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EFFECT OF HARVEST DATE ON FRUIT SET, DROPPING AND CHANGES IN NUTRENT AND ENDOGENS HORMONE OF WASHINGTON NAVEL ORANGE TREES

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ABSTRACT

The effect of picking dates on fruit set, dropping and nutrient change of Washington navel orange were studied during 2009/2010 and 2010/2011 seasons. It is an evident decrease in N, P and K contents in leaves and juice was obtained with delayed harvest date. Activity of pectin methyl esterase and polygalacturonase (PGU) enzymes in fruit peduncles was increased by delayed picking dates. This was related to increasing pre-harvest fruit drop percentage. Delaying time of fruit harvest increased gibberellic acid and indole acetic acid (IAA) and decreased abscisic acid in the leaves. Regarding successive season parameters, delaying harvest date delayed the flowering starting date and full bloom date and increased vegetative bud percentage and decreased flower bud percentage. Moreover, a decrease in fruit set in the following season was also noticed. The data also, revealed that content and endogens hormone of Washington navel orange trees that fruit dropping significantly increased with delaying the date of picking since, the earlier data gave a lower dropping than the other dates.

Key words: Picking date-Washington navel orange - Successive yield-Enzyme - activity- Endogenous hormones

INTRODUCTION

Citrus in Egypt is a major export product. Egypt has the potential to export close to one million tons of fresh fruits by the year 2010 (Hofer, 2006). Today, Egypt stands at the tenth and fourth position among the top citrus producing and exporting countries, respectively (F.A.O., 2010). In Egypt Washington Navel orange is the most important and popular orange variety that is consumed and exported as fresh fruit. Recently, the production of high quality citrus crop for export purposes is highly awarded specially by Navel orange growers. Fruit size represents one of the most important quality characteristics for citrus fresh consumption (Agusti et al., 2002) as well as external features like fruit colour, size, and peel texture are the important parameters to estimate the quality of the fruit, while internal characters contributing to fruit quality include amount and quality of juice, seediness, vitamin C contents, total soluble solids (TSS), titratable acidity (TA) and TSS: TA ratio. (Ahmed,

2006). Since citrus fruits are non-climacteric, commercial harvest for a given variety can occur over a prolonged period in the same orchard. Delayed citrus harvest has previously been reported to influence fruit quality variables during the current season and to reduce the subsequent year's yield. The effects of different harvest time on the storability and fruit quality of some orange cvs has been investigated by (Dundar & Pekmezci, 1991 and Abdi & Mojdeh 1992). However, the effect of picking date on endogenous

plant hormone was studied by (Fekria, 1990), whereas the effect of picking dates on enzyme activity in fruit peduncles was investigated by (Nagar, 1995).

Therefore, the aim of this study was to investigate the effect of harvest dates on yield and fruit quality. Moreover, the effect on flowering, fruiting and yield in the successive season was also studied.

MATERIAL AND METHODS

This study was carried out on "Washington navel" orange trees (Citrus sin ensis L. Osbeck.) grown in a private farm at El-Shohada. Menofeia Governorate during 2009 / 2010 and 2010 2011 seasons. The trees were twenty years old, grafted on Sour orange stock and planted at five meters apart. Trees were almost uniform in vigour and yield and received similar agricultural practices.

In the first season (2009), twenty trees were chosen and divided into 5 groups representing 5 Picking dates (treatments). The picking dates were (15 Dec., 15 Jan., 15 Feb., l5 Mar., 15 Apr.). Each treatment was replicated times (four trees), in a randomized complete block design, However, in the second season (2011) another trees were chosen and the same procedures were adopted as Previously mentioned in the first season.

At harvest date, pre-harvest fruit drop % was calculated and recorded as follows-

$$pre-harvest\ fruit\ drop\% = \frac{Number\ of\ dropped\ fruits\ at\ harvest}{Total\ numbers\ of\ fruits\ /\ tree} \times 100$$

At each picking date. 20-30 leaves samples of non-fruiting shoots of spring flushes (the second and third leaves from the top of non-fruiting shoots) were taken and dried for the determination of N.P and K%. Also, fresh juice sample at each picking date was also taken for the determination of N.P and K%. An appropriate weight of 0.2 g of dry leaves and 10 ml of fresh juice were digested using a mixture of perchloric and su1phonic acid at ratio of 1:4 (v/v) until clear solution was obtained. The digested solut10fl was quantitatively transferred to a 100 ml volumetric flask and raised up by deionized water to the standard volume. The phosphorus was colorimetrically determined by the method of (Truog & Meyer 1929) and potassium was determined by a flame photometer according to (Brown and Lilleland, 1946). Data were expressed as percentages of dry weight for leaves and juice.

For studying the endogenous hormones (gibberellic , auxins and abscissic acid), at each picking date, 20 g full expanded leaves from the top of nonfniting shoots of spring flushes (the second and third leaves from the top) from each replicate were collected and extracted three times each for 24 hours the methyl alcohol at 0°C as described by (Diaz & Martin 1972). The quantity determination of endogenous hormones was measured by a gas liquid chromatography (GLC) apparatus as described by (Vogel, 1975). Peak identification was performed by comparing the relative retention time of each peak with those of standard GA_3 IAA and ABA. Peaks area was measured by

traingulanon and the relative properties of the individual components were therefore obtained. Data was expressed as mg / 100 g dry weight(El-Hammady.,2000)

For studying enzyme activity and relative activity of pectin methyl esterase (P.M.E) and polygalactourenase (P.G.LT) enzymes. 1.0 g. of fruit peduncles from each replicate at each picking date were taken and extracted as described by (Lee & Macmillan, 1968). The reaction mixture for the two enzymes consisted of 2.0 ml pectin solution + 0.5 ml bromomethanol blue ± 1.5 ml water and PH was adjusted at 7.5. The initial absorbance at 620 run for pectin methyl esterase and 445 nm for polygalactourenase enzymes of the mixture was measured vs. water. After that, 20 µl of pectin-methyl-esterase or polygalactourenase enzymes were added to initiate reaction and the decrease in absorbance at 620 and 445 nm were recorded. The initial rate of the reaction was linear for about 3 min. and enzyme activity was recorded (Hagreman & Austin, 1986).

The relative activity was calculated as follows:

$$\text{Relative activity} = 100 - \frac{\text{Enzyme activity at any give date} - \text{enzyme Activity at first picking date}}{\text{enzyme activity at the first picking date}} \times 100$$

Moreover, the residual effect of picking date on flowering starting date, full bloom date, vegetative bud %, flower bud %, fruit set % and yield were studied in the two successive seasons.

Vegetative and flower bud % were calculated on 10 secondary branches for each replicate. However, on each secondary branch. 10 laft inflorescences were labeled and the total number of their flowers was recorded. when fruitlets attained 3-4 mm in diameter, fruit set was calculated as follows:

$$\text{Fruit set \%} = \frac{\text{Total number of fruit set}}{\text{Total Number of flowers}} \times 100$$

After that, fruits for all trees were harvested in mid Dec. when were 11.5 - 12 % for T.S.S., 0.9-1.0% for titrateable acidity and 12.0-12.78 for T.S.S / acid ratio.

Yield as number or weight of fruits / tree was recorded for each tree. Data obtained where statistically analyzed and the multiple range test at 5% level was used to differentiate means (Duncan, 1955).

RESULTS AND DISCUSSION

1. Effect of picking date on flowering fruit set % and yield in the successive season:

It is clear from data in Table (1) that picking date had a great effect on flowering attributes in the following season (successive season) . Delaying picking dates delayed flowering starting date and: full bloom date in the successive' season: This delay attained 5 and 7 days in the: first and second seasoned, respectively. Vegetative bud percentage was increased and flower bud percentage was decrease & E: with deriving harvest date from 15.Dec.to 15 Apr. with high significant differences between different picking dates. Also, data showed that Pre-harvest fruit drop % was increased with delaying date of fruit picking with significant differences between different picking dates.

Table 1. Effect of picking date on flowering attributes, fruit set and preharvest drop in the successive seasons (2009 and 2010) of "Washington navel" orange during 2009-2010 and 2010-2011 seasons.

Picking date	Flowering starting date	Full bloom date	Vegetative bud%	Flower bud%	Fruit set%	Preharvest drop %
First Season						
15 Dec.	20 Feb. 2010	10 Apr. 2010	12.0 d	88.0 a	0.93 a	1.1 d
15 Jan	20 Feb. 2010	12 Apr. 2010	13.6cd	86.4ab	0.75ab	2.2 cd
15 Feb.	25 Feb. 2010	16 Apr. 2010	15.4bc	84.6bc	0.70b	3.7 c
15 Mar	25 Feb. 2010	l7 Apr. 2010	18.7ab	81.3c	0.6 b	5.4 b
l5Apr.	2S Feb 2010	16 Apr 2010	22.0a	78.0b	0.60b	12.0 a
Second Season						
15 Dec.	15 Feb. 2011	8 Apr. 2011	11.5b	88.0a	1.l0a	1.1 d
15 Jan	15 Feb. 2011	8 Apr. 2011	16.7 a	83.3 b	1.00 a	l.3cd
15 Feb.	20 Feb. 2011	11 Apr. 2011	17.8 a	82.2b	0.80ab	3.1 bc
15 Mar	20 Feb 2011	12 Apr. 2011	19.4a	80.6b	0.8Oab	4.7 b
l5Apr.	20 Feb. 2011	12 Apr. 2011	18.6a	81.4b	O.60b	10.4 a

Values within a column in each season having the same letters are not significantly different according to Dunca &s multiple range test a 5% level.

Similar results were mentioned by (Fekria, 1990) and (Soto et. al. 1994) they reported that delaying picking dates of "Washington navel" orange increased vegetative buds and decreased flower buds percentages and consequently decreased flowering percentages in the successive season. On the contrary, (Zayan *et.al.,* 1986) they found no clear effect to different picking dates (early in November, Mid- season in January or late in March) on flowering date in the successive season of "Washington navel" orange delayed, fruit set percentage was decreased. The least fruit set percentage was obtained with trees harvested on 15 April which could be attributed to the effect of mechanical damage which increased flower and fruitlets drop. Also, the obtained results are in harmony with found by (Abdi and Mojdeh, 1992), (El-Hammady.,2000) and (Muhammad, *et. al.,* 2012).

2. Effect of picking date on mineral content of leaf' and juice:

Results in Table (2) showed a clear effect of picking date on N, P and K contents in leaves and juice. Regarding leaf analysis, a general reduction in these elements with delaying harvest dates was observed. However, nitrogen content was reduced till 15 Mar. (first season) and 15 Feb. (second season) and increased after that. A slight change in leaf P content was obtained with delaying harvest date, whereas K content gradually decreased with delaying harvest date. In this respect, (Monselise and Goldschimdt, 1982) and (Han ShuRui, 2014) reported that year citrus trees had less total nitrogen, but higher nitrate levels in the leaves The obtained data are in contrary those of (Fekria, 1990), who found no significant changes in leaf nitrogen to tent of "Washington navel" orange due to harvesting dates.

Table 2. Effect of picking date on nitrogen, phosphorus and potassium in leaves and juice of "Washington navel" orange, during first season (2009-2010) and second season (2010-2011) seasons.

Picking Date	Leaf analysis			Juice analysis		
	N%	P%	K%	N%	P%	K%
First season						
15 Dec	2.25 a	0.21 a	1.30 a	0.12 a	0.28 a	0.43a
15 Jan	2.l0ab	0.l8ab	l.20ab	0.10 a	0.26ab	0.32ab
15 Feb	2.00b	0.15b	1.00bc	0.08ab	0.21bc	0.30b
15 Mar	2.00b	0.l8ab	l.00bc	0.08ab	0.20bc	0.21b
15 Apr	2.l5ab	0.l8ab	0.83 c	0.05 b	0.17 c	0.20 b
Second Season						
15 Dec	2.35 a	0,25 a	1,21 a	0.13 a	0.31 a	0.45a
15 Jan	2.20bc	0.20b	1.l0ab	0.lla	0.30a	0.40a
15 Feb	2.10 c	0.20 b	1.00 b	0.12 a	0.28ab	0.40a
15 Mar	2,20bc	0.19b	1.00b	0.1 a	0.l7bc	0.46a
15 Apr	2.30ab	0.19b	1.l0ab	0.13a	0.l0c	0.15a

Values within a column in each season having the same letters are not significant different according to Duncan's multiple range test at 5% level.

Juice analysis for nitrogen, phosphorus and potassium showed a reduction in these elements with decline picking dates. However. significant differences were only obtained on 15 Dec. and 15 Apr. picking dates (first season). N juice nitrogen content, whereas no significant differences were noticed in the second season A general reduction in P juice content was obtained in the two studied seasons with some significant differences between different pickings. K juice content 'as sharply reduced with delaying picking dates (first season) but slight decrease was noticed in the second season with an increase in 15 Mar. and 15 Apr. picking dates. This reduction in juice N, P and K with delaying picking dates explain the reduction of nutritive value in tree-stored fruits compared with that of early picked fruit.

3. Effect of picking date on leaf endogenous hormones (gibberellins, auxins and abscissic acid).

The changes in plant hormones of 'Washington navel" orange leaves as affected by different picking dates are shown in Table (3). Regarding gibberellins 1evels, it is dear that delaying picking date was related with increasing gibberellins levels until Feb. and declined after that with significant differences between different picking dates. Auxin content in leaves attained the highest level when yield was harvest on 15 Jan. compared with other picking dates. No significant differences were noticed between the last three picking dates (first season) or the last two picking dates (second season) in their auxins content.

On the other hand, a general reduction in ABA content was noticed with delaying picking dates with significant differences between them. The obtained data are in contrary with (Fekria, 1990) who mentioned that early harvested trees of Washington navel" orange contained lower levels of gibberellins and indole acetic acid than in trees harvested later.

It is important to point out that delaying picking date after 15 Feb. caused imbalance in gibberellic and auxins in this critical period (time of flower bud induction).

Table 3. Effect of picking date on leaf endogenous hormones (gibberellic acid. auxins and abscissic acid) and P.M.E & P.G.U enzymes activities in fruit peduncie of "Washington navel" orange during 2009-2010 and 2010-2011 seasons.

Picking date	Endogenous hormones levels						
	Gibberellic acid	Auxins	Abscissic acid	P.M.E[X] activity	Relative activity	P.G.U[Y] activity	Relative activity
First Season							
15 Dec.	50.2c	3.50 b	0.908a	0.432c	100.0c	0.208c	100.0c
15 Jan	58.5b	4.70 a	0.701b	0.503bc	116.4bc	0.280b	134.6b
15 Feb.	63.7a	3.20bc	0.510c	0.527bc	122.0bc	0.320b	153.8b
15 Mar	40.7d	2.10bc	0.310d	0.600b	138.9b	0.400a	192.3a
l5Apr.	32.3e	1.80c	0.108e	0.855a	12010.0a	0.400a	192.3a
Second season							
15 Dec.	48.2c	2.70 a	0.523a	0.223d	100.0d	0.138d	100.0d
15 Jan	53.7b	3.20 a	0.410b	0.325c	145.7c	0.208cd	150.7cd
15 Feb.	58.2a	3.00a	0.310c	0.443b	12010.7b	0.280bc	202.9bc
15 Mar	30.1d	1.20b	0.108d	0.520ab	233.2ab	0.330ab	239.1ab
l5Apr.	30.0d	0.75 b	0.095e	0.580a	260.1a	0.380a	275.4a

Values within a column in each season having the same letters are not significantly different according to Duncan's multiple range test at 5% level.

4. Effect of picking date on pectin-methyl-esterase and polygalactourenase enzyme activity and their relative activity in fruit peduncles.

Results in Table (4) show that pectin methyl esterase and polygalactourenase enzymes activities were gradually increased in fruit

peduricles by delaying fruit harvest. Thus on tree storage of "Washington navel" orange fruits increased fruit drop (Table 1) due to the increase in activity of both These enzymes are responsible of formation of insoluble pectin soluble form and consequently the dunces become more soft and this fruit drop. Moreover, data showed the increase in P.G.U enzyme activity was more pronounced than that of P.M.E in the seasons. It is well known that P.M.E enzyme transformed pectinic to pectin acid whereas P.G.U enzyme transformed pectin acid to ga1ac. acid (Hulme, 1970). So, the increase in P.G.U. enzyme activity is related more fruit drop than that of P.M.E enzyme. The same trend of results was noticed by (Nagar, 1995) who noticed an increase in activates of P.M.E and P.U.G enzymes with a delaying harvesting date of "Kinnow" mandarin fruits.

With regard on preharvest drop, the data reveal that it increased significantly with delaying the data of fruit picking, since the earlier data produced a lower fruit dropping than the later one.

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دراسة تأثير مواعيد القطف على العقد والتساقط والمحتوى المعدنى للبرتقال بسره

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اجريت هذة الدراسة خلال موسمي ٢٠٠٩/٢٠١٠، ٢٠١٠/٢٠١١. ولقد أظهرت الدراسة أن لتأخير موعد الجمع تأثيرا سلبيا على محتوى الأوراق والعصير من عناصر النيتروجين والفوسفور والبوتاسيوم حيث تناقصت مع تأخير موعد الجمع. كذلك لوحظ أن هناك زيادة في نشاط إنزيمات تحلل المواد البكتينية في أعناق الثمار وهي البكتين مثل استريز والبولي جالاكتويرورينيز وارتبط هذا بزيادة نسبة تساقط ما قبل الجمع بزيادة مستوى الجبرلينات والاكسينات حتى ١٥ فبراير ثم تناقص بعد ذلك بينما يتناقص حمض الابسيسيك باضطراد مع تأخير موعد الجمع وبالنسبة لتأثير موعد القطف على الأزهار والإثمار في العام التالي فقد لوحظ أن تأخير الجمع يسبب تأخير في موعد بداية الأزهار وموعد الأزهار الكامل ويزيد من نسبة البراعم الخضرية ويقلل من نسبة البراعم الزهرية على الأشجار كذلك فإن عقد الثمار يتناقص مع تأخير موعد الجمع في الموسم السابق. فى حين أظهرت الدراسة أن تأخر ميعاد الجمع أدى الى زيادة نسبة تساقط الثمار ما بعد الجمع.