grown in the temperate zone, it comes in fourth. Peach is considered one of the most important deciduous trees that shows great success and is widely spread in Egypt's newly reclaimed areas. The introduction of multiple peach cultivars with low to moderate chilling requirements by the agricultural development system has resulted in a rapid increase in Egypt's total planted area. The low chilling requirements of peach is the most important in terms of adaptability and extent, peach trees bear laterally only on previous season's growth which bears only once in its life time therefore requires regular annual pruning. Manipulating time and severity of pruning can be used for avoiding rainy season crop effectively. Work on standardization of pruning techniques and time has been done by many workers in peach [1,2]. The total cultivation area of peaches in Egypt were 29.264 feddans, yielding a total of 272592 tons of fruit [3], it is imperative to maximize productivity given the low marketing prices and high administrative costs in orchards.

Peaches have a habit to set a large number of fruits under optimum growing condition and thereby reduce the possibility of getting commercial fruit size with quality fruit at harvest [4,5]. Fruit trees are pruned to restrict tree size, control tree shape, maintain balance between vegetative and reproductive growth, to improve fruit size and fruit production to obtain a high yield of quality fruit each year. Typically, pruning takes place when the tree is dormant. Given that peach trees bear heavily every year and that pruning them is a difficult, labor-intensive cultural operation, it will be desirable to restrict the early shoots to store carbohydrates before winter and narrow out certain differentiating buds.

For commercial fruit growing, the natural form and shape of the fruit tree has to be modified in a specific manner, so that they perform better for a longer period through the practice of pruning to achieve the target of high production of good fruit quality. Since unwanted portions of plants may develop at the expense of those which are essential from the cultivator's point of view. The pruning techniques have to be, therefore, standardized in terms of amount and severity, keeping in view the fruit bud formation/fruiting behavior of the plant [6]. In this regard, using winter pruning plays the most important role in restricting the canopy growth of the trees and improving fruit quality [7].

The aim of this investigation was to study the effect of different pruning applications on yield and fruit quality of peach Florida Prince cv.

2. Materials and Methods

2.1. Plant materials and treatments

An experiment was conducted on 5 years old peach trees of Florida Prince cv. grafted on the Nemagard rootstock during two seasons (2021-2022 and 2022-2023). Trees were grown in the private orchard at the Khatatbah district, Al Sadat city, Menoufia Governorate, Egypt. The winter pruning process was tested on different dates as following: the first time was in the 15th of October (T1), the second was in the 1st of November (T2), the third was in the 15th of November was control trees (T3) the fourth was in the 1st of December(T4), and fifth was in the 15th of December(T5). The trees were carefully selected as similar size and free of diseases or insect pests and planted in a sandy soil at distances 4×5m under drip irrigation system. The experiment was designed in a complete random. The treatments are 5 pruning dates x 3 replicates (2 tree/replicate) =30 trees. Samples of each tree were tagged randomly at four directions. dormant thinning pruning level application were applied on (one-year-old shoots)85 shoots/tree with heading back cut level treatments on the same shoots, heading back 25% from the shoot length. The length of the shoot was 60 cm.

The experimental trees received the normal agricultural practices adopted in commercial orchards concerning, organic and mineral fertilizers along with irrigation and pest control recommended in this area.

According to the recommendations of the Ministry of Agriculture in Egypt with other cultural practices according to a recommendation of the Agriculture Ministry for sandy soil conditions, each tree was fertilized with 350 g N, 50 g P_2O_5 and 400 g K_2O / year. The trees were sprayed with hydrogen cyanamide at 0.75 % (the product Dormex SKW Torstborg 49% hydrogen cyanamide) in 10 November, and 14 November, for both seasons respectively. Tables (1) and (2) show the soil and water analysis.

Table 1: soil physical properties of the experimental site

Soil depth cm	0 - 30	30 - 60	60 – 90
Soil properties	Values		
Sand (%)	62.28	63.32	63.53
Clay (%)	14.75	15.07	15.29
Silt (%)	22.97	21.61	21.18
Soil texture	Sand		
Ph	7.35	7.40	7.43
EC (dS/m)	2.64	2.64	2.65
Organic matter (%)	0.56	0.58	0.46
Available P (ppm)	7.10	9.7 0	8.60
Available K (ppm)	187.5	166.5	146.5
Available Ca (meq/l)	9.00	9.15	9.21
Available Mg (meq/l)	4.00	4.11	3.99
Available Na (meq/l)	14.50	14.00	15.00
HCO_3 (meq/l)	7.75	8.85	9.00
Cl (meq/l)	9.57	10.77	11.00
SO_4 (meq/l)	19.00	21.40	18.88

Table 2: chemical properties of irrigation water

Ph	EC dS/m	Soluble Salts (meq/l)								SAR	TDS ppm
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}		
7.12	1.5	6.0	3.6	21.95	0.23	0.1	3.0	14	14.7	10	960

The following parameters were measured during the two seasons of the study:

2.2. Total yield and its components

- Fruit weight (g) was determined by using sensitivity balance (0.01 g accuracy).
- Average fruits number per tree.
- Total yield was estimated (kg/tree) after fruits were harvested at the maturity stage (during the 2nd week of April). In the maturity stage, the average number of fruits per tree was counted. The average yield/tree (kg) was calculated by multiplying the average number of fruits/tree x the average weight of fruits of each replicate and yield/feddan (Ton) was calculated multiplying the average yield/tree (kg) x the number of trees/feddan.

2.3. Fruit quality

Asample of ten fruits from each tree (replicate) was collected and then transported directly to the laboratory of the Horticultural Research center in Giza to determine the physical and chemical fruit characteristics. Each season, ten fruits/trees were selected randomly for each replicate and used to determine the following physical and chemical properties:

2.3.1. Fruit physical characteristics

- Fruit size (cm^3) was calculated by using the water displacement method.
- Fruit dimensions (length and diameter cm) and fruit shape index (L/D) were determined by using Vernier caliper with 0.01 mm accuracy.
- Flesh thickness (mm) by using a Vernier caliper Instruction.
- Seed weigh (g), by using a three digits' digital scale.
- Fruit firmness ($Lb./inch^2$) by using a Magness and Tayler pressure tester with a 5/16-inch plunger.

2.3.2. Fruit chemical constituents

- Total soluble solids percentage in fruit Juice (TSS%) by using a hand refractometer.
- Total acidity percentage (%) in fruit juice as malic acid after titration against 0.1 sodium hydroxide using phenolphthalein as an indicator [8].
- Maturity index (TSS/acid ratio).
- Peel anthocyanin content (mg/100g fresh weight). It was determined in samples of one gram of fruit skin extracted with 100/ml of acidified alcohol (ethyl alcohol 95% with 1% HCL). The extract was measured at 535 m n using Carl – Zeiss spectrophotometer according to [9].
- Vitamin C content (mg/100 g f. w.) was determined using 2, 4 - dichlorophenol indophenol dye according to the [8].

2.4. Statistical analysis

The obtained data from both seasons were subjected to analysis of variance (ANOVA) using the CoStat Computer Software program, according to [10]. The treatments arranged in randomized complete block design with three replications. The treatments means were compared by using Duncan's multiple range test at a probability of 0.05 [11].

3. Results and Discussion

3.1. Effect of winter pruning dates on total yield and its components

Data in Table (3) showed the significant effect of winter pruning date applications, where the first of December pruning (T4) gave the highest values concerning fruit weight (109.13 and123.23 g), number of fruits on the tree (318 and 360), total yield per tree (34.35 and 44.36 kg), and per hectare (17.16 and 22.16 ton) compared to the other treatments in the first and second season, respectively. It is noted that in the first season, regarding the number of fruits on the tree, there was no significant difference between T4 and the other treatments, as well as between them and T5 in the second season. As for the characteristics of tree yield and hectare yield, there was no significant difference between T4 and T5 treatments in the first season.

These results are in accordance with those reported by [12] who reported that pruning treatments affected fruit weight. This result is due to the positive role of winter pruning, which affected on the fruit yield [13].

It was reported in previous pruning studies that summer pruning on apple, almond, peach and apricot decreases yield efficiency compared to winter pruning. [14] reported that pre-harvest and post-harvest period pruning on 'Hacıhaliloğlu' apricot variety improve the yield of trees, yet this increase is not statistically significant.

Table 3: Effect of winter pruning dates treatments on total yield and its components of "Florida Prince" peach cultivar trees during 2021/ 2022, and 2022/ 2023 seasons

Character. / Treatment	Fruit weight (g)	No. of fruits per tree	Yield/tree (Kg)	Yield/ha. (Ton.)
2021/ 2022 seasons				
T1: middle of October	82.71 e	291 a	23.76 d	11.88 d
T2: first of November	88.4 d	303 ab	26.36 c	13.16 c
T3: middle of November (control)	99.39 c	312 a	30.63 b	15.3 b
T4: first of December	109.13 a	318 a	34.35 a	17.16 a
T5: middle of December	104.3 b	318 a	32.87 a	16.42 a
2022/ 2023 seasons				
T1: middle of October	83.80 e	327 d	27.41 e	13.71 e
T2: first of November	91.61 d	342 c	31.33 d	15.66 d
T3: middle of November (control)	98.00 c	345 bc	33.81 c	16.9 c
T4: first of December	123.23 a	360 a	44.36 a	22.16 a
T5: middle of December	107.66 b	357 ab	38.44 b	8.07 b

Different letters indicate significant differences ($p \leq 0.05$) using Duncan's Multiple Range Test.

3.2. Effect of winter pruning dates on fruit physical characteristics

It is clear from Table (4) that pruning time on 1st December (T4) gave the highest fruit volume (108.4 and 121.38 cm^3), fruit length (5.69 and 5.02 cm), fruit diameter (6.26 and 5.96 cm), flesh thickness (2.12 and 2.25 mm), seed weight (6.26 and 6.19 g), and fruit firmness (19.586 and 20.91 $Lb/inch^2$) compared to other treatments in the first and second season, respectively. It is noted that in the L/D measurement, there were no significant differences between the treatments during the two seasons.

The presented data are in harmony with [15,16,17] who found that dormant pruning increased fruit size and fruit dimensions (length and diameter) of peach fruits. [18] reported that pruning time did not affect L/D ratio (fruit length/ fruit diameter**.** [19] cleared that increased yield and quality due to time of pruning because of, besides light penetration and fulfillment of chilling hours, it also encourages more flow of nutrients and water to the remaining shoots which flower and that is how the percentage of flowers that develop to form fruits is increased invariably.

Effect of time pruning may be the result of such trees would use less water and be less susceptible to water stress, thereby improving fruit water status and fruit growth rate during stage of final swell when the fruit have a large demand for photosynthesis and water [20,21], also, improved light exposure may have strengthened fruit sink activity, thus increasing fruit size [22]. As, might be due to the stimulation of optimum vegetative and floral growth, which might have brought about balance between the fruiting wood and leaf area [23]. [24] reported that increase in fruit size and weight might be attributed to better source-sink relationship and lesser competition for assimilates among the fruits in pruned trees.

3.2. Effect of winter pruning dates on fruit chemical constituents

The data in Table (5) showed the significant effect of dormant pruning applications at different times on the chemical characteristics of the fruits, where the first of December pruning treatment (T4) gave the highest values in TSS % (11.50 and 11.66 %), TSS /acid ratio (26.62 and 1.99), anthocyanin (4.30 and 5.29 mg/100g) and vitamin C (19.50 and 20.38) in the two seasons, respectively. The highest levels of total acidity (%) were observed in the middle of October pruning (T1) treatment (0.626 and 0.663 %) and the first of November pruning (T2) treatment (0.576 and 0.613%) in the two seasons, respectively, along with the control (T3) in the second season. The results showed that there was no significant difference between T3, T4 and T5 for TSS% in the second season only. The difference between pruning treatments T1 and T2 was not significant for total acidity in both seasons and also with T3 in the second season. There was no significant difference between T4 and T5 for higher values of TSS/acidity ratio in the two seasons. The lowest values of total acidity were recorded from T4 and T5 pruning treatments in the two seasons. The difference between pruning treatments T2, T3, T4 and T5 was non-significant for higher values of anthocyanin trait in the first season only, while the least value was for T1 in both seasons.

Winter pruning time not only affected the total dissolved solids and irrigation on the harvest period, but also affected the fruit yield and total dissolved solids (TSS) [13]. These results are supported by the conclusion of [15] that

dormant pruning treatment significantly increased the percentage of T.S.S in the juice of **(**Mit Ghamr) peach fruits.

Similarly, [25,26] found that the TSS /acid ratio was not significantly affected by time pruning.

Also, [23] confirm that summer or dormant pruning had inconsistent effects of peach fruit soluble solids. This may be attributed to more in fruit size and fruit soluble solids with too relatively is likely due to the Increase the percentage in total photosynthetic production of tree resulting in more carbohydrates available for the fruit.

Table 4: Effect of winter pruning dates treatments on fruit physical characteristics of "Florida Prince" peach cultivar trees during 2021/ 2022 and 2022/ 2023 seasons

Character. / winter pruning date	Fruit volume (cm^3)	Fruit length (mm)	Fruit diameter (mm)	L / D ratio	Flesh Thickness (mm)	Seed weigh (gm)	Fruit firmness ($Lb./inch^2$)
2021/ 2022 seasons							
T1: middle of October	81.66	4.30 e	4.71 e	.913 ab	1.60 e	5.03 b	12.96 bc
T2: first of November	86.99 d	4.60 d	5.03 d	.913 ab	1.71 d	5.16 b	15.04 b
T3: middle of November (control)	98.16 c	5.20 c	5.63 c	.926 a	1.92 c	5.53 b	14.64 b
T4: first of December	108.4 a	5.69 a	6.26 a	.910 b	2.12 a	6.26 a	19.586 a
T5: middle of December	103.37 b	5.49 b	5.99 b	.916 ab	2.02 b	5.59 b	11.10 c
2022/ 2023 seasons							
T1: middle of October	82.00 e	4.26 c	5.26 d	0.810 a	1.61 c	5.23 d	14.82 d
T2: first of November	89.43 d	4.31 c	5.35 cd	0.806a	1.66 c	5.39 c	15.48d
T3: middle of November (control)	97.00 c	4.57 b	5.55 bc	0.823 a	1.75 c	5.46 bc	17.33 c
T4: first of December	121.38 a	5.02 a	5.96 a	0.841 a	2.25 a	6.19 a	20.91 a
T5: middle of December	104.33 b	4.68 b	5.70 b	0.823a	1.96 b	5.55 b	19.11 b

Different letters indicate significant differences ($p \leq 0.05$) using Duncan's Multiple Range Test.

Table 5: Effect of Winter pruning dates treatments on fruit chemical constituents of "Florida Prince" peach cultivar trees during 2021/ 2022, and 2022/ 2023 seasons.

Character. / winter pruning date	TSS %	Total acidity %	TSS /acid ratio	Anthocyanin (mg/100g)	V.C (mg/100 g)
2021/ 2022 seasons					
T1: middle of October	9.68 c	0.626 a	15.53 c	2.79 b	16.89 d
T2: first of November	9.96 bc	0.576 ab	17.34 c	3.66 ab	17.85 c
T3: middle of November (control)	9.96 bc	0. 500 bc	20.07 bc	4.06 a	18.30 bc
T4: first of December	11.50 a	0.443 c	26.62 a	4.30 a	19.50 a
T5: middle of December	10.33 b	0.446 c	23.61 ab	4.27 a	18.72b
2022/ 2023 seasons					
T1: middle of October	10.65 b	0.663 a	1.707 bc	2.90 d	18.63 c
T2: first of November	10.60 b	0.613 ab	1.65 c	3.40 c	18.55 c
T3: middle of November (control)	10.96 ab	0.600 ab	1.83 b	3.81 bc	18.94 c
T4: first of December	11.66 a	0.503 c	1.99 a	5.29 a	20.38 a
T5: middle of December	10.90 ab	0.543 bc	1.83 ab	4.27 b	19.80 b

4. Conclusions

The importance of determining the time for winter pruning in light of the current climate changes and that winter pruning by the first week of December gives the largest number of fruits per tree and the highest weight of the fruit in addition to the highest fruit production per tree and the best quality (physical and chemical quality characteristics) for Florida Prince peaches.

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