Effect of CPPU and GA_3 on fruiting and fruit quality of Washington navel orange

Hifny H. A., Khalifa S.M., Hamdy, A. E. and Abd El-wahed. A.N.

Department of Horticulture, Faculty of Agriculture, Al-Azhar University, Nasr city, Cairo, Egypt.
abdelwahed_abdelwahed@yahoo.com

Abstract: Washington navel orange is a parthenocarpic cultivar thus decrease yield and fruit quality since they are playing the main role in production and exporting potential. The present study was carried out during the two successive seasons of 2014 and 2015 on 13 years Washington navel orange trees grown in a sandy soil in a private orchard at Housh Eisa, El- Behera Governorate, Egypt. The effect of CPPU and GA_3 applied at full bloom on Washington navel orange trees was studied. The results showed that foliar spraying of trees with CPPU at 4 ppm + GA_3 at 30 ppm at full bloom significantly increased of fruit set, retained fruits percentage and yield (kg/ tree), fruit physical parameters such as fruit weight (g), fruit size (cm^3) fruit length, fruit diameter (cm) and fruit juice while fruit drop percentage was decreased percentage 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 could be recommended that spraying Washington navel orange trees with CPPU at 4 ppm and GA_3 at 30 ppm at full bloom gave the highest values of yield (kg) /tree, fruit physical and chemical properties.

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1. Introduction

In Egypt Washingtonnavel orange (***Citrus sinensis* L. Osbeck**) ranked first among the species of citrus. It occupies about 35 % of the total cultivated area of citrus, its acreage reached 181.091 feddans with total production of 1663284 tons per year **(**According to the last census, issued by Ministry of Agric. - Egypt (2015).. 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 fruit set percentage, yield and fruit quality. Gibberellins stimulate cell division and elongation; increase stalk length, increase fruit size of fruits **Fishel (2006)**. The biological effects of applying growth regulators on plants have received much 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) **Whiting (2007)**. Sitofex (CPPU) is a growth regulator (N-(2-chloro-4-pyridinyl)-N-phenylurea); common name forchlorfenuron) which plays a role in cell division and cell wall elongation, also, it is a cytokinin like substance which has strong cytokinin activity by inducing fruit drop and increasing productivity as well as improving fruit size, fruit firmness and delaying maturation **Nickell (1985)**. **Ahmed *et al.* (2012)** found that foliar application of 30 ppm GA3 increased growth parameters of Washington navel orange trees. **Kassem *et al.* (2012)** found that the foliar sprays of GA_3 at 10 ppm of Washington navel oranges by beginning of fruit color change (pre-harvest) increased fruit dimension, fruit juice content, vitamin C content, and TSS% in comparison with control. **Khot *et al.* (2015)** found that foliar application with CPPU at 2 ppm + GA_3 at 40 ppm at full bloom stage increased berry biochemical parameters, quality parameters namely berry length, berry diameter, bunch weight, T.S.S.and the yield of Thompson Seedless grapes compared with control. Application of plant growth regulators such as CPPU and GA_3 individually or in combinations on Washington navel orange trees may improve cropping potential and fruit quality. Therefore, this study aimed to explore the effect of application CPPU and GA_3 on controlling fruit drop and improving yield and fruit quality of Washington navel orange trees under semi-arid conditions in Egypt.

2. 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 a sandy soil in a private orchard at Housh Eisa, 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 present study aimed to elucidate the effect of

some growth regulators at full bloom on growth of Washington navel orange trees and their fruit production.

2.1. The treatments:

CPPU and GA_3 were applied individually or in combinations, at full bloom as foliar spray on the trees as follows:

T1: Control: trees were sprayed with water.
T2: CPPU at 3 ppm.
T3: CPPU at 4 ppm.
T4: GA_3 at 20 ppm.
T5: GA_3 at 30 ppm.
T6: CPPU at 3 ppm + GA3 at 20 ppm.
T7: CPPU at 3 ppm + GA3 at 30 ppm.
T8: CPPU at 4 ppm + GA3 at 20 ppm.
T9: CPPU at 4 ppm + GA3 at 30 ppm.

A complete randomized block design was adopted in this experiment with 9 treatments were 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. The trees of control treatment were sprayed with water.

2.2. Measurements:

2.2.1. The fruiting: -

2.2.1.1. Fruit set number and percentage:

Four branches (two years old) similar in growth were chosen, one branch in each original direction and twelve shoots per each main branch were tagged at balloon stage of the flower. At blooming, all opened flowers/ shoot was counted. After the end of fruit set, the number of fruit set was recorded and fruit set percentage was calculated according to the following equation:

$$\textbf{Initial fruit set \%} = \frac{\text{Total No. of set fruits /shoot}}{\text{Total No. of opened flowers/shoot}} \times 100$$

$$\textbf{Final fruit set \%} = \frac{\text{Total No. of fruits at end of June /shoot}}{\text{Total No. of flowers/shoot}} \times 100$$

2.2.1.2. Retained fruits percentage:

Number of retained fruits were counted at harvest and calculated as follows:

$$\textbf{Retained fruits \%} = \frac{\text{No. of retained fruits at harvest/shoot}}{\text{No. of initial set fruits/shoot}} \times 100$$

2.2.1.3. 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:

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

2.2.1.4. Yield:

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

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

2.3. Fruit quality: -

2.3.1. 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 (cm^3) fruit peel weight (g) and fruit pulp weight (g).

2.3.2. 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).**

3. Results and Discussion

3.1. Effect of foliar spraying with CPPU and / or GA_3 on the fruiting:

Washington navel orange trees were sprayed with the growth regulators CPPU and /or GA_3 aqueous solution at different concentrations at full bloom stage for the two studied seasons. The results in table (1) and fig (1) indicated that the initial and the final fruit set, fruit retention percentages, yield (kg/tree) and increment percentage as influenced by the application of CPPU and / or GA_3. The data indicated that spraying of CPPU and GA_3 significantly increased initial and final fruit set, fruit retention percentages, yield (kg/tree), increment than control percentage and decreased fruit drop percentage as compared with the control. The results showed that the high concentration of CPPU and GA_3 gave an increase in all fruiting parameters better than the low concentrations and control. On the other hand, the results indicated that using combination between CPPU plus GA_3 at 4+30 ppm gave the best results of yield (kg/tree) compared to using each one alone. The highest fruiting parameters were obtained by using CPPU at 4 ppm + GA_3 at 30 ppm in followed descending order by CPPU at 4 ppm + GA_3 at 20 ppm and CPPU at 3 ppm + GA_3 at 30 ppm. On the other hand, the lowest fruiting parameters were obtained from control during the two studied seasons. The results are in agreement with the findings of **Baghdady *et al.* (2014)** who found that sprayed of Valencia orange trees with GA_3 at concentrations 15 or 25 at full bloom stage increased initial and final fruit set percentage in comparison to those of control. In this line **Wally *et al.* (1999)** stated that GA_3 intensifies an orange ability to function as a nutrient sink, it also increase the biosynthesis of IAA in plant tissues, delays the formation of separation layer. This increase is due to CPPU has a promoting effect on fruit set reducing ABA content, due to the physiological basis of CPPU action in promoting fruit setting and fruit enlargement. **Guirguis *et al.* (2003)** found that foliar application of CPPU by 20ppm on Costata persimmon trees at full bloom stage increased the percentage of fruit set and yield kg / tree compared with the control. The abscission layer at the stem resulting in fruit drop is formed due to imbalance of auxins, cytokinins, and gibberellins **Davies (1986).**

We can come to conclusion that foliar application with CPPU and GA_3 at different levels increased initial and final fruit set percentage and yield (kg/tree) while fruit drop percentage was decreased in comparison with that of untreated trees (control). The best foliar application which gave the highest values was obtained with CPPU at 4 ppm + GA_3 at 30 ppm+ compared with control and other treatments.

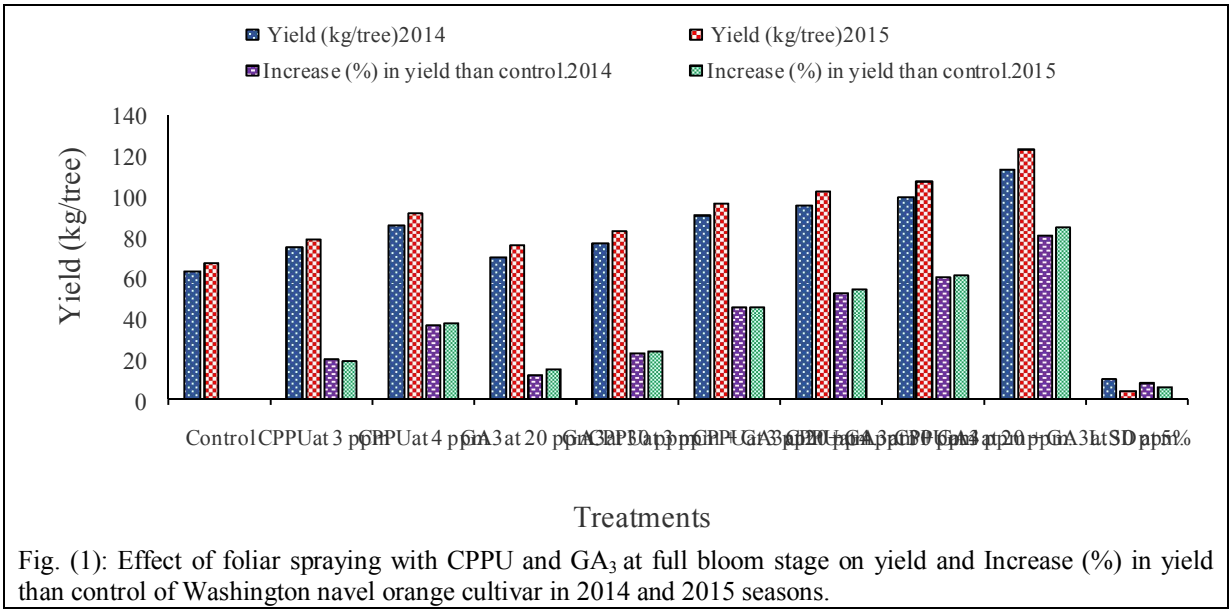

Fig. (1): Effect of foliar spraying with CPPU and GA_3 at full bloom stage on yield and Increase (%) in yield than control of Washington navel orange cultivar in 2014 and 2015 seasons.

Table (1): Effect of foliar spraying with CPPU and GA_3 at full bloom stage on fruit set and yield of Washington navel orange cultivar in 2014 and 2015 seasons.

Character / Treatments CPPU+GA_3(ppm)	Initial fruit set (%)		Final fruit set (%)		Fruit retention (%)		Fruit drop (%)		Yield (kg/tree)		Increase (%) in yield than control.	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
0.0 +0.0	23.65	21.80	1.87	1.84	7.95	9.97	92.05	90.03	62.51	66.46	0.00	0.00
3 + 0.0	32.84	27.51	2.80	2.98	8.53	11.37	91.47	88.63	74.72	78.95	19.68	18.82
4 + 0.0	37.96	35.01	3.25	4.01	8.57	12.16	91.43	87.84	85.02	90.90	36.18	36.81
0.0 +20	29.05	27.31	2.33	2.76	8.06	11.30	91.94	88.70	70.10	76.05	12.10	14.49
0.0 + 30	30.28	27.80	2.74	3.12	9.03	12.69	90.97	87.31	76.33	82.31	22.17	23.93
3 + 20	32.55	30.22	3.55	3.72	10.94	14.49	89.06	85.51	90.45	96.66	44.78	45.53
3 + 30	31.04	31.60	3.70	4.11	12.02	15.08	87.98	84.92	94.93	102.6	52.21	54.40
4 + 20	31.92	30.34	3.95	4.21	12.44	15.48	87.56	84.52	99.46	107.2	59.42	61.28
4 + 30	35.07	34.94	4.74	4.97	13.60	15.33	86.4	84.67	112.7	122.3	80.06	84.14
L.S.D at 5%	3.76	4.92	0.29	0.82	1.83	2.06	1.81	3.46	9.73	4.02	7.68	5.87

3.2. Effect of foliar spraying with GA_3 and CPPU on fruit quality: -

3.2.1. Fruit physical characteristics:

3.2.1.1. Fruit weight, pulp weight, Peel weight (g), size (cm^3) and specific gravity (g/cm^3).

Data in Table (2) indicated that spraying Washington navel orange with CPPU + GA_3 either individually or combination improved the physical characteristics such as fruit weight (g), fruit size (cm^3), specific gravity (g/cm^3) fruit pulp weight (g) and fruit Peel weigh (g). Data in Table (2) showed that effect of CPPU and / or GA_3 on average fruit weight and size of Washington navel orange cultivar in the two studied seasons. Different concentration of CPPU and/ or GA_3 significantly increased this trait during two studied seasons. The highest values of fruit weight (g), fruit size (cm^3), and fruit pulp weight (g) were obtained by using T9 CPPU at 4 ppm+ GA_3 at 30 ppm followed by T8 CPPU at 4 ppm+ GA_3 at 20 ppm and T7 CPPU at 3 ppm+ GA_3 at 30 ppm during both 2014 and 2015 seasons, respectively. The results also showed that the highest specific gravity (g/cm^3) was obtained from control followed by CPPU at 4 ppm and GA_3 at 30 ppm in both season. This significantly increased in fruit weight and size treatments due to application of CPPU might be described to its positive action on enhancing both cell division and cell elongation as well as its great role in activating the biosynthesis of proteins, RNA and DNA **Nickell (1985).** Also, this might be due to the increase of fruit weight ultimately enhanced the number of segments per fruit. Moreover, the positive effect of GA_3 was observed in this study with respect to the number of segments. Gibberellins are known for their ability to increase cell enlargement and enhancing fruit growth in certain species such as citrus **Eman *et al.* (2007).** The present results concerning the effect of CPPU on the fruit weight and dimensions are in harmony with hose obtained by **Flaishman *et al.* (2006)** and **Kim *et al.* (2006)** who found that foliar application with CPPU and GA_3 at 4 to 40 ppm increased fruit weight and size of different fruit tree cultivars as compared with that of control trees. The increase in fruit size could be attributed directly to the CPPU effects whereas; exogenous application of CPPU acts as early and rapid on cell division in the fruitlet and also on subsequent growth. Thus, the fruit becomes bigger in size due to the increased cells, which are able attract so much water, minerals and carbohydrates that enable the fruit to expand to large size **Kano (2003).** Also, **Kassem *et al.* (2012)** found that the foliar sprays of Washington navel oranges with $GA_3$10 ppm at pre-harvest increase fruit size.

3.2.1.2. Fruit length and diameter(cm):

Concerning the response of polar and equatorial fruit diameters to various CPPU and/or GA_3 Table (2) displayed obviously that different applied treatments of CPPU and/or GA_3 significantly increased fruit length (cm) and fruit diameter (cm) compared to control treatment for the two studied seasons. However, T9 CPPU at 4 ppm+ GA_3 at 30 ppm significantly increased the tallest polar and equatorial diameters, followed in descending order by T7 CPPU at 3 ppm+ GA_3 at 30 ppm, T8 CPPU at 4 ppm+ GA_3 at 20 ppm and T6 CPPU at 3 ppm+ GA_3 at 20 ppm in the two studied seasons. 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, **Nevine and Ghany (2016)** found that foliar application with CPPU at 10 ppm on Anna apple at full bloom and 3 weeks after full bloom increased fruit diameter and length of. The increase in fruit dimensions (length and diameter) might be due to both the GA_3 and CPPU ability in the division and elongation of the fruit cells. **Hamada *et al.* (2008)** who found that the effects of (CPPU) with and without strapping on fruit growth of Japanese persimmon were evaluated by measuring parenchyma cell size and the number of cell layers in mesocarp throughout fruit development.

3.2.1.3. Juice volume (cm^3):

Juice is an extremely important parameter for industrial processing, also related to size, which, in turn, although determined by the genetic characteristics of a cultivar, is affected by cultural practices such as the application of growth regulators **Nawaz *et al.* (2008).** Data in table (2) showed that the highest Juice volume (cm^3) of the first and second seasons was obtained from spraying trees with T9 CPPU at 4 ppm+ GA_3 at 30 ppm, followed descending by T8 CPPU at 4 ppm+ GA_3 at 20 ppm and T7 CPPU at 3 ppm+ GA_3 at 30 ppm. The results are in agreement with that reported by **Baghdady *et al.* (2014)** who sprayed GA_3 at concentrations 15 or 25 ppm at full bloom stage on Valencia orange trees increased some fruit quality such as fruit juice than in comparison to those of control. Also, **Abdel- Fattah *et al.* (2010)** found that foliar application with CPPU at concentrations 2.5 to 10 ppm when average diameter of berries reached at least 6 mm was very effective in enhancing berry weight and fruit juice in various grapevine Cultivars compared to that of control.

We can come to conclusion that foliar application with GA_3 and CPPU at different ranged increased fruit weight, fruit size, fruit length, fruit diameter and Juice volume (cm^3) in comparison with that of untreated trees (control). The best foliar application was T9 CPPU at 4 ppm + GA_3 at 30 ppm compared with control and other treatments.

Table (2): Effect of foliar spraying with CPPU and GA_3 at full bloom stage on some fruit physical characteristics of Washington navel orange cultivar in 2014 and 2015 seasons.

Character. / Treatments CPPU+ GA_3(ppm)	Fruit weight (g)	Fruit size (cm^3)	Specific gravity ($g/cm^{3)}$	Fruit length (cm)	Fruit diameter (cm)	Fruit peel weight (g)	Fruitpulpweight (g)	Juice volume (cm^3)
Season 2014								
0.0 +0.0	316.6	346.27	0.91	8.69	7.90	60.88	255.73	110.70
3 + 0.0	318.36	352.27	0.90	8.99	8.12	58.13	260.23	114.33
4 + 0.0	320.09	351.53	0.91	8.99	8.16	58.61	261.48	117.13
0.0 +20	318.63	350.33	0.90	8.79	8.01	57.74	260.89	121.97
0.0 + 30	319.66	351.13	0.91	8.97	8.10	57.51	262.15	119.07
3 + 20	320.85	353.53	0.90	9.13	8.20	57.47	263.05	123.00
3 + 30	323.63	358.40	0.90	9.39	8.31	56.83	266.79	127.60
4 + 20	325.29	360.47	0.90	9.13	8.21	57.44	267.85	130.70
4 + 30	328.13	368.60	0.89	9.47	8.40	55.83	272.30	135.50
L.S.D at 5%	1.39	2.15	0.004	0.18	0.17	3.79	4.17	3.52
Season 2015								
0.0 +0.0	322.02	352.77	0.91	8.93	7.90	64.11	257.91	117.03
3 + 0.0	325.51	363.73	0.89	9.18	8.37	62.55	262.96	122.80
4 + 0.0	329.29	371.23	0.89	9.37	8.41	63.19	266.11	126.70
0.0 +20	324.18	359.07	0.90	9.09	8.37	62.71	261.47	130.30
0.0 + 30	325.30	360.30	0.90	9.22	8.24	63.03	262.27	127.70
3 + 20	326.85	367.13	0.89	9.41	8.33	62.87	263.98	132.80
3 + 30	329.28	373.80	0.88	9.56	8.52	62.33	266.95	136.00
4 + 20	332.06	373.87	0.89	9.39	8.29	63.85	268.21	139.40
4 + 30	337.64	385.47	0.88	9.87	8.76	60.84	276.80	154.50
L.S.D at 5%	3.84	9.77	0.02	0.17	0.27	1.69	3.57	4.59

3.2.2. Fruit biochemical characteristics:

3.2.2.1. Total soluble solids (TSS) and total acidity percentage:

Data in table (3) showed that all CPPU and GA_3 treatments significantly increased TSS (%) of fruit juice when compared with that of control in the two studied seasons. The highest values of TSS percentage were obtained when trees were treated with CPPU at 4 ppm + GA_3 at 30 ppm followed in descending by (T7) CPPU at 3 ppm+ GA_3 at 30 ppm and (T3) CPPU at 4 ppm. Spraying Washington navel orange trees at full bloom with CPPU and/or GA_3 either individually or in combinations at all tested concentrations resulted in a decrease in total acidity% in comparison with control. In this regard, CPPU at 3 ppm + GA_3 at 20 ppm treatment recorded the least total acidity % in Washington navel orange fruits in comparison with control and other treatments. The results are in agreement with that reported by **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 decrease in total fruit acidity could be attributed to the stimulation occurred in fruit maturity, whereas the fruit ripened earlier than

those of control trees. **Hifny *et al.* (2009).** Also, **Khot *et al.* (2015)** found that foliar application of Thompson Seedless grapes with CPPU at 2 ppm + GA_3 at 40 ppm at full bloom stage increased T.S.S compared with control.

Data in table (3) showed that TSS/acid ratio significantly increased by increasing CPPU and GA_3 concentrations in the two seasons in comparison with control treatment. Maximum values of TSS/Acid ratio were achieved after spraying the Washington navel orange trees with T9 CPPU at 4 ppm+ GA_3 at 30 ppm and T7 CPPU at 3 ppm+ GA_3 at 30 ppm. Insignificant difference in TSS/Acid ratio was noticed between these treatments and GA_3 treatments. These results are in agreement with that of **Hikal (2013)** on Washington navel orange who found that TSS/acid ratio of fruits was increased while fruit total acidity was decreased by spraying the trees with GA_3 at 25 ppm. Also, **Xiao *et al.* (2007)** found that the spraying of CPPU with concentration 10 to 25 ppm on Diospyros Kaki Zenjimaru cv. at 10 days after full bloom increased weight of fruit, reducing TSS content and TSS / acid ratio of fruit.

3.2.2.2. Total carbohydrates (%) and fruit moisture (%)

Data in table (3) showed that all treatments increased Total carbohydrates (%) and fruit moisture (%) when compared with that of control in the twostudies seasons. The highest values of Total carbohydrates (%) and fruit moisture (%) were obtained from (T9) CPPU at 4 ppm+ GA_3 at 30 ppm. Meanwhile, the lowest values of total carbohydrates (%) and fruit moisture (%). In general, the above trends were in line with those reported by **Bhat *et al.* (2012)** showed that the application of CPPU applied twice i.e. on 7 and 15 days after fruit set improved berry size, TSS, sugars and peel thickness of seedless grape c.v Tas-A-Ganesh.

3.2.2.3. Vitamin C (mg/100ml) of fruit juice:

Table (3): Effect of foliar spraying with CPPU and GA_3 at full bloom stage on some fruit chemical characteristics of Washington navel orange cultivar in 2014 and 2015 seasons.

Character. / Treatments CPPU+ GA_3(ppm)	TSS (%)	Total acidity (%)	TSS/acid. Ratio	Total carbohydrates (%)	Fruit moisture (%)	V.C (mg/100ml) of fruit juice
Season 2014						
0.0 +0.0	9.60	1.13	9.11	24.21	70.07	46.67
3 + 0.0	11.53	1.02	11.30	28.68	71.20	56.67
4 + 0.0	11.67	1.00	11.72	32.26	71.33	60.00
0.0 +20	10.07	1.02	9. 91	30.24	70.73	51.67
0.0 + 30	10.47	1.07	9.99	32.87	71.40	50.00
3 + 20	10.73	0.90	12.03	35.00	72.47	48.33
3 + 30	11.67	0.96	12.32	35.70	71.33	56.67
4 + 20	10.93	1.09	10.05	36.36	71.07	53.33
4 + 30	12.20	0.92	13. 36	38.96	73.20	61.67
L.S.D at 5%	0.63	0.18	2.13	2.72	0.86	11.55
Season 2015						
0.0 +0.0	11.63	1.15	10.12	27.70	68.00	51.67
3 + 0.0	12.87	1.09	11.95	30.59	69.67	63.43
4 + 0.0	13.43	1.05	12.94	33.50	70.33	61.57
0.0 +20	12.87	1.02	12.67	31.90	70.17	55.00
0.0 + 30	12.33	0.98	12.63	35.62	70.83	58.33
3 + 20	12.63	1.02	12.47	36.36	70.50	55.00
3 + 30	13.53	1.02	13.27	37.20	69.50	65.00
4 + 20	12.83	0.96	13.72	37.34	68.83	58.63
4 + 30	13.57	0.98	13.81	40.30	71.17	68.33
L.S.D at 5%	0.53	0.18	2.62	1.50	0.81	6.39

Data in Table (3) showed that spraying Washington navel orange trees with CPPU + GA_3 at different concentrations either individually or in combinations increased Vitamin C compared with that of control in the two studies seasons. The highest values of Vitamin C were obtained when trees were sprayed with from CPPU at 4 ppm + GA_3 at 30 ppm. The results are in agreement with that reported by **Hikal (2013)** who revealed that foliar sprays Washington navel oranges with GA_3 at 20 ppm at pre-harvest increased V. C when compared with that of control. Also, **Khan *et al.* (2014)** indicated that, application with GA_3 at 20 ppm after fruit set increased Vitamin C of 'Blood Red' sweet oranges during experimental seasons.

We can come to the conclusion that foliar application of Washington navel orange with GA_3 and CPPU at different concentrations significantly increased TSS (%), Total acidity (%), TSS/acid ratio, total carbohydrates (%), fruit moisture (%) and V.C (mg/100ml) of fruit juice. in comparison with that of untreated trees (control). The best foliar application was obtained with T9 CPPU at 4 ppm + GA_3 at 30 ppm compared with control and other treatments.

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