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Effect of GA_3 and NAA on Growth, Yield and Fruit Quality of Washington Navel Orange

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FRUIT DROP and fruit quality are the most values in Washington navel orange since they are playing the main role in production and exporting potential. The current study was carried out during the two successive seasons of 2014 and 2015 on thirteen years Washington navel orange trees grown in sandy soil in a private orchard located at Housh Eissa, El-Behera Governorate, Egypt. The effect of GA_3 and NAA applied one week after full bloom on Washington navel orange trees was studied. The results showed that foliar spray of trees with GA_3 at 20 ppm+ NAA at 25 ppm at one week after fruit set increased significantly vegetative growth parameters such as (shoot length (cm), leaves number per shoot at the three growth cycles, as well as leaf area (cm^2) compared the other treatments and control. Spraying trees with GA_3at 20 ppm+ NAA at 25 ppm decreased fruit drop percentage and increased significantly yield (kg/ tree), fruit physical parameters such as fruit weight (g), fruit size (cm^3) fruit length, fruit diameter (cm) and fruit juice in comparison to other treatments and control. Fruit biochemical characteristics such as TSS, total acidity, TSS/acid ratio and V.C were also positively affected by using this treatment compared with other treatments and control. It might be recommended that foliar spraying Washington navel orange trees with 20 ppm GA^3 and 25 ppm of NAA one week after fruit set gave the highest values of yield (kg) /tree, fruit physical and chemical properties.

Keywords: Growth regulators, Navel orange, Foliar spraying, Growth, Yield, Fruit quality.

Introduction

Washington navel orange (*Citrus sinensis* L. Osbeck) is one of the most important species in the genus citrus. In Egypt Washington navel orange ranked first among the species of citrus. It occupies about 35 % of the total cultivated area of citrus, since its acreage reached about 181091 feddans with total production of 1663284tons per year. According to the last census, issued by Ministry of Agriculture, Egypt (2015). Yields are fluctuated in several zones because of need useful pollen, once in a while create suitable ovules and furthermore, are poorly parthenocarpic (Krezdorn, 1965). Flower and fruitlet drop of navel orange happened in three stages and sum to a total 91%, giving a fruit set of 9% (Villafane, et al. 1989). Gibberellins and (NAA) have a board series of usages in citriculture; GA_s have been used in citrus production with several purposes including flower reduction, improved fruitlet setting, enhancement of fruit superiority and improved ripening control (Agustí and Almela, 1991). The treatment of GA_3 rapidly after flowering at concentrations ranged 10 and 15 p.p.m. can effect in delayed abscission and improved fruitlet set, mostly in Clementine tangerines (El-Otmani, 1992). Though, the problem of June drop and pre-harvest fruit drop exists extensively in many Egyptian orchards, whereas, Washington navel orange is a parthenocarpic cultivar thus decrease in yield and fruit quality can affect it. Young parthenocarpic fruits tend to be more easily to drop than young fruits from pollinated flowers (Schafer et al., 1999). The use of growth regulators to enhancing fruit set and fruit size has become important in agriculture today because they have the ability to increase vegetative growth, fruit set percentage, yield and fruit quality. GAs encourage cell division and elongation; increase stalk length, enhance flower and fruit volume of fruits, Auxins promote shoot elongation, thin tree fruit, and flower formation (Fishel, 2006).The biological effects of applying growth regulators on plants have received much

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attention due to their important use in agriculture: in particular, the economical application of growth regulators on flowers and fruits (as parthenocarpic, thinning, and elongating agents) and on shoot (as a controlling agent of plant height and lateral branching) (Whiting, 2007). Hanafy et al. (2012) reported that foliar treatment of 30 ppm GA3 improved growth parameters of Washington navel orange trees.

Eman et al. (2007) sprayed Washington Navel orange with GA_3 at 10 or 20 ppm one week after fruit set increased in final fruit set percentage and fruit yield (kg per tree) as compared to untreated plants. Kassem et al. (2012) studied the effect of foliar sprays of Washington navel oranges by GA_3 as a pre harvest treatment. They reported that fruit dimension, fruit juice content, vitamin C content, TSS% and total acidity % had increased in comparison with control. Greenberg et al. (2000) stated that fruit weight of Washington Navel orange was positively affected by spraying the trees once after fruit setting with NAA at 10-50 ppm. Treatments of growth regulators such as GA_3 and NAA separately or in mixtures on Washington Navel orange plants might increase fruiting potential and fruit superiority. Hence, this work designed to discover the result of foliar spraying Washington Navel orange trees with GA_3 and NAA on adjusting fruit drop percentage and increasing yield and fruit value of under new reclaimed land environments.

Material and Methods

This study was carried out during the two consecutive seasons of 2014 and 2015 on thirteen years old Washington navel orange trees [*Citrus sinensis* L. (Osbeck)] grown in sandy soil in a private orchard at Housh Eissa, El- Behera Governorate, Egypt. Washington navel orange trees were budded on citrus rootstock namely Sour orange (*Citrus aurantium* L.). The trees are planted 4 × 4 meters apart. All trees are irrigated using drip irrigation system. The chosen trees for the experimentation were similar in vigor and subjected to the same cultural practices that followed in the farm. The tested trees were sprayed with GA_3 and NAA either individually or in combinations 7 days after full bloom to study their effects on growth, yield and fruit quality of Washington navel orange as follows:

The treatments:

GA_3 and NAA were applied individually or in combinations, 7 days after full bloom as foliar spray on the trees as follows:

T1: Control: trees were sprayed with water only.
T2: GA_3 at 20 ppm.
T3: GA_3 at 30 ppm.
T4: NAA at 20 ppm.
T5: NAA at 25 ppm.
T6: GA_3 at 20 ppm + NAA at 20 ppm.
T7: GA_3 at 20 ppm + NAA at 25 ppm.

A complete randomized block design was adopted in this experiment with 7 treatments where each treatment had three replicates with one tree per each. Each tree was received 10 L of the applied solution plus 5cm per liter of tween 20 to avoid the surface tension except those of control treatment which sprayed with water only.

Measurements:

Shoot length (cm):

Twenty shoots/tree replicated 3 times (3 trees) were devoted to measure the shoot length (cm) periodically every week. It was repeated three growth cycles

Number of leaves/ shoot:

Twenty shoots per tree were chosen where 5 shoots per main branch (two years old), nearly uniform in diameter and length were labeled on 1st March. Number of leaves/ shoot were recorded. It was repeated three growth cycles .

Leaf area (cm²):

Twenty mature leaves replicated three times were abscised in December, then leaf area (cm^2) was calculated according to the following equation of Ahmed and Morsy (1999).

Leaf area = 0.49 (Length x Width) + 19.09 = ... cm^2.

Fruit drop percentage:

Four main branches in each replicate were tagged and the number of fruits per twelve shoots per each main branch of fruiting shoots was recorded twice, 7 days after fruit set and at harvest date. Consequently, the fruit drop % was recorded according to the following equation:

$$\text{Fruit drop\%} = \frac{\text{No. of fruits at fruit set - No of retained fruits at harvest}}{\text{No. of fruits at fruit set}} \times 100$$

Yield:

Harvesting was achieved on December 15th for each season, yield (Kg/tree) was recorded. Fruit yield increment or reduction percentage is compared with the control was calculated by the following equation:

Fruit physical characteristics

At harvest, samples of twenty fruits of each tree replicated three times were devoted to determine the following fruit characteristics: Fruit weight (g), fruit volume (cm3) fruit peel weight (g) and fruit pulp weight (g).

$$\text{Fruit yield increment or reduction (\%)} = \frac{\text{Fruit yield (kg)/treatment - Fruit yield (kg)/ control}}{\text{Fruit yield (kg)/ control}} \times 100$$

Fruit biochemical characteristics

Titratable acidity (%), TSS (%) and Ascorbic acid (vitamin C.) "mg/100 ml juice" were recorded. Statistical Analysis: A completely randomized block design was followed and the results were statistically analyzed using F-value test. The means were compared by L.S.D at the level of 5% probability according to Snedecor and Cochran (1980). The obtained data were calculated using (COSTAT) program according to Stern (1991).

Results and Discussion

Effect of GA_3 and NAA on vegetative growth of Washington navel orange cultivar:

Shoot length

Trees were sprayed with the growth regulators GA_3 and /or NAA aqueous solution at different concentrations one week after fruit set stage for the two studied seasons. The results in Fig. 1 showed that the application of GA_3 and NAA increased significantly the three growth cycles (spring, summer and autumn flush shoot length) of Washington navel orange trees in comparison to untreated plants. The results are in agreement with those of Ghosh et al. (2013) who found that foliar spraying of sweet orange with 25 ppm GA_3 at starting from pea stage of fruit development (after fruit set) increased shoot length in comparison to that of control. The results also showed that the combination between NAA and GA_3 increased the spring flush shoot length (cm). The highest shoot length was obtained when the trees were sprayed with combination between GA_3 and NAA both at 20 ppm (T6) followed in descending order by (T5) NAA at 25 ppm, (T7) GA_3 at 20 ppm+ NAA at 25 ppm and (T3) GA_3 at 30 ppm. On the other hand, the lowest value of shoot length was obtained from "control" during the two studied seasons. Wang et al. (2013) found that foliar spraying of 'Cara cara' navel orange with GA_3at concentrations of 10, 20 and 30 ppm during the early period of fruit growth increased significantly shoot length and leaf area in comparison to that of control. The improving effects of foliar application of GA_3 and NAA during one week after fruit set on the vegetative growth might be attributed to the stimulation of growth that leads to an increasing in shoot length. GA_3 and NAA are important growth regulators for the plant, since they are playing an important role is cell division and cell wall elongation and leads to the increase shoot length (Crosier et al., 2000).

Number of leaves per shoot and leaf area (cm^2)

The results in Table 1 showed that spraying trees with GA_3 at 20 to 30 ppm and NAA at 20 to 25 ppm significantly improved the number of leaves per shoot and leaf area compared to that of control. The results indicated that high concentration of GA_3 and NAA led to an increase in number of leaves per shoot and leaf area better than the low concentration, also the combination between GA_3 and NAA seemed to be better than individual treatments. Trees treated with GA_3 at 20 ppm+ NAA at 25 ppm significantly increased the largest number of leaves per shoot and leaf area followed by T6 (GA_3 at 20 ppm+ NAA at 20 ppm), T5 (NAA at 25 ppm) and T3 (GA_3 at 30 ppm) respectively in the both studied seasons compared to control. The result might be due to the promotion effect of NAA and GA_3 on improving growth characteristics. The current results are in contract with those of other workers who found that spraying Washington navel orange with GA_3 and NAA increased average leaf area of as compared with control (Singh et al. 2016). Also, Maleknezhad et al. (2012) found that foliar spray of 'Satsuma' mandarin with GA_3 at 15 and 30 ppm at pre-harvest increased number of leaves compared with control. It is well known that foliar spraying of GA_3 has the capacity to encourage growth of plants and improvement in a variety of trial systems. This might be owing to the increase of photosynthetic rates or due to more effective use of photosynthetic yields. In this case, there are numerous different studies on the involvement of GAs with photosynthetic processes. Davies (1987) stated that NAA belongs to artificial forms of Auxins. Auxins show main role in cell elongation, cell division, vascular tissue, differentiation, apical dominance, leaf senescence and fruit abscission.

The increase in number of leaves per shoot at different vegetative growth cycles of navel orange might be due to that elongation that happened in shoot length (cm) as a result of foliar application with those of GA_3 and NAA. Crosier et al. (2000) reported that auxin is also required for cell elongation, and has different effects depending on the organ in which it is present; it encourages growth in the shoot and number of leaves per shoot in comparison with that of control. It could be concluded that all growth cycles of Washington navel orange responded positively to the foliar spraying of combinations between GA_3 and NAA since it stimulated the shoot length, number of leaves per shoot as well as leaf area in comparison with those of other foliar treatments or control.

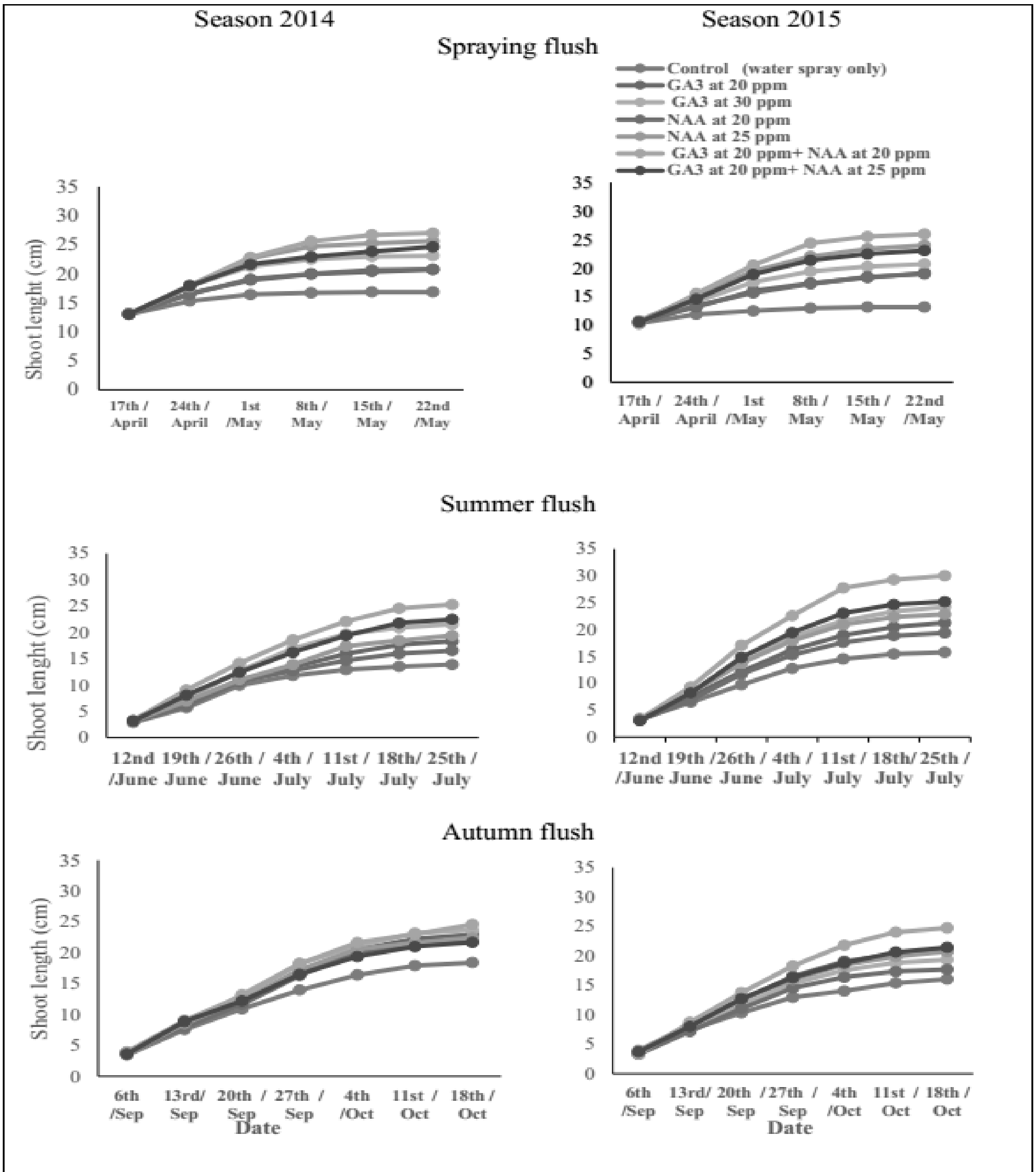

Fig. 1. Effect of foliar spraying with GA3 and NAA at 7 days after fruit set on shoot length (cm) of Washington navel orange cultivar in 2014 and 2015 seasons.

TABLE 1. Effect of foliar spraying with GA_3 and NAA at 7days after fruit set on number of leaves per shoot and leaf area (cm^2) of Washington navel orange cultivar in 2014 and 2015 seasons.

Growth cycles / Character	Spring flush		Summer flush		Autumn flush		Leaf area (cm^2)	
	Number of leaves per shoot							
Treatments (ppm) GA_3 + NAA	2014	2015	2014	2015	2014	2015	2014	2015
0.0+0.0	8.40 d	7.37 e	7.22 e	8.05 f	9.75 d	8.68 e	36.86 e	37.44d
20+0.0	10.54 c	10.44 d	9.65 cd	11.48de	12.24abc	10.52bcd	40.10d	41.92 c
30+0.0	11.97bc	11.43cd	11.89 b	13.19bc	13.12 ab	10.20 cd	42.67 c	43.09 c
0.0+20	10.68 c	10.47 d	9.04 d	10.81 e	11.63 c	9.58 de	42.80 c	41.35 c
0.0+25	13.29ab	13.14 b	10.53 c	12.35cd	12.06abc	10.96 bc	44.03bc	45.39b
20+20	14.53 a	15.03 a	13.68 a	17.02 a	13.22 a	13.19 a	45.82 b	46.83b
20+25	12.85 b	12.54bc	12.49ab	14.15 b	11.74 bc	11.60 b	48.98 a	50.42 a

Means followed by the same letter's within each column are not significantly different at 0.5 level.

Effect of foliar spraying with GA_3 and NAA on fruiting

The results in Table 2 showed that NAA and GA_3 significantly reduced fruit drop percentage when compared with the untreated plants (control). On the other hand, yield (kg/tree) and increment increased were significantly increased than control percentage in comparison to the control. The results showed that the high concentration of GA_3 and NAA gave an increase in estimated yield (kg/tree) and decrease fruit drop percentage better than the low concentrations and control. On the other hand, the results indicated that using combination between NAA plus GA_3 at 20+20 ppm gave the best results of yield (kg/tree) compared to using each one alone. The highest yield (kg/tree) was obtained by using GA_3 at 20 ppm+ NAA at 25 ppm in followed descending order by GA_3 at 20 ppm+ NAA at 20 ppm, NAA at 25 ppm and NAA at 20 ppm. On the other hand, the lowest yield (kg/tree) was obtained from

TABLE 2. Effect of foliar spraying with $GA_3$and NAA at 7 days after fruit set on fruit drop and yield of Washington navel orange cultivar in 2014 and 2015 seasons.

Character / Treatments (ppm) GA_3 + NAA	Fruit drop (%)		Yield (kg/tree)		Increase % in yield than control	
	2014	2015	2014	2015	2014	2015
0.0+0.0	92.05a	91.39a	62.51 e	66.46 f	0.00 f	0.00f
20+0.0	87.94b	87.48b	78.30 d	84.45 e	25.24e	27.1e
30+0.0	87.69b	86.74bc	86.04cd	92.67 d	37.81d	39.47d
0.0+20	85.34bc	84.35c	93.25bc	100.71c	49.47c	51.55 c
0.0+25	84.55bc	84.89c	95.25bc	102.60bc	52.49 c	54.39 c
20+20	85.43c	84.11c	100.37ab	107.99b	60.61b	62.53b
20+25	81.71d	79.33d	108.40 a	116.55 a	73.47 a	75.43 a

Means followed by the same letter's within each column are not significantly different at 0.5 level.

control during the two studied seasons.

The results are in contract with the findings of Muñoz-Fambuena et al. (2012) who found that GA_3 applied at the floral bud induction period significantly increased fruit yield per tree of Washington navel orange. GA_3 is being used to improve the fruit set of parthenocarpic cultivars that tend to flower profusely. Similarly, Mohamed (2011) found that spraying Washington navel orange with GA_3 at concentration 10 ppm at 3 times (beginning of flowering, full bloom and after fruit set), gave the maximum fruit retention percentage, and yield/ tree, but reduced total fruit drop percentage as compared to the control. Also, Nawaz et al. (2008) found that foliar application NAA with concentration 20 ppm at two weeks after fruit set reduced pre-harvest fruit drop and increased in fruit yield, fruit weight of Kinnow mandarin trees compared to control. Moreover, Kojima et al. (1996) working on Satsuma mandarin, found a sequence of peaks of endogenous ABA, IAA and GA_3 concentrations in fruitlets, and concluded that these hormones may play a sequential and synergistic role in the retention and growth of fruitlets.

We can come to conclusion that foliar application with GA_3 and NAA at different levels decreased fruit drop percentage and increased yield (kg/tree) in comparison with that of untreated tree (control). The best foliar application which gave the highest values of yield (kg/tree) was obtained with GA_3 at 20 ppm+ NAA at 25 ppm compared with control and other treatments.

Effect of foliar spraying with GA_3 and NAA on some physical properties

Average fruit weight and fruit size

Data in Table 3 indicated that spraying Washington navel orange with GA_3 + NAA either individually or combination improved the physical characteristics of such as fruit weight (g), fruit size (cm^3), specific gravity (g/cm^3) fruit pulp weight (g) and fruit Peel weigh (g) (Table 3). The highest values of fruit weight (g), fruit size (cm^3), fruit peel weight (g) and fruit pulp weight (g) were obtained by using GA_3 at 20 ppm+ NAA at 25 ppm followed by GA_3 at 20 ppm+ NAA at 20 ppm, NAA at 25 ppm) and GA_3 at 30 ppm during both 2014 and 2015 seasons, respectively. On the other hand, the highest values of specific gravity (g/cm^3) was obtained from control treatment.This is due to the decrease in fruit weight and fruit size compared with all treatments. The results are in contract by that of (Abdrabboh, 2013) who found that spraying Manzanillo olive trees with GA_3 and NAA at concentrations fluctuated from 50 to 100 ppm improved the physical fruit properties than untreated plants (control). The present results may be attributed to stimulative influence of this bioregulator on cell extension and/or cell division. The increase in fruit size may be attributed to the increase in cell division and cell elongation caused by NAA and GA_3 (Ranjan et al. 2003). Agrawal and Dikshit, (2008) reported that the application of NAA increased fruit weight and yield by causing cell elongation by enlargement of vacuoles and loosening of cell wall after increasing cell wall plasticity. Also, (Stern et al. 2007) reported that treatments of NAA encourage cell expansion in the fruit mesocarp, which in turn, causes an increase in fruit volume and yield.

Juice volume (cm^3)

Data in Table 3 proved that juice volume was significantly increased by using GA_3 and NAA as compared with control in both seasons. Meanwhile, spraying trees with GA_3 only was superior to using combination of GA_3 plus NAA. The highest juice volume was obtained by using GA_3 at 20 ppm+ NAA at 25 ppm followed in descending order by GA_3 at 20 ppm+ NAA at 20 ppm and NAA at 25 ppm. The obtained finding are in contract with that reported by Baghdady et al. (2014) who reported that spraying Valencia orange trees with GA_3 at concentrations 15 or 25 ppm at full bloom stage increased fruit juice in comparison to those of control. Also, Farag and Nagy (2012) indicated that spraying Washington naval orange with NAA at concentration 25 ppm at full bloom increased juice volume as compared with the control. Also, Rokaya et al. (2016) reported that the increase in juice percentage of Mandarin may be explained by the fact that hormones play a regulating role in the mobilization of metabolites within a plant and it is well established fact that developing fruits are extremely active metabolic “sinks” which mobilize metabolites and direct their flow from vegetative structure.

Fruit length and diameter

Concerning the response of polar and equatorial fruit diameters to various GA_3 and NAA, Table 3 displayed obviously that different applied treatments of GA_3 and NAA significantly increased fruit length (cm) and fruit diameter (cm) in comparison with untreated plants t for the two studied terms. However, GA_3 at 20 ppm+ NAA at 25 ppm significantly increased the tallest polar and equatorial diameters, followed in descending order by GA_3 at 20 ppm+ NAA at 20 ppm, NAA at 25 ppm and GA_3 at 30 ppm in the two studied periods. The present results are in agreement with that reported by Abd El-Rahman et al. (2012) who reported that foliar application of Washington naval orange with GA_3 at 50 ppm at full bloom stage increased fruit diameter and fruit length. Similarly, Ghazzawy (2013) found that foliar application of Barhee date palm cultivar with NAA at 90 ppm at hababouk stage increased fruit dimensions in comparison to that of control. The increase in fruit dimensions (length and diameter) might be due to both the GA3 and NAA ability in the division and elongation of the fruit cells. (Stern et al., 2007) reported that treatments of NAA stimulated cell expansion in the fruit mesocarp, which in turn, caused an enhancement in fruit volume.

We can come to conclusion that foliar application of Washington naval orange with GA_3 and NAA at different levels increased fruit weight, fruit size, fruit length, fruit diameter and juice volume (cm^3) in comparison with that of untreated tree (control). The best foliar application was GA_3 at 20 ppm+ NAA at 25 ppm in comparison to untreated plants (control) and other application.

TABLE 3. Effect of foliar spraying with GA_3 and NAA at 7 days after fruit set on some fruit physical characteristics of Washington navel orange cultivar in 2014 and 2015 seasons.

Character. / Treatments (ppm) GA_3 + NAA	Fruit weight (g)	Fruit size (cm^3)	Specific gravity (g/cm^3)	Fruit length (cm)	Fruit diameter (cm)	Fruit Peel weigh(g)	Fruit pulp weight (g)	Juice volume (cm^3)
2014 Season								
0.0+0.0	316.61e	346.27f	0.91a	8.69 d	8.02 d	60.88 d	255.73e	110.74 f
20+0.0	322.87d	379.8e	0.85b	9.19 c	8.42 c	64.17b	258.7 de	126.37 e
30+0.0	325.93cd	384.5cd	0.85b	9.60 b	8.68 b	63.45 bc	262.48cd	131.82 d
0.0+20	326.08cd	381.9 de	0.85b	9.19c	8.43 c	62.54bcd	263.54 c	135.17cd
0.0+25	326.91c	387.13c	0.84b	9.80ab	8.63 b	62.47bcd	264.44 c	138.80 c
20+20	333.47b	392.53b	0.85b	9.78ab	8.75 b	64.21b	269.26 b	145.33 b
20+25	340.74a	400.6a	0.85b	10.05a	8.93 a	67.52a	273.23 a	158.63 a
2015 Season								
0.0+0.0	322.02 e	352.77 e	0.91a	8.93 f	7.90e	64.11 b	257.91 f	117.03 e
20+0.0	330.88 d	382.83 d	0.86 b	9.51 e	8.46 d	63.76 b	267.12 e	136.27 d
30+0.0	336.55 c	393.33bc	0.86b	9.83 de	8.78 cd	64.16 b	270.57de	139.67 d
0.0+20	334.73cd	389.0cd	0.86b	10.25bc	9.11 bc	63.78 b	275.12bc	144.37 c
0.0+25	338.90 c	396.30bc	0.86b	10.14 cd	9.01 bc	64.85 ab	271.70cd	147.40 c
20+20	343.25 b	398.87 b	0.86b	10.54 ab	9.34 ab	65.03 ab	278.22ab	155.90 b
20+25	347.89 a	415.33 a	0.84c	10.71 a	9.49 a	66.30 a	281.59 a	167.27 a

Means followed by the same letter's within each column are not significantly different at 0.5 level.

Effect of foliar spraying with GA_3 and NAA on some fruit biochemical characteristics

Total soluble solids (TSS) and total acidity percentage

Data in Table 4 showed that all GA_3 and NAA application significantly improved TSS (%) in comparison to that of the untreated trees (control) in the two studied periods. The highest values of TSS percentage were obtained when trees were treated with GA_3 at 20 ppm+ NAA at 25 ppm followed in descending by GA_3 at 20 ppm+ NAA at 20 ppm and NAA at 25 ppm. Spraying Washington navel orange trees 7 days after full bloom with GA_3 and/or NAA either separately or in mixtures at all tested concentrations resulted in a decrease in total acidity% in comparison with control. In this regard, GA_3 at 20 ppm+ NAA at 20 ppm application recorded the least total acidity percentage in Washington navel orange fruits when compared with untreated plants (control) and other application. The results are in agreement with that reported by Farag and Nagy (2012) who sprayed Washington naval orange with NAA at concentration 25 ppm at full bloom decreased total acidity of as compared with the control. Also, Khan et al. (2014) found that application with GA_3 at 20 ppm after fruit set increased TSS 'Blood Red' sweet oranges compared with control. The significant decline in total acidity might be attributed to the incitement happened in orange maturity, whereas the fruit ripened earlier than those of untreated plants (control) (Hifny et al. 2009).

Results in Table 4 showed that TSS/acid ratio significantly improved by increasing GA_3 and NAA rates in the two studied seasons when compared to untreated plants. Maximum values of TSS/Acid ratio were achieved after spraying the Washington navel orange trees with GA_3 at 20 ppm+ NAA at 20 ppm and NAA at 25 ppm. Insignificant difference in TSS/Acid ratio was noticed between these treatments and GA_3 treatments. These obtained results are in contract with that of Brahmachari et al. (1997) on Guava trees and with Hikal (2013) on Washington navel orange who found that TSS/acid ratio of fruits was improved while fruit total acidity was reduced by foliar spraying the plants with GA_3 at 25 ppm+ NAA at 20 ppm.

Vitamin C (mg/100ml) of fruit juice

Data in Table 4 showed that spraying Washington navel orange trees with GA_3 +NAA at different concentrations either individually or in combinations increased Vitamin C in comparison to that of untreated plants (control) in the two studied seasons. The highest values of Vitamin C were obtained when trees were sprayed with from GA_3 at 20 ppm+ NAA at 25 ppm. The obtained results are in contract with that reported by Hikal (2013) who revealed that foliar sprays Washington navel oranges with GA_3 at 20 ppm and NAA at 25ppm of at pre-harvest increased V. C when compared with that of control. Also, Kassem et al. (2010) found that foliar application of Costata persimmon trees with GA_4 at 20 ppm+ NAA at 25 ppm at pea stage increased V.C compared with control.

We can come to conclusion that foliar application of Washington navel orange with GA3 and NAA at different concentrations significantly increased TSS (%), Total acidity (%), TSS/ acid ratio and V.C (mg/100ml) of fruit juice in comparison with that of untreated tree (control). The best foliar application was obtained with GA_3 at 20 ppm+ NAA at 25 ppm in comparison to untreated plants (control) and other application.

TABLE 4. Effect of foliar spraying with $GA_3$and NAA at 7 days after fruit set on some fruit chemical characteristics of Washington navel orange cultivar in 2014 and 2015 seasons.

Character. / Treatments (ppm) GA_3 + NAA	TSS(%)	Total acidity (%)	TSS/acid ratio	V.C (mg/100ml) of fruit juice
2014 Season				
0.0+0.0	10.27e	1.13a	9.11c	46.00b
20+0.0	11.17d	0.92bc	12.35ab	50.00ab
30+0.0	11.27cd	1.00 abc	11.31b	53.33a
0.0+20	11.73b	0.94 bc	12.51ab	55.33a
0.0+25	11.80 b	0.87 bc	13.61a	56.33a
20+20	11.60bc	0.85c	13.72a	54.67a
20+25	12.53 a	1.04ab	11.99ab	55.33a
2015 Season				
0.0+0.0	11.63e	1.15a	10.12c	53.20c
20+0.0	11.90de	0.92bc	11.72abc	57.63b
30+0.0	12.13d	1.05ab	10.87bc	59.53b
0.0+20	13.53b	0.90c	11.97abc	65.87a
0.0+25	13.70b	1.09a	12.54ab	59.53b
20+20	12.50c	0.87c	12.15ab	60.80b
20+25	14.23a	1.11a	12.89a	61.43b

Means followed by the same letter᾽s within each column are not significantly different at 0.5 level.

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تأثير حمض الجبرلين ونفثالين حامض الخليك على نمو ومحصول وجودة ثمار البرتقال بسرة (واشنطن)

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إن تساقط الثمار وجودة الثمار من أهم الصفات فى البرتقال بسرة (واشنطن) حيث يمثلا دوراً رئيسياً فى الانتاج وامكانية التصدير. أجريت هذه الدراسة خلال موسمين متتالين ٢٠١٤ و ٢٠١٥ على اشجار صنف البرتقال بسرة (واشنطن) مثمرة بعمر ١٣ سنه نامية فى بستان خاص بالاراضى حديثة الاستصلاح يقع فى منطقة حوش عيسى محافظة البحيرة مصر.

إن تاثير كلا من حمض الجبرلين ونفثالين حامض الخليك كمعاملات رش ورقى بعد العقد باسبوع على البرتقال بسرة (واشنطن) تمت دراستهما . أوضحت النتائج ان الرش الورقى بمنظمى النمو (حمض الجبرلين بتركيز ٢٠ جزء فى المليون ونفثالين حامض الخليك بتركيز ٢٥ جزء فى المليون) بعد اسبوع من العقد ادى الى زيادة معنوية فى قياسات النمو الخضرى مثل (طول الفرخ بالسنتيميتر وعدد الاوراق للفرخ فى دورات النمو الخضرى الثلاثة) وبالمثل مساحة الورقة البالغة بالسنتيميتر المربع مقارنة بالاشجار الغير معاملة الكنترول.

إن رش الاشجار بمنظمى النمو (حمض الجبرلين بتركيز ٢٠ جزء فى المليون و نفثالين حامض الخليك بتركيز ٢٥ جزء فى المليون) ادت الى قلة تساقط الثمار معنويا وعلى الجانب الاخر ادت المعاملات الى زيادة معنويه فى كل من محصول الشجرة من الثمار(كجم/شجرة) و الحضائص الطبيعية للثمرة مثل (وزن الثمرة بالجم - حجم الثمرة بالسم ٣ وابعاد الثمرة ارتفاع وقطر بالسم وكذلك حجم العصير بالثمرة مقارنة بالاشجار الغير معاملة الكنترول.

كما ادت المعاملات كذلك الى زيادة ايجابية فى محتوى الصفات الكيماوية للثمرة نسبة المواد الصلبة الذائبة الكلية والنسبة المئوية للحموضة الكلية و نسبه المواد الصلبة الكلية الى الحموضة الكلية وبالمثل محتوى الثمرة من فيتامين ج مقارنة بالاشجار الغير معاملة (الكنترول).

إنه من الممكن التوصية برش اشجار صنف البرتقال بسرة (واشنطن) المثمرة بمنظمى النمو (حمض الجبرلين بتركيز ٢٠ جزء فى المليون و نفثالين حامض الخليك بتركيز ٢٥ جزء فى المليون) بعد اسبوع من العقد لانتاج محصول ثمار عالى وفى نفس الوقت يتميز بجودة وخصائص طبيعية و كيماوية جيدة.