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EFFECT OF PRE-HARVEST SPRAYING ON YIELD AND FRUIT QUALITY OF WASHINGTON NAVEL ORANGE FRUITS

Ezz, Thanaa M.* ; M. A. Aly*; Ekbal Z. A. Ahmed and M. H. A. Khalaf****

*** Dept. of Pomology, Fac. Agric. (Saba Basha), Alex. Univ., Egypt.**

****Post-Harvest Pomology Res. Dept., Horticultural Res. Inst., Agric. Res. Center, Giza, Egypt.**

ABSTRACT

This investigation was carried out during the two successive seasons of (2007 and 2008) to examine the effectiveness of pre-harvest spraying of vitamin C (ascorbic acid) at 6 % and 12 %, yeast at 1 g/liter and 3 g/liter, sugars at 0.20 % and 0.30 % and gibberellic acid at 100 ppm and 200 ppm as well as control treatment on yield and fruit quality of Washington Navel orange fruits.

The obtained data indicated that fruit weight, yield (number of fruits per tree and weight of fruits per tree kgm) significantly increased with increasing the concentrations of all treatments. In addition, the highest values of fruit quality resembled by increasing total soluble solids, ascorbic acid, reducing sugars, non-reducing sugars, total sugars and decreasing fruit acidity.

INTRODUCTION

It is well known that most of new reclaimed areas in Egypt are planted with fruit trees especially citrus. Citrus is considered the first economic fruit crop in Egypt. As citrus occupies the greatest acreage among all fruit species grown in Egypt, the factors controlling its growth and productivity had received considerable attention during the last few years. Nevertheless, the yield of many citrus is still unsatisfactory, despite favorable climate and other environmental factors.

Navel orange is considered one of the most popular citrus variety for both local consumption and export thus there is an economical importance for prolonging the period of marketing which may be achieved by storing fruit on tree storage (Mehana, *et al*. 1987). On the other hand keeping Navel fruits on tree after maturation reduce its marketability due to the development of certain rind disorders. Moreover, long harvest season may result in reduction in the total yield by increasing fruit drop percentage (El-Otmani, 1991). The total citrus cultivated area in ARE reached 394548 feddans producing 3134179 tons of fruits annually according to the Annual Book of Agricultural Statistics, Cairo, 2007. Oranges are considered the most important citrus crop. "Washington" Navel orange is one of the leading varieties. for local market and especially export. The total cultivated areas of its cultivar in ARE reached 138267 feddans producing 1166550 tons of fruits annually according to the Annual Book of Agricultural Statistics, Cairo, 2007. Nowadays, we are in need to offer the consumer with safety product by using natural compounds such as: ascorbic acid, active dry yeast, sugar, and gibberellic acid to improving yield and fruit quality of Washington Navel orange.

Ascorbic acid is natural and organic antioxidant having auxinic action, it provided diseases control against most fungi infections on differential fruits trees (Elad, 1992), and those compounds have synergistic effect on improving growth and productivity of fruits (Farag, 1996).

Foliar sprays with active dry yeast on fruit plants have recently received apparent interest. The various positive effects of applying active dry yeast were attributed to its contents of different nutrients, higher percentage of proteins, large amount of vitamin B and natural plant growth hormones, namely, Cytokinins. In addition, application of active dry yeast is very effective in releasing CO_2 which improved net photosynthesis (Larson *et al*., 1962; Ferguson *et al*., 1987 and Idso *et al*., 1995).

Gibberellic acid is commonly applied to citrus intended for the fresh-fruit market because such applications improve peel quality, delay rind coloration and delay the onset of senescence related to peel disorders thus extending the harvest season when applied as a preharvest spray (El-Otmani, 1991 and Fidelibus *et al*., 2002). Gibberellic acid is used by citrus growers not only to increase rind firmness externally, but also internally moreover it retains the fruit round shape and reduces fruit drop in Navel orange (Harty *et al*., 2004). Therefore, This investigation was carried out during the two successive seasons of 2007 and 2008 in order to study the effectiveness of preharvest spraying of gibberellic acid, ascorbic acid, active dry yeast and sugar treatments on yield and fruit quality of Washington Navel orange cultivar.

MATERIALS AND METHODS

This investigation was carried out during the two successive seasons of (2007 and 2008) on 25-years-old Washington Navel orange (*Citrus sinensis* L. Osbeck) trees budded on sour orange (*Citrus aurantium* L.) rootstock, to examine the effect of some pre-harvest treatments on yield, fruit quality and extending of storage life of Washington Navel orange fruits. Trees were growing in clay soil in an private orchard at Kafr El-Dawar region, EL-Behira governorate, Egypt. Trees received normal horticultural practices including: surface irrigation, fertilization, pruning, as well as pest and disease control. The trees were planted at (4.0 × 4.5) meters apart. Twenty seven uniform trees distributed in the orchard were selected for this investigation. In April of the two growing seasons, twenty shoots from all over the outer circumference of each tree were tagged in order to secure leaf samples of the same age. Fruit samples were collected at two weeks intervals from each of the selected trees during August, 15 to August, 31 in both seasons.

This experiment was laid-out in completely randomized design (CRD) with three replications. Each treatment was represented in three trees.

The following treatments were carried out:

1-Control (sprayed with water only).
2- Vitamin C (Ascorbic acid) at 6 %.
3- Vitamin C (Ascorbic acid) at 12 %.
4- Yeast at 1 g/liter.
5- Yeast at 3 g/liter.

6- Sugars at 0.20 %.
7- Sugars at 0.30 %.
8- Gibberellic acid at 100 ppm.
9- Gibberellic acid at 200 ppm.

Three foliar spraying were carried out to trees from each treatment as follows:

The first application was just after 35 and 40 days from full bloom for Washington Navel orange trees. The second application was after three weeks from the first one, and the third application was after three weeks from the second. At harvest on maturity stage (late November), under the experimental conditions, **the following determinations were carried out:**

1. Average fruit weight: The average fruit weight determined as (gm/fruit).

2. Yield: The yield was determined as (Kg/tree).

3. Fruit quality:

3.1. Total soluble solids percentage:

A hand refractometer was used to determine the total soluble solids percentage in fruit juice.

3.2. Vitamin C (Ascorbic Acid**)**:

Vitamin(C) content was determined in fruit juice using 2, 6-dichlorophenol-indo-phenol blue dye as mg ascorbic acid per 100 ml Juice. (A.O.A.C., 1980).

3.3. Acidity percentage:

Fruit juice acidity was determined according to (A.O.A.C., 1980) by titration with 0.1 N sodium hydroxide using phenolphthalein as an indicator and expressed as citric acid percentage.

3.4. TSS/Acid ratio.

3.5. Sugars determination:

For sugars determination, the flesh of each fruit sample was cut into small pieces by a clean knife and mixed well. Five grams of the cut flesh were taken and extracted by distilled water according to (A.O.A.C., 1980). The total sugars were determined colorimetically using phenol and sulphuric acid according to (Malik and Singh, 1980). The reducing sugars were determined by the Nelson arsenate-molybdate colorimetric method (Dubois *et al*., 1956). The non-reducing sugars were calculated by the difference between total sugars and reducing sugars.

Statistical analysis:

Data of the present study were subjected to the analysis of variance test (ANOVA) as completely randomized design (CRD). The least significant differences (LSD) at the 5 % level of probability were calculated using a computer program costat and (Duncans, 1955)**.**

RESULTS AND DISCUSSION

1. Yield:

Data in Table 1 showed that all spraying treatment significantly increased yield as number of fruits per tree and weight per kilograms per tree compared with control in both seasons of study. Moreover, in two seasons of

this study, the statistically analysis showed that the treatments of gibberellic acid at (100 ppm, 200 ppm), vitamin C at (6%, 12%) and sugar at (0.20%, 0.30) were more effective on yield than that yeast at (1g per liter, 3 g per liter). These results are in agreement with those obtained by Abd El- Megeed (2002) spraying gibberellic acid on Washington Navel orange trees and reported that gibberellic acid treatments are more effective in improving yield. Moreover, Moor (1979) found that yeast contains tryptophan, which consider precursor of IAA, so it has a promotive effect on fruit size. Subba Rao (1984) reported that the possibility of using the active dry yeast for improving growth and productivity of fruit. However, the various positive effects of applying active dry yeast as newly used biofertilizer were attributed to its own content from different nutrients, high percentage of proteins, large amount of vitamin B and the natural plant growth hormone namely cytokinins (Abd-Elmotty *et al*., 2005). Ascorbic acid is natural and organic antioxidants having auxinic action, they provided diseases control against most fungi infections on differential fruit trees (Elad, 1992), and those compounds have synergistic effect on improving growth and productivity of fruits (Farag 1996).

2. Effect of pre-harvest spraying treatments on physical parameters of Washington Navel orange fruit.

2.1. Fruit weight (gm):

Data of the presented in Table 1 showed the effect of pre-harvest spraying treatments on fruit weight of Washington Navel orange trees, in 2007 and 2008 seasons. In both seasons of study, results showed that, all treatments significantly increased fruit weight compared with control. In addition, statistically analysis showed that the treatments of gibberellic acid at (100 ppm, 200 ppm), vitamin C at (6%, 12%) and sugar at (0.20%, 0.30%) were more effective on yield than that yeast at (1g per liter, 3 g per liter).

Table (1): Effect of pre-harvest spraying treatments on fruit weight (gm) and yield as (No. of fruits per tree and Kilograms per tree) of Washington Navel orange trees in 2007 and 2008 seasons.

Treatments	Fruit weight (gm)		No. of fruits per tree		Yield (kg)	
	2007	2008	2007	2008	2007	2008
Control	205.00	211.80	295	293	60.47	62.82
Vitamin C at 6 %	213.00	218.66	301	297	64.11	64.67
Vitamin C at 12 %	216.00	220.30	315	315	68..04	69.30
Yeast at 1 g/liter	204.39	212.00	296	293	60.38	62.11
Yeast at 3 g/liter	210.00	216.55	296	298	62.16	64.53
Sugar at 0.20 %	219.00	215.55	320	321	70.08	69.01
Sugar at 0.30 %	220.00	218.00	322	324	70.84	70.63
GA_3 at 100 ppm	221.40	221.00	324	323	71.73	71.38
GA_3 at 200 ppm	221.50	235.00	325	332	71.99	72.02
L.S.D. 0.05	6.90	4.73	4.57	6.45	2.31	2.03

The positive effect of study pre-harvest treatment on fruit weight may be due to their role of them in the physiology of fruit trees. These results are in agreement with those reported by Atawia and El- Desouky (1997) sprayed Washington Navel orange with gibberellic acid at (25-50) ppm plus yeast at 100 ml/l at full plum and they reported that yeast followed by GA_3 significantly

increased fruit weight. Abou-Rawash *et al*. (1998) sprayed "Taimour" mango trees with ascorbic acid at 2110 ppm and indicated that fruit weight is improved by the treatment as well as spraying Washington Navel orange trees after fruit set with yeast extract significantly increased fruit weight (Khafagy *et al*. 2010).

3. Effect of pre-harvest spraying treatments on chemical parameters of Washington Navel orange fruits.

3.1. Total soluble solids:

Data in Table 2 showed that, in both seasons, all treatments caused a significant increase in total soluble solids percentages compared with the control. Moreover, gibberellic acid treatments in two seasons of this study are more effective on total soluble solids content compared with other treatments, except for yeast at 1 g per liter in 2007 season. In agreement with these results, are those previously reported by Ting and Attaway (1971) found that in Hamlin and Pineapple oranges and Dancy tangering, the increase of total sugars upon ripening was due mostly to sucrose. Moreover, Abd El-Migeed (2002), Mostafa *et al*. (2005) and El-Sherbini *et al.* (2008) working on different varieties of oranges, found that spraying GA_3 increased total soluble solids content. In accordance with those results, are those previously found by Elham *et a*l. (2010) working on Keitte mango trees and Khafagy *et al*. (2010) on Washington Navel orange trees, they found that spraying trees with yeast increased total soluble solids.

3.2. Vitamin C:

Data in Table 2 declared that as an average for all used treatments, the initial of ascorbic acid increased in both seasons compared with control. Statistical analysis presented that all treatments caused a significant increase, except of the gibberellic acid at 100 ppm in the first season. Moreover, in the two seasons of study, vitamin C treatments at (6 %, 12 %) and sugar at (0.20 %, 0.30 %) are more effective than that other treatments on increasing ascorbic acid (mg per 100 ml juice). These results are in agreement with those obtained by Hegab (2000) treated Balady mandarin trees with ascorbic acid (100, 200 and 400 ppm) four times; on middle of January, at starting of bloom, just after fruit setting and at one month after. Results showed that all treatment improved ascorbic acid content. As well as, Barakat *et al.* (2007) worked on Washington Navel orange and El-Shobaky and El-Helaly (2007) worked on Valencia orange trees. They found that gibberellic acid spray treatment increased fruit vitamin C content.

3.3. Acidity:

Data in Table 2 indicated that, in both seasons, all treatments significantly decreased fruit juice acidity compared with control. The statistically analysis, showed that vitamin C treatments at (6 % and 12 %) are more effective on decreasing acidity percentages than that other treatments. These results agreed with those obtained by Barakat *et al*. (1997), they found that treated fruit with vitamin C. at 100 ppm decreased fruit acidity. As well as Mostafa and El-Hosseiny (2001) worked on Washington Naval orange trees, they found that active dry yeast at concentrations of 0.1, 0.2, 0.3 % deceased fruit acidity. El-Sherbini *et al*. (2008) reported that spraying of gibberellic at full bloom (100, 1000, 4000

ppm). They found that the treatments reduced fruit acid content of Balady mandarin.

Table (2): Effectiveness of some natural pre-harvest spraying treatments on total soluble solids, acidity, TSS/AC ratio, vitamin C, reducing sugars, non-reducing sugars and total sugars content of Washington Navel orange fruits in 2007 and 2008 seasons.

Treatments	TSS		Acidity		TSS/AC ratio		Vitamin C		Reducing Sugars		Non-reducing Sugars		Total Sugars	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Control	8.00	8.14	2.22	2.27	5.17	5.91	55.0	53.5	3.80	3.90	3.30	3.30	7.10	7.20
Vitamin C at 6 %	8.70	9.00	1.40	1.48	6.88	6.80	63.3	63.0	4.80	4.90	4.40	4.20	9.20	9.10
Vitamin C at 12 %	9.18	9.80	1.52	1.50	6.99	6.90	64.0	63.3	4.80	4.90	4.60	4.30	9.40	9.20
Yeast at 1 g/liter	9.60	9.70	1.71	1.80	5.80	5.93	62.0	61.0	4.50	4.60	4.30	4.10	8.80	8.70
Yeast at 3 g/liter	9.10	9.25	1.85	1.89	6.68	6.73	63.5	62.0	4.80	4.80	4.20	4.30	9.00	9.10
Sugar at 0.20 %	9.50	9.75	1.90	1.93	7.11	7.01	63.0	62.5	4.90	5.00	4.70	4.80	9.60	9.80
Sugar at 0.30 %	9.30	9.60	1.95	2.00	7.22	7.23	63.8	63.0	5.00	5.10	4.80	5.10	9.80	10.20
GA_3 at 100 ppm	9.49	9.60	2.01	2.10	7.01	7.12	59.0	59.0	4.00	4.20	3.60	3.60	7.60	7.80
GA_3 at 200 ppm	9.55	9.61	2.11	2.20	7.24	7.35	58.0	60.0	4.30	4.30	3.80	3.90	8.10	8.20
Mean	9.15	9.38	1.85	1.90	6.71	6.77	60.4	60.82	1.54	4.63	4.20	4.15	8.73	8.81
L.S.D. 0.05	1.09	1.17	0.19	0.16	0.30	0.24	7.01	4.47	0.37	0.45	0.54	0.32	0.53	0.55

3.4. TSS / Acid Ratio:

Data in Table 2 showed that in the two seasons of study 2007 and 2008, all treatments caused a significantly increase in TSS/Acid ratio comparing with control. Moreover, in the two seasons of study, the statistically analysis showed that the two higher concentrations of sugar at 0.30 % and Gibberellic acid at 200 ppm were more effective on TSS/Acid ratio than other treatments. These results are on the contrary with those reported by El-Otmani and Coggins (1991) reported that spraying gibberellic acid at 10 ppm on Washington Navel orange trees had no effect on the TSS/TA ratio. These results are in agreement with those obtained by Rapisarda *et al*. (2001) worked on orange fruits of two blood varieties (Tarocco and Moro). They found that a higher maturity index (TSS/TA) for the two cultivars.

3.5. Reducing sugars

Data in Table 2 showed that all spray treatments caused a significant increase in reducing sugars compared with control in the two season of study. In the first year of study, the statistically analysis showed that the two highest concentration vitamin C at 12 % and the two higher concentrations of sugar at (0.20 %, 0.30 %) were more effective than other treatments.

Moreover, all concentrations in all treatments were more effective in increasing reducing sugars percentage, except for yeast at 1 g per liter and gibberellic acid at 100 ppm in the second year of this study. The increase in reducing sugars may be attributed to accumulation of sugars as a result of the metabolism of polysaccharaides. These results agreement with El-Shobaky and El-Helaly (2007) worked on Valencia orange trees. They found gibberellic acid spray treatments increased reducing sugars. As well as **El-**Shobaky *et al*. (2010) worked on Keitte mango trees. They found that spraying Keitte mango trees once at full bloom with algae at 2 % combined with yeast at 0.2 % was very effective in improving reducing sugars.

3.6. Non-reducing sugars

Data in Table 2 showed that all spray treatments caused a significant increase in non-reducing sugars compared with control in the two season of study. Statistically analysis, in the two seasons of study, showed that the two concentrations of sugars at (0.20 % and 0.30 %) were more effective than other treatments in non-reducing sugar percentages. These results are in agreement with El-Shobaky and El-Helaly (2007) and Basharat *et al*. (2008) working on different verities of orange. They reported that GA_3 spray treatments increased non-reducing sugars content.

3.7. Total sugars

Data in Table 2 showed that, in both seasons, all treatments caused a significant increase in total sugars content compared with control. In the two season of study, statistically analysis showed that the two concentrations of sugars at (0.20 % and 0.30 %) were more effective than other treatments in total sugar treatments percentages. These results may be due to the accumulation and translocation of carbohydrates in fruits. These results are in agreement with El-Shobaky and El-Helaly (2007) and Basharat *et al*. (2008) working on different verities of orange. They reported that GA_3 spraying treatments increased total sugars content. As well as El-Shobaky *et al*. (2010) worked on Keitte mango trees. They found that spraying Keitte mango trees once at full bloom with algae at 2 % combined with yeast at 0.2 % was very effective in improving total sugars.

Summary

This investigation was carried out during the two successive seasons of (2007 and 2008) to study the effect of pre-harvest spraying of some treatments on yield, fruit quality and storability of Washington Navel orange fruits by using foliar spraying such as control (sprayed with water only), vitamin C (Ascorbic acid) at 6 %, vitamin C (Ascorbic acid) at 12 %, yeast at 1 g**/**liter, yeast at 3 g**/**liter, sugars at 0.20 %, sugars at 0.30 %, gibberellic acid at 100 ppm, gibberellic acid at 200 ppm. Three foliar spraying were carried out to trees from each treatment as follows: The first application was just after 35 and 40 days from full bloom for Washington Navel orange trees. The second application was after three weeks from the first one, and the third application was after three weeks from the second. At harvest on maturity stage (late November), under the experimental conditions, the data presented that all treatments increased the yield and fruit weight in both seasons more than control. In addition, vitamin C (at 6 % , 12 %), sugar (at 0.20 % , 0.30 %)

and Gibberellic acid at (100 ppm , 200 ppm) were more effective than that yeast at (1 g per liter , 3 g per liter) on yield and fruit weight.

All treatments increased TSS, non-reducing sugars, total sugars and vitamin C in both seasons more than control, where, sugar treatments at (0.20 % , 0.30 %) and vitamin C at 12 % were more effective than other treatments. In contrast, all treatments decreased fruit juice acidity and reducing sugars compared with control. Moreover, vitamin C treatments (at 6 % and 12 %) are more effective on decreasing acidity and reducing sugars than those other treatments.

All treatments generally increased TSS/Acid ratio compared with control. In addition, the two higher concentrations of sugar at 0.30 % and Gibberellic acid at 200 ppm were more effective on TSS**/**Acid ratio than other treatments.

Conclusion

- Foliar spray of vitamin C, yeast, sugar and gibberellic acid to Washington Navel orange trees three time after full bloom, increased the yield and improved fruit quality.
- Results declared that the higher concentrations of treatments are more effective than the low concentration on yield, fruit quality and storability of Washington Navel orange fruits.
- Foliar spray of vitamin C and sugars are more effective than Gibberellic acid and yeast in the same concentration.

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دراسة تأثير الرش ببعض المواد قبل الجمع علي المحصول والجودة والقدرة التخزينية لثمار البرتقال أبو سرة

سناء مصطفى عز*، محمود احمد علي*، أقبال زكريا على احمد ** و محمد حسن عبد الحميد خلف**

*** قسم الفاكهة – كلية الزراعة (سابا باشا) – جامعة الإسكندرية**

****قسم بحوث تداول الفاكهة – معهد بحوث البساتين – مركز البحوث الزراعية**

أجريت هذه الدراسة خلال موسمين متتالين (2007 /2008) بهدف دراسة تأثير الرش ببعض المركبات قبل الجمع على المحصول والجودة والقدرة التخزينية لثمار البرتقال أبوسرة وذلك باستخدام الرش الورقى لبعض المعاملات مثل: معاملة الكنترول (المقارنة) بالماء المقطر - فيتامين (ج) بتركيز 6 ٪ - فيتامين (ج) بتركيز 12 ٪ - الخميرة بتركيز 1 جرام/ لتر - الخميرة بتركيز 3 جرام/ لتر - السكر بتركيز 0.20٪ - السكر بتركيز 0.30 ٪ - حمض الجبريلليك بتركيز 100 جزء فى المليون - حمض الجبريلليك بتركيز 200 جزء فى المليون. ولقد تم الرش ثلاثة مرات كما يلى: الرشة الأولى بعد اكتمال مرحلة عقد الثمار لأشجار البرتقال أبو سرة بحوالى (35-40) يوم. الرشة الثانية بعد ثلاثة أسابيع من الرشة الأولى ثم الرشة الثالثة بعد ثلاثة أسابيع من الرشة الثانية. عند وصول الثمار إلى مرحلة اكتمال النضج تم تقدير المحصول.

لقد أظهرت نتائج هذا البحث أن أدت جميع المعاملات أدت إلى زيادة المحصول ووزن الثمار فى موسمى الدراسة أكثر من معاملة المقارنة هذا بالاضافة الى ان معاملات فيتامين (ج) بتركيز (6 ٪- 12 ٪)، السكر بتركيز (0.20 ٪ - 0.30 ٪) وحمض الجبريلليك بتركيز (100 جزء فى المليون – 200 جزء فى المليون) كانت اكثر تأثيرا فى زيادة المحصول من معاملة الخميرة بتركيز (1 جرام/لتر – 3 جرام/لتر).

بالأضافة إلي ما سبق أتضح أن جميع المعاملات قد أدت إلى تحسين المواد الصلبة الذائبة الكلية والسكريات الغير مختزلة والسكريات الكلية وفيتامين (ج) مقارنة بمعاملة المقارنة وكانت اكثر المعاملات تأثيرا هى معاملات فيتامين (ج) بتركيز (6 ٪- 12 ٪)، السكر بتركيز (0.20 ٪ - 0.30 ٪) بالنسبة لباقى المعاملات. فى حين ادت جميع المعاملات الى خفض نسبة الحموضة والسكريات المختزلة في عصير الثمار عن معاملة المقارنة وكانت أكثر المعاملات تأثيرا فى ذلك هى فيتامين (ج) عند التركيزان(6 ٪- 12 ٪).

كذلك تبين ان هذه المعاملات أدت إلى زيادة نسبة المواد الصلبة الذائبة الكلية إلى الحموضة عن معاملة المقارنة. هذا بالأضافة إلى التركيزات العالية من السكر عند تركيز 0.30 ٪ وحمض الجبريلليك عند تركيز 200 جزء فى المليون كانت أكثر تركيزا من باقى المعاملات فى زيادة نسبة المواد الصلبة الذائبة الى الحموضة.

طبقا لهذه النتائج يتضح الأتى:

- رش أشجار البرتقال أبوسرة بفيتامين (ج)، الخميرة ، السكر وحمض الجبريلليك ثلاثة مرات بعد مرحلة اكتمال عقد الثمار يؤدى إلى زيادة المحصول وتحسين جودة الثمار.
- أوضحت النتائج أن التركيزات العالية من المعاملات المستخدمة أعطت تأثير إيجابي أكثر من التركيزات المنخفضة على المحصول وجودة الثمار.

رش أشجار البرتقال أبوسرة بفيتامين (ج) والسكر يعطى نتائج أفضل من الرش بحمض الجبريلليك والخميرة عند نفس التركيزات لكليهما.

قام بتحكيم البحث

أ.د / نبيل رشاد ابو سمره — كلية الزراعة – جامعة المنصورة

أ.د / بهيه عبد العزيز فهمى — مركز البحوث الزراعية