Effect of Irrigation Scheduling under some Biostimulants Foliar Application for Navel Orange Trees on some Water Relations, Productivity, Fruit Quality and Storability in the North Nile Delta Region

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ABSTRACT

A field investigation was performed during the two successive growing seasons 2014/ 2015 and 2015/ 2016 at a private orchard, located at Brembal, Motobus district, Kafr EL- Sheikh Governorate, Egypt, on twenty years old Navel orange trees budded on Sour orange rootstock spaced at 6*6 metres apart to study the effect of irrigation scheduling at (0.0, 0.8, 1.0 and 1.2 of EP) under biostimulants foliar application on productivity, fruit quality, storability and some water relations for Navel orange trees.

The main results can be summarized as follows:

The highest values for WA (seasonal water applied), CU (seasonal crop water consumed) and Ecu (consumptive use efficiency) were recorded under irrigation treatment I_0(control) combined with *Azospirillum* compared with Jisemar, while, the lowest values were recorded under irrigation treatment (I_1). I_1 and I_2 treatments have recorded the highest values of PIW(productivity of irrigation water) and WP(water productivity).

Treatment I_2 recorded the highest values of fruit set and the lowest rates of dropped, splitting and creasing fruits compared with the other treatments specially with *Azospirillum* while, the lowest irrigation level treatment (I_1) showed the lowest rate of fruit set and the highest rate of fruit drop also, high irrigation levels (I_0)gave the highest rates of splitting and creasing fruits compared with the lowest rates in I_2. Results displayed a significant increasing of SSC% and SSC/acid ratio in fruits at the low irrigation level I_1 when comparing with the low values in I_0, as it was clear with Jisemar, whereas, acidity did not show any stable trend. Moderate irrigation level I_2 recorded the high values of V.C and peel fruit firmness compared with the low values at I_0 specially with-*Azospirillum*. *Azospirillum* application gave the high levels of chlorophyll with the high irrigation levels $I_0$and I_3compared with the lowest in I_1,in contrast, I_1 recorded the high rates of carotene than with I_0, but Jisemar application was the most effective in that respect..

Treatment I_2 combined with *Azospirillum* recorded the highest values of fruit number, yield(kg/tree) and ton/fed. during the two seasons, while I_0 and I_3 recorded the highest values for fruit weight than the others.

During storage, I_2 treatment recorded the best results on reducing fruit weight loss, limiting of fruit decay and maintaining the high levels of fruit firmness till the end of storage period specially with (*Azospirillum*) with a high significant differences. I_2 and I_1treatments recorded the high levels of SSC% and VC juice contents at the end of storage during the two seasons.

Key words: Bio-stimulants, orange fruits, *Azospirillum*, irrigation, water relations and storability.

INTRODUCTION

Citrus fruits are considered one of the most important fruit crops in the world as well as in Egypt. However, it occupied the third position all over the total fruit crops after grapes and apples.

Citrus fruits are popular in Egypt because of their nice low price and nutritive value. Orange is the most important citrus crop in Egypt. Navel oranges enjoy the most significant importance for local market and also for export markets.

In Egypt, water is one of the most critical factors in crop production. Rainfall is low, Therefore, almost agricultural production is mainly dependent upon irrigation. Water resources are limited and concentrated upon the Nile River. Under limitation of water resources which faces Egypt, we should do our best towards effective relationalization of irrigation water on the farm level. The present share of water in Egypt is less than 1000 m^3/capital/year which equivalent to the international standards of water poverty limit (EL-Quosy, 1998).

Maximizing water use not only reduce production cost but also help to meet the environmental regulation due to reduce the leaching of nutrients into ground water (Hanks, 1983). Under optimum level of soil moisture content, water distribution in plant tissues occurs at a level very suitable for growth development and fruiting (Mills *et al.* 1996 and Mpelasoka *et al.* 2001.

Egyptian citrus growers used to over irrigate their orchards (7500-8000 m^3 /*fed*./season). This creates different problems to both soil properties and also cultivated trees productivity and quality caused by soil logging problems, salinity, leaching of nutrients and hence reduction in soil fertility, raising soil water table and spreading pathological disorders. So, any control on

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amount of irrigation water applied according to pan evaporation (irrigation scheduling) is very important.

Foliar application of some nutrients on trees has good effects on both yield and quality to reduce the application of fertilizers containing all nutritional requirements for trees as mineral application and to avoid soil salinity hazards. Bio-stimulants increased plant use efficiency of nutrients and induced plant tolerance to biotic stresses which reflected on an increase of plant yield. Bio-stimulants are composed of biological substances and microorganisms containing bioactive compounds as mineral nutrients, humic substances, vitamins, free amino acids, chitin, polysaccharides and oligosaccharides (Bulgari *et al.* 2015).

So, the main targets for this present investigation were:

First studying the effect of irrigation practices on relationalization of Navel orange irrigation and some water relations in the studied area and

Second investigate the effect of water under different levels and some biostimulants foliar application behavior on productivity, quality, and storability of fruits.

MATERIALS AND METHODS

A field trial was carried out during the two successive growing seasons of 3014/2015 and 2015/2016 at a private orchard, located at Brembal village, Motobus, District, Kafr EL-Sheikh Governorate on twenty years old Navel orange trees (*Citrus sinensis*, Osbeck), budded on sour orange (*Citrus aurantium*, L.) rootstock spaced 6×6 metres apart to investigate the effect of irrigation scheduling and foliar application with some biostimulants on productivity, fruit quality, storability and some water relations for Navel orange trees. The trees were selected in a good health condition and uniformity in both vegetative growth and fruit load. The experimental design used in this study was split plot. Twenty one trees were selected and divided randomly into treatments, each treatment contained three trees (replication). The main plots were randomly assigned by irrigation scheduling treatments (I) which were:

(I_0) - Traditional irrigation like practice by local farmers in the studied area (check treatment or control)

(I_1) - Irrigation with 0.8 EP

(I_2) - Irrigation with 1.0 EP

(I_3) - Irrigation with 1.2 EP

(EP) - Pan accumulated evaporation.

While, sub-plots were randomly assigned by foliar application with some bio-stimulants (B):

(A) - Foliar application with bio-stimulant *Azospirillum* sp.

(J) - Foliar application with bio-stimulant Jisemar.

Bio-stimulants specifications are:

1- Jisemar:is a commercial bio-stimulants which contains seaweed extract 20.5%, free amino acids 6.5%, total nitrogen 5.8%, phosphorus 3%, Boron 0.17% and potassium 4.6 %.

2-*Azospirillum* sp.: brought about from Bacteriological Lab., Sakha Agricultural Research Station, Egypt.

It used at concentration of $4x10^{10}$colony forming unit/ ml (C.F.U.ml^{-1}).

Foliar application was carried out before flowering and after fruit set.

The orchard soil is clay in texture with a good drainage system network.

The studied soil physical characteristics such as mechanical analysis were determined according to the international pipette method. Soil field capacity(F.c%) and permanent wilting point(PWP%)were determined according to (Klute, 1986). Available soil moisture (AW%) was calculated as the difference between the field capacity and permanent wilting point.The studied chemical characteristics such as, soil reaction (pH) values were determined in 1:2.5 soil water suspension (Jackson,1973).

Total soluble salts were measured by electrical conductivity (EC) apparatus in the saturated soil paste extract (Jackson, 1973). Soluble cations and anions (Ca^{++}, Mg^{++}, Na^{+}, K^{+}, HCO^{-}, CO_3^{--}, Cl^{-} and SO_4^{--} as meq/L) were determined in soil paste extract (Jackson, 1973). But SO_4^{-2} was calculated by the difference between cations and anions.

Data collection:

A) Water relationships:

1- Amount of irrigation water applied (WA, m^3/*fed.)*: It was measured for each irrigation and then seasonal water applied was recorded by using cutthroat flume (30*90cm) through the whole growing season and calculated as (m^3/*fed*.) according to (Early, 1975).

2-Water consumptive use (CU, & m^3/*fed*.): To compute the actual consumed water of the growing plants, soil moisture percentages were determined (on weight basis) before and after each irrigation as well as at harvest. Soil samples were taken

from successive soil layers of the effective root zone: (0-15, 15-30, 30-45 and 45-60 cm). This method is one of the direct methods of water consumptive use estimation based on soil moisture depletion (SMD) or the so-called actual crop water consumed (Etc) as stated by Hansen *et al.*, (1979).

Equation for calculation of CU:

$$CU = \sum_{I=1}^{I=n} \frac{\theta 2 - \theta 1}{100} * Dbi * Di * A$$

Where:

CU = Seasonal water consumptive use (m^3/*fed.*) in the effective root zone (60cm & 0.6m) = Evapotranspiration,

i = Number of soil layers (1- 4),

Θ_2 = Soil moisture percentage, 48 hours after irrigation,

Θ_1 = Soil moisture percentage before the next irrigation,

Dbi = Soil bulk density (kg/m^3) of the concerned layers,

Di = Soil layer thickness (15 cm.) and

A = Irrigated area (m^2).

3 - Irrrigation water efficiencies:

3- 1- Consumptive use efficiency (Ecu,%):

It was calculated according to (Doorenbos and Pruitt, 1975), as follows:

Ecu = CU/WA

Where :WA= Amount of seasonable water applied (m^3/*fed.*)

3-2-Water productivity (WP, kg/m^3):

It was calculated according to Ali *et al.*, (2007), as follows :

WP = Y/Cu

Where :Y=Marketable yield (kg/*fed.*)

3-3-Productivity of irrigation water (PIW, kg/m^3):

It was calculated according to Ali *et al.*,(2007)

PIW =Y/WA

4- Determinations of yield and fruit properties at harvest time:

4- 1- Fruit splitting: It was counted weekly from August till harvest time (end January) and the percentage was calculated seasonally according to the formula :

$$\text{Fruit splitting \%} = \frac{\text{Total number of splitted fruits}}{\text{Total number of setted fruits at end of June}} \times 100$$

4- 2- Fruit set and pre-harvest fruit drop:

Four branches around all sides of each experimental tree were chosen randomly and labeled before the beginning of this study. During both experimental seasons, data used to determine the yield of each selected branch as follows:

- **Fruits set %**: calculated according to the following formula:

Table1.The mean values of some soil physical and chemical characteristics

Parameter	Value
Some physical properties	
Particle size distribution %	
Clay	51.36
Silt	38.31
Sand	10.33
Texture grade	Clayey
F. C %	43.00
PWP %	23.37
AW %	19.63
Some chemical properties	
pH (1: 2.5 soil water suspension)	8.2
E c(ds./ m in soil paste)	1.68
Soluble cations (meq/ L)	
Ca^{++}	3.18
Mg^{++}	3.96
Na^{+}	7.70
K^{+}	0.14
Solubeanions (meq/ L)	
Co_3^{--}	0.0
HCo_3^{-}	2.00
Cl^{-}	9.00
So_4^{--}	5.30

$$\text{Fruits set \%} = \frac{\text{Total number of setted fruits at end of June}}{\text{Total number of flowers of full bloom}} \times 100$$

}**Pre- harvest fruits drop%**: counted at 3 days intervals starting from the first August till harvest time during the seasons and total were calculated as the following **:**

Pre- harvest fruits drop%=

$$\frac{\text{Total number of dropped fruitrs}}{\text{Total number of setted fruits at end of June}} \times 100$$

4-3- Yield: Fruits were picked when SSC/acid ratio reached to 12-16 nearly end January during the two study years. Yield was calculated based on fruit number, average fruit weight, yield Kg per tree (replicate) and fruit yield ton/*fed*.. Fruit samples were packed in plastic boxes and transported to the laboratory of Sakha Horticulture Research Station to determine the following:

4-4- Fruit characteristicsat harvest:

a-Physical characteristics: Firmness as peel fruit firmness was measured by using a hand penetrometer according to Harold (1985) and expressed as (gm/mm^2) and SSC/ acid of juice ratio was estimated and calculated.

b - Chemical characteristics: Juice soluble solids content (SSC%) was determined by using a hand refractometer, titratable acidity expressed as citric acid (%) was estimated by titration of filtered juice by NaOH (0.1 N) with presence of phph indicator according to AOAC(1990), ascorbic acid content (V.C) was determined in filtered juice using 2,6 dichlorophenol indophenol as described by AOAC (1990) and expressed as(mg/100ml juice), total chlorophyll and carotene pigments for fruit rind according to the method of Wensttein (1957) by extraction of one gram from the skin of three fruits with 10 ml 85% acetone in a warring blender for five minutes, chloroplast pigments were determined in the filtered extract, chlorophyll a, b and carotene were determined by measuring the optical density at wave length of 662, 644 and 440nm., respectively using acetone 85% as reference. the present pigments were calculated as (mg/100g of fresh weight).

c - Determination of fruit characteristics during cold storage:

Thirty six fruits of each replicate were washed, dried and stored in plastic box at 6±1^{0}C and 90-95% relative humidity. Samples were taken at 20 days intervals during storage period till 80 days, for determining fruit decay and weight loss percentages as follow:

$$\text{Fruit decay \%} = \frac{\text{Total number of decayed fruits} \times 100}{\text{Total number of stored fruits}}$$

$$\text{Weight loss\%} = \frac{(\text{initial fruit weight} - \text{fruit weight now}) \times 100}{\text{fruit weight at initial time of storage}}$$

Also, the changes of above fruit characteristics during cold storage period were determined .

Statistical analysis:

Statistical analysis of the experiment data was analyzed according to the split plot design and all data obtained throughout this present work were tested by analysis of variance (Little and Hills, 1998). Duncan's multiple range tests were used for making comparisons among the treatments means (Duncan, 1955).

RERSULTS AND DISCUSSION

1- Influence of irrigation scheduling treatments and foliar application with some bio-stimulants on some water relations:

A- Irrigation water applied(WA, m^3/*fed.*) and Water consumptive use (CU, m^3/*fed.*):

Presented data in Table (2) clearly illustrated that, the amount of irrigation water applied and water consumptive use, were affected by irrigation treatments. The highest overall means were recorded under irrigation treatments (I_0) and the lowest values were recorded under irrigation treatment (I_1) (irrigation with 0.8 EP). Generally, the values of (WA) and (CU) were lower under scheduling treatments in comparison with traditional irrigation(I_0) and the values can be arranged in the order I_0>I_3>I_2>I_1, for both seasons. The increase in values of irrigation water applied under traditional irrigation (I_0) in comparison with other irrigation treatments might be attributed to the decrease of the period between irrigations and hence, the increasing number of waterings. Also, the increase of CU under (I_0), comparing with (scheduling treatments) might be attributed to increasing the amount of water applied under the conditions of this treatment and hence, the increasing rate of evaporation from the soil surface and transpiration from plant surfaces which resulted from increasing the values of CU. These results are in a great harmony with those obtained by Mikhael *et al*., (2010) who concluded that, the amount of irrigation water applied for (Desert Red) peach trees were clearly affected by irrigation treatments, where the highest values were recorded under irrigation at 80% of field capacity in comparison with other irrigation treatments 70 and 60% of field capacity.

Table 2. Effect of irrigation and bio-stimulants foliar application on seasonal amount of water applied (WA) and water consumptive use (CU) for Navel orange crop during the two seasons

Irri.Treat..	Bio-stim	WA (M^3/*Fed.*)			Cu (M^3/*Fed.)*		
		1st season	2nd season	Mean	1st season	2nd season	Mean
I_0(cont.)		7840.37	7720.73	7780.55	4943.43	4853.14	4898.29
I_1	A	4630.18	4540.39	4585.29	2792.90	2720.14	2756.52
(0.8 EP)	J	4630.18	4540.39	45.85.29	2700.30	2680.30	2690.30
Mean		4630.18	4540.39	4585.29	2746.60	3700.22	2723.41
I_2	A	6530.48	6448.14	6489.31	3987.68	3870.50	3927.09
(1.0 Ep)	J	6530.48	6448.14	6489.31	3857.07	3780.48	3818.78
Mean		6530.48	6448.14	6489.31	3922.38	3825.49	3872.94
I_3	A	720013	7113.22	7156.68	4448.08	4315.31	4381.70
(1.2 Ep)	J	7200.13	7113.22	7156.68	4304.07	4212.38	4258.23
Mean		7200.13	7113.22	7156.68	4376.08	4263.85	4319.97

The data in a column followed by the same symbol are not significant at p= 0.05

The same results werefound by El-Abd *et al.* (2012) on Navel orange, Garcia and Brunton (2013) and Moursi and Soliman (2015) on peach. Data showed that, foliar application has not affected the water applied. On the other hand, the use of *Azosiprillum* (A) recorded the highest values of CU compared with Jisemar (J) which

might be attributed to increasing the vegetative growth and hence, a higher rate of transpiration from plant surface by the increase of the plant surface area exposed to sunlight.

B- Consumptive use efficiency (Ecu,%), productivity of irrigation water (PIW, kg/m^3) and water productivity (WP, kg/m^3):

Data in Table (3) clearly illustrated that, the highest overall mean values of consumptive use efficiency (Ecu, %) were recorded under irrigation treatment (I_0), compared with the other treatments, in the meantime foliar application with (A) resulted in the highest mean values of (Ecu, %), compared with (J). Both productivity of irrigation water (PIW, kg/m^3) water productivity WP (kg/m^3)were affected by both irrigation and foliar application treatments. The highest overall mean values were recorded under irrigation treatment I_1 and I_2, values of 2.92; 4.91 kg/m^{3}for I_1, and 2.91,4.87 kg/m^3 for I_2 of PIW and WP, respectively. On the contrary, the lowest overall mean values were recorded under I_0(control) and the values are 2.18 kg/m^3 and 3.47 kg/m^3 for PIW and WP, respectively. Generally, the overall mean values for WP and PIW can be arranged in the order $I_1 > I_2 > I_3 > 1_0$. The increase in the overall mean values for both WP and PIW under irrigation treatment I_1 (irrigation with 0.8 EP) and I_2 (irrigation with 1.0EP) might be attributed to the decrease of the overall mean values for both water consumptive used and seasonable water applied, when compared with other irrigation treatments.

Table 3. Effect of irrigation and bio-stimulants foliar application on water consumptive use efficiency (Ecu, %),productivity of irrigation water (PIW, kg/M^3)and water productivity (WP, Kg/ M^3)for Navel orange crop during the two seasons

Irri.Treat.	Bio-stim.	Ecu (%)			PIW (kg / M^3)			WP (kg/ M3)		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		63.05	62.86	62.96	2.14	2.23	2.19	3.39	3.54	3.47
I_1	A	60.32	59.91	60.12	2.87	3.05	2.96	4.75	5.09	4.92
(0.8 Ep.)	J	58.32	59.03	58.68	2.81	2.95	2.88	4.81	4.99	4.90
Mean		59.32	59.47	59.40	2.84	3.00	2.92	4.78	5.04	4.91
I_2	A	61.06	60.03	60.55	2.90	2.99	2.95	4.74	4.98	4.86
(1.0 Ep.)	J	59.06	58.63	58.85	2.83	2.90	2.87	4.78	4.95	4.87
Mean		60,06	59.33	59.70	2.87	2.95	2.91	4.76	4.47	4.87
I_3	A	61.78	60.67	61.23	2.42	2.49	2.46	3.92	4.10	4.01
(1.2 Ep.)	J	59.78	59.22	59.50	2.38	2.47	2.43	3.99	4.18	4.09
Mean		60.78	59.95	60.37	2.40	2.48	2.45	3.96	4.14	4.05

The data in a column followed by the same symbol are not significant at p= 0.05

These results are in accordance with those obtained by El-Abd *et al.*(2012) on Navel orange trees and Moursi and Soliman (2015) on peach trees.

Results indicated that, there was a general trend of increase of the overall mean values of WP and PIW under foliar application with *Azospirillum*(A) compared to Jisemar(J).

2– Influence of irrigation scheduling treatments and foliar application with some bio-stimulants on:

A- Fruit set, drop percentages ,splitting and creasing of fruits (%):

Data from Table (4) indicated that, *Azospirillum* sp (A) recorded the highest fruit set (%) compared with the other promoter Jisemar (J) under all irrigation treatments during the two seasons. The same trend was found with (I_2) treatment compared with the other treatments, but (I_1) recorded the lowest values of fruit set. In contrast, the highest values of fruit drop was found at the highest and lowest level of irrigation compared with the moderate irrigation treatments in a high significant manner during the two seasons, respectively, especially with (I_2) treatment. This was more pronounced with *Azospirillum* (A) treatment than Jisemar (J). On the other hand, irrigation treatment(I_2) gave the best results of decreasing splitting and creasing fruits with high significant differences during the two study seasons, on contrary with I_0 which recorded the highest rates of the two characters, and that was clear with the use of biostimulant (A) compared with (J)during both seasons, respectively. These results are in a good agreement with those obtained by El-Abd (2005) and Abo El-Enein(2012) on Washington Navel orange, as the highest fruit set percentage was found with the trees irrigated with 4000 m^3/*fed*/year and irrigated 70% of FC followed by control and besides that treatments recorded the lowest fruit drop% and increased fruit removal force (F.R.F). Taha and Eid 2011 mentioned that, poly amines contained in bio-stimulants regulate fruit setting and ripening.

Zaghloul *et al.* (2015) reported that, spray with Jisemar and/or *Azospirillum* sp. gave best results than those of water sprayed treatment on increasing fruit set%, and the lowest drop% for the two seasons. It was shown that, decreasing or increasing soil moisture content may subject roots to inefficient water which caused the increase of fruit drop % especially during June drop period, so to avoid that stress, soil must be kept fairly wet during summer months.

El-Boray *et al*. (1995)found that, the highest fruit set % and low fruit drop (%) was recorded on Washington Navel orange trees irrigated with 4000 m^3/*fed*/year. On study of irrigation scheduling on Malta Blood Red sweet orange (Lai *et al*., 1997) noticed that, irrigation applied at 15 days interval reduced fruit drop. Rubino *et al*.,(2004) showed that, physiological disorders (creasing, splitting, and scald) are associated with water shortage and water irrigation quality.

B– Fruit chemical characters at harvest:

1- Fruit soluble solids content (SSC %), acidity(%) and SSC/acid ratio:

Results of Table (5) indicated that, there was a significant difference in SSC (%); acidity (%) and SSC/acid ratio between most irrigation treatments during the two seasons especially with deficit and high irrigation levels. I_1treatment gave fruits with the highest values of the above parameters followed by I_2 during the two study seasons compared with the other treatments especially with Jisemar application. On the other hand I_0(control) recorded the lowest values of SSC% and SSC/acid ratio. These finding was supported by Peŕez-Peŕez *et al*. (2009) on Sweet orange “Lan late” and Abo El-Enien(2012) on Navel orange, they found that, moderate water stress produced the highest TSS, TSS/acid ratio and as vitamin C. In this respect Zaghloul *et al*. (2015) on Navel orange trees claimed that, spray with different PGPR increased SSC% and SSC/acid ratio, this may be related to the role of bio-stimulants spray in increasing the vegetative stage period of the tree as a result of continuous supply of nutrients due to the action of improving efficiency nutrient use resulted from stimulating action(Calvo *et al*., 2014). The reason of increasing acidity may be due to the effect of these bio-stimulants in inducing continuous supplement of elements in longer vegetative growth time, and hence prolonging maturity stage and delayed picking date of the fruits, (Zaghloul *et al*., 2015) on Navel orange.

2- Vitamin C content (mg/100 ml), total chlorophyll and carotene (mg/100gm):

Data presented in Table (6) showed that, vitamin C values varied among irrigation treatments with a high significant differences between them. Vitamin C content increased with decreasing irrigation levels. The highest values of V.C content was found with the fruits of trees irrigated with I_2 (moderate irrigation) compared with the lowest values recorded under high irrigation treatment I_0 (control) during both seasons, respectively. Foliar application did not affected significantly V.C when applying different irrigation treatments.I_2A recorded the highest V.C content compared with the other These findings are on line with those of Nour El-Din *et al*. (2012) on apple trees, El-Shazly and Mostafa (2015) and Zaghloul *et al*. (2015)on Navel orange.

Table 4. Effect of irrigation and bio-stimulants foliar application on fruit set (%), fruit drop (%), fruit splitting (%) and fruit creasing (%) for Navel orange fruits during the two seasons

Irri. Treat.	Bio-stim.	Fruit set (%)			Fruit drop(%)			Splitting fruits			Creasing fruits		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		6.8d	6.7cd	6.8	11.9c	12.3c	12.1	6.4a	6.1a	6.3	8.2a	8.3a	8.3
I_1	A	6.4e	6.6d	6.5	13.6b	13.8b	13.7	5.4bc	5.0b	5.2	5.4c	6.4b	5.9
(0.8.Ep.)	J	6.2e	6.6d	6.4	14.9a	14.3a	14.6	5.1c	5.0b	5.1	6.3bc	6.2b	6.3
Mean		6.3	6.6	6.5	14.3	14.1	14.2	6.2	6.0	6.1	5.9	6.3	6.2
I 2	A	7.9a	7.6a	7.8	9.6d	9.4e	9.5	4.3d	4.1c	4.2	1.7e	1.6d	1.7
(1.0 Ep.)	J	7,6b	7.5a	7.6	10.0d	10.1d	10.0	4.8cd	4.3c	4.6	2.2e	2.1d	2.2
Mean		7.8	7.6	7.7	9.8	9.8	9.8	4.6	4.2	4.4	2.0	1.9	2.0
I_3	A	7.3c	7.2c	7.3	12.0c	12.5c	12.3	5.9ab	5.9a	5.9	3.7d	4.3c	4.0
(1.2Ep.)	J	7.2c	7.3b	7.3	12.9b	13.7b	13.3	6.0ab	5.3b	5.7	3.9d	4.8c	4.4
Mean		7.3	7.3	7.3	12.5	13.1	12.8	5.7	5.2	5.5	3.8	4.6	4.2

The data in a column followed by the same symbol are not significant at $p = 0.05$

Table 5. Effect of irrigation and bio-stimulants foliar application on SSC (%), acidity(%)and SSC/acid ratio for Navel orange fruits at harvest during the two seasons

Irri. Treat.	Bio-stim.	SSC(%)			Acidity (%)			SSC/acid ratio		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		12.54e	13.17d	12.86	0.98b	0.99ab	0.99	12.87e	13.37d	13.12
I_1	A	13.97ab	13.90b	13.94	1.00a	1.00a	1.00	13.97ab	13.90bc	13.94
(0.8 Ep.)	J	14.17a	14.20a	14.19	.0.99ab	0.99ab	0.99	14.31a	14.34a	14.33
Mean		14.07	14.05	14.06	1.00	1.00	1.00	14.07	14.05	14.06
I_2	A	13.43c	13.57c	13.50	1.00a	1.00a	1.00	13.43cd	13.57c	13.50
(1.0 Ep.)	J	13.87b	13.97ab	13.92	0.99ab	0.99ab	0.99	14.01ab	14.11b	14.06
Mean		13.65	13.77	13.71	1.00	1.00	1.00	13.65	13.77	13.71
I_3	A	13.03d	13.27cd	13.15	.098b	0.99ab	0.99	13.30d	13.40d	13.35
(1.2 Ep.)	J	13.23d	13.47cd	13.35	0.98b	0.99ab	0.99	13.50b	13.61c	13.56
Mean		13.13	13.37	13.25	0.98	0.99	0.99	13.40	13.51	13.45

The data in a column followed by the same symbol are not significant at p= 0.05

Table 6. Effect of irrigation and bio-stimulants foliar application on V. C content(mg/100 ml juice), total chlorophyll (mg/100g) and carotene (mg/100g) for Navel orange fruits at harvest during the two seasons

Irri. Treat.	Bio-stim.	V. C			Chlorophyll			carotene		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0(cont.)		54.87d	55.18e	55.03	43.70a	44.08ab	43.89	52.86e	53.87f	53.12
I_1	A	57.10bc	57.11bc	57.11	36.67e	37.83e	37.25	66.20b	75.62a	70.91
(0.8 Ep.)	J	56.58c	56.75cd	56.67	36.07e	37.23e	36.65	72.07a	75.82a	73.92
Mean		56.84	56.93	56.89	36.37	37.53	36.95	69.14	75.72	72.43
I_2	A	58.17a	58.73a	58.45	38.03d	40.06d	39.05	66.80b	67.69c	67.26
(1.0 Ep.)	J	57.74ab	58.07ab	57.91	35.58e	38.77de	37.18	66.20b	72.27b	6924
Mean		57.69	58.40	58.18	36.81	39.42	38.12	66.50	69.98	68.24
I_3	A	56.76c	55.68e	56.22	42.34b	45.27a	43.81	58.47d	64.57d	61.52
(1.2 Ep.)	J	56.81c	55.95de	56.38	39.81c	42.78bc	41.30	62.18cd	59.81e	61.00
Mean		56.79	55.82	56.31	41.08	44.03	42.56	60.33	62.19	61.26

The data in a column followed by the same symbol are not significant at p= 0.05

They showed that, the spray with bio-stimulants led to increase vitamin C in fruits.

The highest total chlorophyll was obtained with the high level of irrigated treatments (I_0 followed by I_3) with highly significant differences compared to the other treatments ,in contrast, the opposite trend was found with I_1. *Azospirillum* application which produced the highest chlorophyll content than Jisemar for all irrigated levels during the two seasons. There was a positive relation between irrigation amount and peel chlorophyll content. The above mentioned results are in accordance with those reported by El-Abd (2005), Hussein *et al*., (2013) and El-Zawily, (2016) on Washington Navel orange, Peŕez-Peŕez *et al*., (2009) on “Lane late” Sweet orange trees and Navarro *et al*. (2010) on “Clemenules” mandarin citrus trees. Hamza and Suggars (2001) mentioned that, *Azospirillum* sp. and others PGPA groups considered as bio-stimulants. (Zaghloul *et al*. 2015) on Washington Navel orange regarding the above results.

On the other hand, there was a general trend showing an increase in carotene content (%) with the decrease of irrigation levels. The highest carotene content in peel was resulted from I_1 followed by I_2, I_3 and I_0 during the two seasons, respectively. Jisemar showed the highest values of carotene (%)while *Azospirillum* recorded the lowest values with irrigation treatments in the two seasons. The above results are in line with those reported by(Zaghloul *et al*. 2015) on Washington Navel orange fruits. The increase in peel carotene might be attributed to the maturation phase when peel color changes markedly Huff, (1984) and Bulgari *et al*. (2015) reported that, bio-stimulants including PGPR and phytohormones help in increasing the biosynthesis of chlorophyll content and carotenoids and consequently net photosynthesis improved in plant.

C) - Fruit (number/tree and weight g), yield (kg/tree and ton/*fed.)* and peel fruit firmness (gm/mm^2):

Data of Table (7) revealed that, the number of fruits per tree, yield kg/tree and ton/*fed*. were in significant increase under moderate irrigation treatment (I_2) compared to the lowest and the highest irrigation levels (I_1) and (I_0). *Azospirillim* application recorded the best results compared with Jisemar in this respect with all irrigation treatments. These results could be attributed to the high level of fruit set % and the reduction of fruit drop resulting in higher yield/tree and ton/*fed*.

Data tabulated in Table (7) exhibited that, the heaviest fruits belonged always to (I_0) compared to fruits of lower weight obtained by deficit irrigation (I_1) and the other treatments gave intermediate values of fruit weight with no differences. *Azospirillum* spray gave highest values of fruit weight than Jisemar treatment. These data are in accordance with those reported by El-Sayed and Ennab (2013) on Valencia orange trees, Hussien *et al.* (2013) and El-Zawily, (2016) on Washington Navel orange trees. They mentioned that, number of fruits was significantly higher in trees with full and moderate irrigation than those treated with deficit irrigation under drip irrigation system. The reduction in fruit weight under deficit soil moisture content could be attributed to the reduction in fruit cell enlargement through the reduction of fruit turgor early in the season and decrease cell water content. El-Boray*et al*. (1995), Abd El-Aziz (1998) , El-Abd (2005) and Abo El-Enien, (2012) reported that, fruit weight were increased with the high irrigation level.

Khalil *et al*., (2000) and Wassel *et al*. (2007)a on Balady mandarin trees, idicated that, yield as kg/tree was increased by using the moderate irrigation rate. Furthermore, Zaghloul, (2004) and Zaghloul *et al*. (2015) on Navel orange trees pointed that, GA3 or growth bio-stimulants (*Azospirillum* sp and Jisemar)significantly increased orange fruit number/tree and fruit yield kg/tree.

Data in Table (7) showed that, foliar application had a positive effect on peel fruit firmness and, *Azospirillum* was more effective in causing an increase in peel firmness compared with Jisemar with significant differences. This trend was found also with the low level of irrigation treatment which increased firmness compared with high level irrigation which recorded the lowest fruit firmness during the two seasons. We can arrange the treatments from high to low fruit firmness $I_2A > I_1A > I_2G > I_1G > I_3 > I_0$ in the two seasons. These results are in line with the findings of Abd El-Razek and Saleh (2012) on Florida prince peach and Zaghloul, *et al*. (2015)on Washington Navel orange. In this concern, Ali and Gobran (2002), Abo El-Enien (2012) and El-Zawily(2016) on Navel orange trees, Romero *et al*. (2006) on Clemenules mandarin trees. El-Sayed and Ennab (2013) on Valencia orange, revealed that, water stress increased peel thickness and peel firmness .

The increase in fruit firmness may be due to the effect of bio-stimulators on inducing high potentially of fruit rind resistance to pathogens, Van Loon (2007)and Govindasamy *et al*. (2008) mentioned that, PGPR regulate plant ethylene level and produces antibiotics, leaving an effect on quality parameters as firmness. The reduction in fruit firmness with high rate of irrigation may be due to the increase of fruit size and its water content, Mikhael and Mady (2007)reported that, deficit irrigation regime induced significantly higher fruit firmness.

3– Influence of irrigation scheduling treatments and foliar application with some bio-stimulant on fruit characteristics during cold storage:

A) – Weight loss (%):

Data of Table (8)showed that, Loss of weight started at 20 days of storage in the two seasons. Fruit weight loss was increased with the prolonging of storage time. It was clear that, I_0 treatment resulted in the highest values of weight loss till the end of storage followed by I_3, I_1 and I_2. I_2 irrigation treatment reduced the weight loss compared to other treatments. Foliar application showed the best results on reduction of weight loss especially with *Azospirillum* sp till the end of storage period. Such findings are in harmony with those reported by Zaghloul (2004) and Zaghloul *et al*.(2015)on Navel orange fruits, who mentioned that, the main reason of fruit weight loss was the evaporation and transpiration plus the amount of dry matter loss by fruit respiration, and bio-stimulants foliar application gave the lowest decrease of weight if compared to control during storage, the same results were agreed with those found by Ggabr, *et al*. (2012) on apple trees.

B) – Fruit decay (%):

From Table (9) displayed data showing that, fruit decay percentage increased with the progress time of storage during the two study seasons. High levels of irrigation water showed raising values of fruit decay percentage, in contrast with the lowest values of fruit decay recorded with the minimized amounts of irrigation water which was clear with I_2 compared with other treatments. Foliar application minimized the increase of fruit decay with high significant differences between them till the end of storage. *Azospirillum* reduced fruit decay percentage compared to Jisemar. These results were in agreement with those findings of Zaghloul(2004) and Zaghloul *et al*. (2015)on Navel orange fruits, as bio-stimulant treatments enhanced control rot

Table 7. Effect of irrigation and bio-stimulants foliar application on fruit number /tree, fruit weight (g), yield (kg/tree and ton/fed.) and peel fruit firmness (gm/mm^2) for Navel orange fruits during the two seasons

Irri. Treat.	Bio-stim.	Fruit no/tree			Fruit weight			Yield kg/tree			Yield ton/fed.			Firmness		
		1st season	2nd season	Mean	1st season	2nd Season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		496.17e	501.33c	494.58	290.83a	295.28a	293.06	144.30cd	148.06c	146.18	16.74d	17.18d	16.96	55.79e	58.44f	57.12
I_1	A	423.33g	432.33e	427.83	270.29c	276.08c	273.19	114.42e	119.36d	116.89	13.27e	13.85e	13.56	86.33b	88.04b	87.18
(0.8 Ep.)	J	418.67h	423.33e	421.00	267.54c	272.54c	280.04	112.01e	115.37e	113.69	12.99e	13.38e	13.19	73.51d	77.01d	75.26
Mean		421.00	427.83	424.42	268.92	274.31	271.62	113.22	117.37	115.29	13.13	13.62	13.38	79.92	82.53	81.23
I_2	A	564.33a	566.67a	565.49	288.99ab	293.45ab	291.22	163.08a	164.60a	163.84	18.92a	19.28a	19.10	92.57a	95.21a	93.89
(1.0 Ep.)	J	560.33b	564.33a	562.33	283.91b	286.96b	285.44	159.10a	161.46a	160.28	18.45a	18.73b	18.59	81,38c	82.49c	81.94
Mean		562.33	565.50	563.92	286.45	290.21	288.33	161.09	163.03	162.06	18.69	19.01	18.85	86.98	88.85	87.92
I_3	A	523.00c	528.33b	525.67	287.69ab	288.67b	288.18	150.44b	152.49b	151.47	17.45b	17.69c	17.57	59.22e	63.04e	61.13
(1.2 Ep.)	J	517.67d	525.00b	521.34	285.81b	288.79b	287.30	147.95c	151.61b	149.78	17.16bc	17.59c	17.38	56.17e	58.03f	57.10
Mean		520.33	526.67	523.50	286.75	288.73	287.74	149.19	152.05	150.62	17.31	17.64	17.48	57.70	60.54	59.12

The data in a column followed by the same symbol are not significant at p= 0.05

Table 8. Effect of irrigation and bio-stimulants foliar application on weight loss (%) for Navel orange fruits during cold storage in the two seasons

Irri. Treat.	Bio-stim.	0 time of st.			After 20 days of st.			After 40 days of st.			After 60 days of st.			After 80 days of st.		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		0.00	0.00	0.00	5.11a	6.01a	5.56	9.07a	9.34a	9.21	11.26a	12.39a	11.83	14.37a	14.43a	14.40
I_1	A	0.00	0.00	0.00	3.73bc	4.13cd	3.93	5.58c	6.12c	5.85	7.32de	8.62c	7.97	10.12cd	10.62cd	10.37
(0.8 Ep)	J	0.00	0.00	0.00	3.92b	4.40c	4.16	5.75c	6.88b	6.63	8.50bc	8.75c	8.63	11.01c	10.57d	10.79
Mean		0.00	0.00	0.00	3.83	4.27	4.05	5.67	6.50	6.09	7.91	8.69	8.30	10.57	10.60	10.58
I_2	A	0.00	0.00	0.00	3.73bc	4.13cd	3.93	4.02e	4.48d	4.37	7.06e	6.68d	6.87	8.54d	9.76e	9.15
(1.0 Ep)	J	0.00	0.00	0.00	3.92b	4.40c	4.16	4.26d	6.48bc	5.83	7.58cd	7.12cd	7.35	6.62e	10.14de	9.38
Mean		0.00	0.00	0.00	3.83	4.27	4.05	4.14	5.48	4.81	7.32	6.90	7.11	7.58	9.95	8.77
I_3	A	0.00	0.00	0.00	4.72a	5.33b	4.03	6.77b	7.18b	6.98	9.59ab	8.63c	9.11	12.85 b	12.11c	12.48
(1.0 Ep)	J	0.00	0.00	0.00	4.85a	5.37b	5.11	7.23b	7.48b	7.36	10.30ab	9.62b	9.96	10.33cd	12.98b	11.66
Mean		0.00	0.00	0.00	4.79	5.35	5.07	7.00	7.33	7.17	9.95	9.13	9.54	11.59	12.55	12.07

The data in a column followed by the same symbol are not significant at p= 0.05

Table 9. Effect of irrigation and bio-stimulants foliar application on decay (%) for Navel orange fruits during cold storage in the two seasons

Irri.Treat.	Bio-stim.	0 time of st.			After 20 days of st.			After 40 days of st.			After 60 days of st.			After 80 days of st.		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		0.00	0.00	0.00	6.48a	5.56a	6.02	9.30a	7.40a	8.35	13.87b	13.87a	13.87	19.45a	18.52a	18.99
I_1	A	0.00	0.00	0.00	1.85d	1.85c	1.85	3.70d	5.56b	4.63	9.30d	9.30d	9.30	11.15e	9.30d	10.23
(0.8 Ep)	J	0.00	0.00	0.00	3.70c	1.85c	2.78	7.40b	7.40a	7.40	11.15c	9.30d	10.23	12.92d	11.15c	12.04
Mean		0.00	0.00	0.00	2.78	1.85	2.32	5.55	6.48	6.02	10.23	9.30	9.77	12.04	10.23	11.14
I_2	A	0.00	0.00	0.00	0.00e	1.85c	0.93	1.85e	3.70c	2.78	7.40e	5.56e	6.48	9.30f	7.40e	8.35
(1.0 Ep)	J	0.00	0.00	0.00	1.85d	1.85c	1.85	5.55c	7.40a	6.48	9.30d	9.30d	9.30	11.15e	9.30d	10.23
Mean		0.00	0.00	0.00	0.93	1.85	1.39	3.70	5.55	4.63	8.35	7.43	7.89	10.23	8.35	9.29
I_3	A	0.00	0.00	0.00	3.70c	3.70b	3.70	7.40b	7.40a	7.40	11.15c	11.15c	11.15	16.67c	16.67b	16.67
(1.2 Ep)	J	0.00	0.00	0.00	5.56b	3.70b	4.63	9.30a	7.40a	8.35	14.81a	12.92b	13.87	18.52b	16.67b	17.60
Mean		0.00	0.00	0.00	4.63	3.70	4.17	8.35	7.40	7.88	12.98	12.04	12.51	17.60	16.67	17.14

The data in a column followed by the same symbol are not significant at p= 0.05

Table10. Effect of irrigation and bio-stimulants foliar application on firmness for Navel orange fruits during cold storage in the two seasons

Irri.Treat.	Bio-stim.	0 time of st.			After 20 days of st.			After 40 days of st.			After 60 days of st.			After 80 days of st.		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		55.79e	58.44f	57.12	52.95e	57.75f	55.35	49.70e	53.72f	51.71	41.38f	48.17d	44.78	33.87d	35.46d	34.67
I_1	A	86.33b	88.04b	87.18	80.78b	83.76b	82.27	80.43ab	80.91b	80.67	73.11b	75.43a	74.27	62.30b	64.99a	63.65
(0.8 Ep)	J	73.51d	77.01d	75.26	69.61c	73.65d	71.63	65.90c	70.02d	67.96	58.53d	71.49c	60.01	55.83c	55.04b	55.44
Mean		79.92	82.53	81.23	75.29	78.71	76.96	73.17	75.46	74.32	65.82	68.46	67.14	59.07	60.02	59.55
I_2	A	92.57a	95.21a	93.89	88.07a	89.37a	88.72	84.32a	86.71a	85.52	77.90a	78.94a	78.42	69.11a	69.58a	69.35
(1.0 Ep)	J	81,38c	82.49c	81.94	78.66b	79.99c	79.30	75.32b	76.00c	75.66	69.03c	69.64b	69.34	59.74b	62.83a	61.29
Mean		86.98	88.85	87.92	83.37	84.66	84.03	79.82	81.36	80.59	73.47	74.28	73. 88	64.43	66.21	65.32
I_3	A	59.22e	63.04e	61.13	61.87d	62.59e	62.23	58.20d	58.05e	58.13	46.90e	50.34d	48.62	36.87d	40.66c	38.77
(1.0 Ep)	J	56.17e	58.03f	57.10	61.67d	62.39e	62.03	58.00d	59.85e	58.93	46.70e	50.14d	48.42	36.67d	40.46c	38.57
Mean		57.70	60.54	59.12	61.77	62.49	62.13	58.10	58.95	58.53	46.80	50.24	48.52	36.77	40.56	38.67

The data in a column followed by the same symbol are not significant at p= 0.05

Table 11. Effect of irrigation and bio-stimulants foliar application on vitamin C content (mg /100 ml juice) for Navel orange fruits during cold storage in the two seasons

Irri. Treat.	Bio-stim.	0 time of st.			After 20 days of st.			After 40 days of st.			After 60 days of st.			After 80 days of st.		
		1st season	2nd season	Mean	1st season	2nd Season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		54.87d	55.18c	55.03	52.32b	52.18c	52.57	50.27d	50.01b	50.14	47.30b	43.05b	54.18	41.20e	40.07c	40.64
I_1	A	57.10bc	57.11bc	57.11	54.65ab	54.81ab	54.73	53.46bc	51.49ab	52.48	52.14a	50.42a	51.28	51.66a	46.43ab	49.05
(0.8 Ep)	J	56.58c	56.75cd	56.67	55.75a	52.37bc	54.06	54.46ab	51.14b	52.80	51.74a	49.59a	50.67	49.17bc	47.11a	48.14
Mean		56.84	56.93	56.89	55.20	53.59	54.40	53.96	51.32	52.64	51.94	50.01	50.98	49.00	46.77	47.89
I_2	A	58.17a	58.73a	58.45	57.26a	56.62a	56.94	56.29a	52.64ab	45.47	52.94a	49.54a	51.24	48.83ab	47.92a	47.88
(1.0 Ep)	J	57.74ab	58.07ab	57.91	56.91a	55.22ab	56.07	55.24ab	54.47a	45.86	52.28a	50.38a	51.33	51.24ab	46.98a	49.11
Mean		57.96	58.40	58.18	57.09	55.92	56.51	55.77	53.56	54.67	52.61	49.96	51.29	51.45	46.95	49.20
I_3	A	56.76c	55.68e	56.22	55.48a	56.20a	55.84	52.75bc	52.85ab	52.80	50.55ab	48.22a	49.39	48.03cd	43.06b	45.55
(1.2 Ep)	J	56.81c	55.95de	56.38	55.11a	55.69ab	55.40	51.85cd	50.70b	51.14	49.57ab	46.81ab	49.19	46.32d	41.69bc	44.01
Mean		56.79	55.82	56.31	55.30	55.95	55.63	52.17	51.78	51.98	50.06	47.52	49.29	47.18	42.38	44.78

The data in a column followed by the same symbol are not significant at p= 0.05

Table 12. Effect of irrigation and bio-stimulants foliar application on SSC (%) for Navel orange fruits during cold storage in the twoseasons .

Irri. Treat.	Bio-stim.	0 time of st.			After 20 days of st.			After 40 days of st.			After 60 days of st.			After 80 days of st.		
		1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean	1st season	2nd season	Mean
I_0 (cont.)		12.54e	13.17d	12.86	12.83c	13.17c	13.00	12.80c	12.99c	12.90	12.93c	13.13c	13.03	12.88d	13.25c	13.07
I_1	A	13.97ab	13.90ab	13.94	13.83a	14.07a	13.95	13.80a	13.90a	13.85	13.93a.	14.51a	13.97	13.93a	13.83ab	13.88
(0.8 Ep.)	J	14.17a	14.20a	14.19	13.83a	13.90a	13.87	13.60a	13.83a	13.72	13.73ab	14.00a	13.87	13.70b	13.96a	13.83
Mean		14.07	14.05	14.06	13.83	13.99	13.91	13.70	13.87	13.79	13.83	14.01	13.92	13.82	13.89	13.85
I_2	A	13.43c	13.57c	13.50	13.63ab	13.77b	13.70	13.46ab	13.64a	13.55	13.70ab	13.93a	13.82	13.63b	13.97a	13.80
(1.0 Ep.)	J	13.87b	13.97b	13.92	13.60b	13.23c	13.42	13.13bc	13.28b	13.21	13.53b	13.50b	13.52	13.47c	13.53b	13.50
Mean		13.65	13.77	13.71	13.62	13.50	13.56	13.30	13.46	13.38	13.72	13.72	13.67	13.55	13.75	13.65
I_3	A	13.03d	13.27cd	13.15	12.57c	12.97d	12.77	12.47d	12.88c	12.68	12.97c	12.97c	12.89	12.87d	12.97d	12.92
(1.2 Ep.)	J	13.23d	13.47cd	13.35	12.03d	13.03cd	12.53	11.73e	12.86c	13.30	13.07c	13.07c	12.54	12.33e	13.00d	12.67
Mean		13.13	13.37	13.25	12.30	13.00	12.65	12.10	12.87	12.49	13.02	13.02	12.71	12.60	12.98	12.80

The data in a column followed by the same symbol are not significant at p= 0.05

pathogens, therefore caused a decline in fruit decay percentage and enhanced fruit shelf life.

This may be due to the direct impact of decline in rots infection and the decrease of decayed fruits during shelf life (Esitken, 2011), and resistance to plant pathogens (Van Loon, 2007). Gabr *et al*. (2012) mentioned that, foliar application of (A) or (J) on apple caused a reduction on fruit decay % compared with the control.

C) –Peel fruit firmness (gm /mm^3):

Data listed in Table (10) revealed that, moderate irrigation treatments level (I_2) and deficit irrigation level (I_1) recorded the highest peel firmness level in both seasons compared to (I_0)and (I_3) levels. In contrary, high level irrigation of (I_0 and I_3) recorded the least peel fruit firmness with significant differences. Peel fruit firmness showed a decrease with the progress in storage period in the two seasons for all treatments and the high values were recorded between I_2A and I_1A till the end of storage time. *Azospirillum* foliar application recorded the high values of peel fruit firmness followed by Jisemar spray with all irrigation treatments at harvest time and gradually slowed the decrease of peel fruit firmness with the advanced of storage time. The reduction in peel firmness with high rate of irrigation may be due to the increase in fruit size and its water content. On the other hand Farage,(2001), Zaghloul (2004) and Zaghloul *et al*. (2015) indicated that, application of PGPR regulates fruit ethylene production and retards the progress of peel fruit senescence which caused the slowing of rind softening rate during storage. Also, Gabr *et al*. (2012) found that, foliar application treatments with bio-stimulants had the highest fruit texture at harvest snd during storage.

D) – Vitamin C content (mg / 100 ml juice):

Regarding the data of Table (11), it was clear that, vitamin C content declined gradually with the advance in storage time. Foliar application slowed the reduction of V.C content with the increase in storage period compared with I_0 (control). The lowest irrigation levels caused the highest values of V.C till the end of storage period (I_2) followed by I_1, I_3 and I_0. Spraying with *Azospirillum* reduced clearly the loss of V.C during storage with I_1 in the first season and I_2 in the second season, the same trend was found with Jisemar with I_1 and I_2 in the second season compared with other treatments. These findings were supported by those of Zaghloul (2004) and Zaghloul *et al*. (2015) on Navel orange trees. They reported that, spraying with GA_3 or growth bio-stimulant caused a decreasing loss of V.C content during storage period.

E) – Soluble solids content SSC (%):

From data in Table (12), it was noticed that, there was a gradual decrease in SSC (%) with the progress of storage time. Fruits of low level irrigation treatments (I_1 and I_2) gave the highest values of SSC (%) and maintain these values of SSC (%) till the end of storage period during the two seasons with high significant differences. On the other hand, the highest irrigation level recorded the least values of SSC at the end of storage time with foliar application. *Azospirillum* showed the highest values of SSC at the end of storage compared to other treatments especially with I_1 in the first season and I_2 in the second season. Zaghloul,(2004) and Zaghloul *et al*., (2015) pointed out that, applied GA_3 or growth bio-stimulants on Navel orange trees left SSC % at the end of storage with little change when compared with other treatments. Gabr *et al*. (2012) mentioned that, apple fruits applied with bio-stimulants maintained its SSC (%) higher than control at the end of storage period.

Recommendations

This study recommended that, Navel orange trees should be irrigated with 0.8 EP or 1.0 EP for maximizing both (PIW) and (WP), 1.0 EP irrigation treatment recorded the better results on increasing yield and enhancing fruit storability resulting in reducing the fruit weight loss, decay, maintaining peel firmness and fruit quality parameters at the end of storage period better than 0.8 EP specially when (A) is compared with (J) application.

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الملخص العربي

تأثير جدولة الرى تحت الرش ببعض المنشطات الحيوية لأشجار البرتقال أبو سرة على بعض العلاقات المائية وإنتاجية وجودة وتخزين الثمار فى منطقة شمال دلتا النيل

على السيد زغلول، السيد أبو الفتوح مرسي

أجريت دراسة حقلية فى حقل خاص بمنطقة برمبال– مركز مطوبس– بمحافظة كفر الشيخ– مصر خلال موسمى٢٠١٤/٢٠١٥ و٢٠١٥/٢٠١٦ علي أشجار برتقال أبوسرة عمر ٢٠ عام مطعومة علي أصل النارنج ومنزرعة على أبعاد ٦*٦ متر وذلك لدراسة تأثير جدولة الرى بمعدلات(٠.٠ و٠.٨ و١.٠ و١.٢ من وعاء البخر) تحت الرش بمنشطات النمو الحيوية على بعض العلاقات المائية وإنتاجية وجودة والقدرة التخزينية لثمارالبرتقال أبو سرة . ويمكن تلخيص النتائج الرئيسية فيما يلى:

سجلت معاملة الرىI_0 (الكنترول) القيم الأعلى فى كمية الماء المضاف وكذلك كمية الماء المستهلك وكفاءة الماء المستهلك مقارنة بالقيم الأقل فى المعاملة (I_1). وكانت هذه القيم أكثر وضوحا عند الرش بالآزوسبيريللم مقارنة بالجيسيمار خلال موسمى الدراسه. وقدسجلت كلا المعاملتين I_1 و I_2 القيم الأعلى فى إنتاجية وحدة المياه المضافة PIW وكذلك إنتاجية وحدة المياه المستهلكه WP.

عند الحصاد سجلت المعاملة (I_2) أعلى القيم فى نسبة العقد والقيم الأقل فى نسبة التساقط والتشقق والتبحير مقارنة بباقى المعاملات خاصة مع الآزوسبيريللم بينما أظهرت المعاملة الأقل فى مستويات الرى (I_1) أقل المعدلات فى نسبة العقد و أعلى المعدلات فى نسبة التساقط كما أعطت معاملة المعدل الأعلى من مياه الري(I_0) أعلى نسبة لكل من التشقق وتبحير الثمار مقارنة بالنسب الأقل فى(I_2). أوضحت النتائج زيادة معنوية فى نسبة المواد الصلبة الذائبة الكلية ونسبة المواد الصلبة الكلية/الحموضة فى ثمار معاملة الري المنخفض(I_1) مقارنة بالقيم الأقل فى (I_0) وكانت الزيادة واضحة فى الرش بالجيسيمار بينما لم يكن هناك إتجاه ثابت بالنسبة للحموضة. سجلت معاملة الرى المتوسطة (I_2) القيم الأعلى فى المحتوى من فيتامين ج وصلابة قشرة الثمار مقارنة بالقيم الأقل مع(I_0) خاصة مع الآزوسبيريللم. أعطى الأزوسبيريللم النسب الأعلى من الكلوروفيل عند مستويات الرى الأعلى (I_0 وI_3) مقارنة بالقيمة الأقل مع (I_1) وفى المقابل سجلت نفس المعاملة (I_1) القيم الأعلى من الكاروتين مقارنة بالقيم الأقل فى (I_0) وكان الرش بالجيسيمار الأكثر تأثيرا فى زيادة مستوى الكاروتين.

أظهرت معاملة الري (I_2) مع الآزوسبيريللم أعلى القيم فى كل من عدد الثمار والمحصول (كجم/شجرة والطن/فدان) خلال عامى الدراسة بينما سجلت المعاملاتان (I_0 و I_3) أعلى القيم فى وزن الثمار عنه فى المعاملات الأخرى.

سجلت المعاملة(I_2) أحسن النتائج فى خفض النسبة المئوية لفقد الوزن والحد من نسبة التلف مع الإحتفاظ بالمستويات الأعلى من الصلابة حتي نهاية فترة التخزين خاصة مع الآزوسبيريللم وكانت الفروق معنوية. سجلت المعاملاتان(I_2) و(I_1) القيم الأعلى فى محتوى عصير الثمارمن المواد الصلبة الذائبة الكلية وفيتامين ج فى نهاية فترة التخزين خلال موسمى الدراسة.